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C/o Faculty of Sciences,
National Open University of Nigeria
University Village, Plot 91, Jabi Cadastral Zone, Nnamdi Azikiwe Expressway, Jabi, Abuja, FCT
E-mail: njpls@noun.edu.ng
Website: www.njpls.nou.edu.ng

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General Information

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EDITORIAL

Designing strategies to cultivate research culture requires tact. Adopting a project action plan matrix would help a business-like approach that would enable higher education institutions to be better managers. The special Feature is a compendium to guide strategy development and project management in higher education institution.

It is our hope that this issue would be a great reference resource material.

Professor Monioluwa O. Olaniyi

Editor-in-Chief

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STRATEGIES FOR ESTABLISHING RESEARCH CULTURE AT THE NATIONAL OPEN STRATEGIES FOR ESTABLISHING RESEARCH CULTURE AT THE NATIONAL OPEN UNIVERSITY OF NIGERIA: A PROJECT ACTION PLAN APPROACH AND CASE STUDY OF THE FACULTY OF SCIENCE

Monioluwa Omolara Olaniyi
Department of Pure and Applied Sciences
Faculty of Science
National Open University of Nigeria

A project action plan approach is useful in designing strategies to achieve goals in a business-like manner in a university system. Many academics approach activities as normal, more so if they are supposed regular activities. However, the attainment of success in any deal requires deliberate effort and well-thought strategies. In this era of high competition and dwindling funds for education, higher education institutions need to be innovative and deliberate in consciously determining strategies to attain set goals. Hence the project management approach is innovative and would be highly beneficial to the development of strategies that would help to cultivate a culture in a higher education institution.

The first step in the adoption of a project action plan is to undertake an environmental scan, whereby you will identify the strength, weaknesses, opportunities, and threats; commonly referred to as the SWOT analysis; but as well undertake a gap analysis in which you will identify your current situation and level of operation, determine the height you desire to attain (Creately, 2016). Determining the gap is helpful to guide the decision on how, when, and what you require to attain the desired height. Consequently, gap analysis and SWOT analysis are complementary.

This is particularly of significance where service provision determines your success as with the higher education institution. Also, when a culture is not in place, it becomes necessary to put strategies in place to get you to where you desire to be. Otherwise, without a deliberate effort, it may be difficult to achieve your purpose of development. It is paramount for managers of higher education institutions to be aware of this and to understand the relevance of a project management approach to institutional development. Consequently, this paper presents a project action plan matrix designed for the establishment and encouragement of a culture of applied research and strengthening the teaching of practical science at the Faculty of Sciences of the National Open University of Nigeria as a referral for the development of a project action plan for the establishment of a sustainable research culture at the National Open University of Nigeria.

The presented matrix would serve as a good guide in the development of project action plans for most projects in higher education institutions. Using a project action plan (PAP) matrix is particularly rewarding because it helps you detail your actions considering your peculiar environment. It will also guide your activities and provide a basis for monitoring and evaluation. Using Please note that the results of this project action plan have been published in Olaniyi (2019). However, this paper details the PAP matrix in hope that it would form a good reference document for many who desire change in their institution and as well be change agents.

Environmental Scan

Gap and SWOT analysis are useful procedures to help an organization increase visibility, better support strategy, and reach institutional goals. If you understand your institution's strengths and weaknesses, and gaps in attaining desired goals, you can better focus to attain the heights. While the SWOT analysis helps to assess the institution's strengths, weaknesses, opportunities, and threats, the gap analysis compares the actual level of performance of an institution to the desired level. Carrying out both techniques successively scans the internal and external environment of your institution and can ensure that the institution is better positioned for quality service delivery and student success. This will also help the university Management to identify the people, processes, and technologies that align with strategic goals and facilitate better communication and decision-making.

The environmental scan enables you to determine:

1. The strength of the university and each Faculty

2. What could be considered as a weakness of the university and the Faculty in attaining desired goals

3. Opportunities that could be explored in achieving your set goals and

4. Likely threats to your plan so you are informed ahead of time and have an alternate plan that would effectively weaken the strength of the perceived threat to achieving your goal.

For instance, expertise in each discipline may be part of your strength; opportunities to explore may be international linkages, alumni base, endowments, external research grants and funding especially those with a special focus on prevailing challenges in Africa, IDPs, climate change, digital education, etc. Facilities available for research could also be part of your strength/opportunities; available markets to recruit PG students (especially the large alumni base of the university) could be an important strength. The flexibility of the ODL systems, which makes the National Open University of Nigeria (NOUN) the first choice among many working-class citizens, could also be considered a strength.

The National Open University of Nigeria and Status of Research Work

Undertake an environmental scan of the extent and level of research ongoing by identifying the gap as well as the strength, weaknesses, opportunities within the institution and threats external to it that would affect the effectiveness of undertaking the level and category of research so desired. This would help to determine required tools, facilities and resources that must be provided to get to the goal that would be set.

Cultivating Research Culture at the National Open University of Nigeria

It would be more effective to have a University Research Committee in place to monitor the activities of the proposed structured plan to ensure adherence! In attempting to establish a research culture at the National Open University of Nigeria, it is necessary to first do an environmental scan with gap analysis and an analysis of the strength, weaknesses, opportunities of the system/institution, and threats (SWOT) that are external to the institution such as competition.

Each Faculty should prepare:

SWOT and Gap Analyses Hence, the Heads of Departments and Deans may need to be trained to guide them to undertake an environmental scan of their various departments and faculties!

Faculties should submit their SWOT and Gap analyses to the University Research Committee who reviews and comes up with harmonized analyses for the university.

Key tasks: Each group of activities to address a set goal should be determined and the tasks to achieve this goal are also specified. Then define a milestone that would ensure that the key task has been accomplished. It will be useful to encourage Departments to prepare a Project Action Plan (PAP) matrix

Milestones: as determinants of success are major progress points that must be reached to establish that you have attained success.

Action Plan: Each Dean should submit a Project Action Plan (PAP) to be critiqued. The reviewed PAP would be returned to Faculties and deadlines should be given for submission of updated

workable PAP. Timeline for the execution of PAP should be set and monitoring and evaluation plans should also be put in place.

Some Suggested Activities to help cultivate the culture of research at the University

1. **Institute Faculty Seminar Series:**

- Set up a Faculty Seminar Committee
- Only papers presented and approved at Faculty Seminar should be sponsored for conference attendance Organize workshop training in winning grant proposal writing.
- Consciously organize research teams and encourage multi and interdisciplinary team building
- Senate Research Committee should develop guidelines for assessing Senate Research grants and should fund good research proposals, hence teams to be encouraged and mentored to produce fundable research proposals:

- Departments could institute weekly Seminar series to discuss current publications that present advances in research in their respective disciplines. This will help direct the thoughts of academics in fields of research and form research focus and interest. In this case, the Department can produce a roster for presentation by academics in the Department.
- Faculty could also form inter and multidisciplinary research groups (with membership across the various Departments) that would have seminars bi-weekly. They could also stimulate academic discuss by reviewing published work in their areas of interest.
- Faculties should institute monthly Seminar series where such groups or individuals can enlighten the Faculty on current advances in fields of research for development or present a research proposal for discussion.
- Monthly reports of Seminars within the Faculty (both at the Faculty level and across the Departments) should be submitted to the University Research Committee through the Dean.
- An annual Proceedings of Faculty Seminars should be produced to encourage participation.
- A reward system can be instituted to recognize scholarship by academics.
- This could be done by giving an award to the best researcher of the year for instance with several factors taken into consideration including but not limited to: publication in high-impact journals and total no. published annually by academics in Faculties should be submitted with copies of the publications, to the committee for consideration of an award.
- Conference paper presentation & quality of paper should be evaluated annually and an award given. o Research grant acquired will also be evaluated including monetary value and number.
- Best researcher of the year award would be determined using several of these parameters.
- This could be done by giving award to the best researcher of the year for instance with several factors taken into consideration including but not limited to: publication in high impact journals and total no. published annually by academics in Faculties should be submitted with copies of the publications, to the committee for consideration of an award.
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- Research grant acquired will also be evaluated including monetary value and number.
- Best researcher of the year award could be determined using several of these parameters.

2. **Conference attendance:**

- Any paper to be presented in a conference must first have been presented at departmental/Faculty level and recommendation made before author could receive approval to present in the conference.
- To receive conference support, the author must have presented at the faculty level and the application submitted with minutes of the faculty seminar where it was presented.

- An academic applying for financial support or time away for a conference should route the application through due process, with a recommendation from the Chairman, Faculty Research and Seminar Committee, and the Dean of the Faculty.

3. Repository of research publications: should be developed by the university and academics should deposit their publications into it. Encourage academics to cite their peers in the Department, Faculty, and the University at large. This will increase the relevance of the work done by each; making these works readily accessible is important. Map a strategic research plan for the university and have it published with each Faculty's defined activities as presented by the Dean. This is to help guide activities and ensure focused action.

4. Postgraduate enrolment:
Develop competitive postgraduate curricula that would increase student enrolment for postgraduate studies. As focused postgraduate students' research increases with increased supervision by our academic staff, research activities in the university would be strengthened.

5. Funding of research and publication of research results in Q-rated journals with improved visibility:

The university should invest in funding quality research and institute research grants such as Senate Research Grant award, which should be guided by rules that would ensure that quality data are collected from well-thought research proposals and published in Q-rated journals. Also ensure that the projects are relevant and can be cited by many others in the university, that is they should engage in applied research that would be of direct benefit to the university.

Publishing in Q-rated journals and citing your publications would improve the university's visibility and build up the university's reputation as well as the academics'. Consequently, academics should be encouraged to share their publications with their peers in the university and encourage them to cite one another in subsequent publications. This means follow-up research should be encouraged so that problems are identified and resolved through research and application; hence, research for development is embraced.

6. Execution, Monitoring, and Evaluation

- A workshop should be organized for all Deans (SPGS and Faculties) and University Research Committee members where each Dean would present his/her Project Action Plan (PAP), defend it, and receive approval before proceeding to execute.
- All Deans submit a regular report as execution commences. Research Committee should determine the regularity of the report and communicate appropriately. The report should specify why the target was not met and what is to be done to ensure that target is met.
- At execution, a Representative of the Ethics / Research Committee must be invited to the different activities (including Seminars, workshops, etc)
- At the end of a defined period, all Deans present their report in a workshop, and the level of execution would be evaluated.
- At this stage, an annual research report will be demanded, which the university would compile into its annual compendium.

Recommendations:

The success of any project depends largely on the buy-in of stakeholders, therefore, ensure that all stakeholders are properly sensitized to be sure of their support for the project. You must also identify what could be the threat to your project or factors that could compete with your set goals. This would help you plan to circumvent such and ensure your project's success. You must clearly define your objectives and project outcomes, which would be your guiding tools. The major features of the PAP are the key tasks and milestones, which must be clearly defined as they are instruments to determine the management and level of success of the project.

Please see below a Project-Action-Plan matrix, a strategic plan for the strengthening of teaching of practical science in Open and Distance Learning and establishing a sustainable culture of applied research at the Faculty of Sciences of the National

Open University of Nigeria. This strategic plan was developed and implemented, and the results are presented in Olaniyi (2019). Hence, the PAP presented here is a good reference material for strategy development and it would be useful to use the matrix together with the published result in Olaniyi (2019) so that the strategies that worked could be strengthened while those that failed could be further investigated to determine the cause; whether it was due to intrinsic factors or external factors, which could be corrected or better handled.

Project Action Plan (PAP) for Strengthening the Teaching of Practical Science in Open and Distance Learning and Establishing a Sustainable Culture of Applied Research at the Faculty of Sciences of the National Open University of Nigeria.

General objective of the Project Action Plan (PAP):

1. To ensure students are adequately exposed to science practical training in the open and distance learning (ODL) system,
2. To stimulate interest in applied research and allow academics to earn from their products,
3. To encourage research collaboration across global divide
4. To strengthen skills of academics in preparing learner-friendly learning materials
5. To enhance the visibility of the national Open University of Nigeria in capacity building and national development

Intended outcome/product of my PAP:

1. Memoranda of understanding between National Open University of Nigeria and selected (36) universities in Nigeria for laboratory practical
2. Multimedia materials (CD, online video, etc.) for science practical demonstration and teaching would be developed
3. MoU with universities in the global north (especially ODL institutions) for access to Virtual laboratory facilities as well as other learning and research facilities
4. Interactive practical course materials would be developed and collaboration with other ODL institutions on course material development established
5. Products of science research would be available for showcasing at different forum
6. Increase in number of publications in high impact factor journals
7. Increase in number of faculty presenting their research results in local and international conferences, hence
8. Patents would be registered and subsequently, increase in number over time
9. Research and Development Roadmap 2018-2023 would be available for the Faculty
10. Philanthropists and industries support faculty research drive
11. Increased mobility of academic staff in the faculty and internationalization
12. Increased number of grant-winning proposals and development-focused applied research
13. Better visibility and enhanced advocacy for NOUN

Potential risks for my PAP I should be aware of:

1. University Management's position
2. Possible conflict of interest with some other units in the university responsible for academic planning and research coordination
3. Limited funds for research
4. Limited time for research due to the heavy academic and administrative workload of academic staff
5. Poor motivation of academics for high-impact, ground-breaking research due to poor research infrastructure
6. Delay in processes due to bureaucratic bottlenecks

The Project Action Plan Matrix for Strengthening the Teaching of Practical Science in Open and Distance Learning and Establishing a Sustainable Culture of Applied Research at the Faculty of Sciences of the National Open University of Nigeria.

Key task A: Build awareness / passion for teaching of practical science and applied research among stakeholders	**My role?**	**When?**	**Who?**	**Who else?**	**Resources, materials, support**	**How to measure?**
Task 1 Brief the Vice-Chancellor (VC) about Part I of DIES training workshop in Germany and my PAP	Present PAP proposal and plan to VC	4/7/2017	Dean	Vice-Chancellor	Media and publicity personnel	1. Photographs of meeting 2. DVD of Video recording of meeting 3. Minutes of meeting
Task 2 Review PAP in line with discussion in Task 1 above	Update PAP	5/7/2017	Dean	None	Secretarial facilities	1. Reviewed proposal that incorporated VC's suggestions 2. Presentation slides reviewed as in 1. Above
Task 3 Meeting with would be collaborators on proposed collaborative research in line with plan earlier supported by Faculty Board in April, 2017 and approved by University Management	Led team of 3 from NOUN	6-7/9/2017	Dean	OUUK STEM Faculty Collaborators NOUN Team members	Travel grant Funds for organizing meeting, meals and Refreshments	1. E-mail communication trail 2. Invitation letters 3. Minutes of Faculty Board's deliberation and decision on collaboration proposal 4. Slides of presentations at collaborative workshop 5. Report of meeting 6. Identified collaboration interests Roles assigned among workshop participants 7. Agreed workplan 8. Resultant request for partnership with another team (UNISA-OUUK)
Task 4 Discuss outcome of collaborative	Present collaborative	11/7/2017	Dean	Vice-Chancellor	Secretarial facilities	1. Report submitted

workshops with Vice-Chancellor and identified areas of collaboration in training and research	research proposal					
Task 5 Interact with HODs and staff on training cadre on proposal for PhD training possibilities arising from collaborative workshop	Present reviewed plan	11/7/2017	Dean	HoDs Assistant Lecturers & other academic staff without PhD	Administrative staff Secretarial facilities	1. Record of meeting 2. Written briefs 3. Roles assigned 4. Committees formed 5. Staff enrolled for PhD
Task 6 Present outcome of collaborative workshop and plan to strengthen teaching of practical science and research with Faculty Board during statutory Board meeting	Chair meeting and direct activities	20/7/2017	Dean	Faculty Board	Refreshment	1. Minutes of meeting 2. Consent of Board
Milestone A: **Stakeholders are sensitized on plan for enhanced teaching of practical science in open and distance education and the need to develop a culture of applied research at the Faculty of Sciences of the National Open University of Nigeria**						

Key task B: **Explore opportunities for partnership with developed institutions in the delivery of practical science in ODL**	**My role?**	**When?**	**Who?**	**Who else?**	**Resources, materials, support**	**How to measure?**
Task 1 Link-up ODL institutions in global north to learn delivery of practical science	Internet search	2/2017	Dean	Identified ODL institutions	1. Computer 2. Internet connectivity 3. Time	Online subscription Admission letter for webinar
Task 2 Receive invitation for partnership	Facilitate	/3/2017	Dean	Partners in STEM Faculty of OU, UK	1. Computer 2. Internet connectivity	1. E-mail communicatio n and invitation for collaborative workshop
Task 3 Present Proposal to Vice-Chancellor for approval	Facilitate	22/3/2017	Dean	Vice-Chancellor	Secretarial facilities	2. NOUN Management' s approval letter
Task 4 Present proposal to Faculty Board for deliberation and suggestions on partnership terms	Direct meeting	20/4/2017	Dean	Faculty Board	Refreshment Secretarial facilities	1. Minutes of meeting 2. Extracts of decision reflecting suggestions made by Board
Task 5	Invitee	28/6/2017	Coordinator, OU Alliance	Dean	Internet access	1. E-mail invitation /

Invitation for additional presentation on research networking experience with global north countries at an OU Alliance GCFR conference at OU,UK			GCFR Conference			communicatio n trail 2. Programme of activities
Task 6 Interaction with Vice-Chancellor for brief on discussions at OU and goodwill message from the VC	Anchor	3/7/2017	Dean	Vice-Chancellor	Cameras, Video recording, personnel of media and publicity unit	1. Still photos 2. Recorded goodwill message of the Vice-Chancellor for the OUUK
Task 7 Faculty Seminar on presentations of overview of the FOS, NOUN for the collaborative workshop	Facilitate	4/7/2017	Dean	NOUN's two team members Faculty Board	Faculty Board, Multimedia projector	1. Power point presentation slides for the three team members 2. Likely interactive methods of teaching practical science identified by Faculty Board discussed
Task 8 NOUN team visits OU for collaborative workshop	Lead NOUN team	6-7/7/2017	Dean	NOUN Team members; STEM Faculty partners, OU Alliance GCFR Conference organizers	Fund provided by partners with minimal contribution from NOUN Management	1. Report of workshop 2. Photographs and video shots 3. Methods used by OU in teaching practical science highlighted. 3. Possibility of collaboration through adoption of OU technology customized for Nigeria identified 2. Joint research project areas identified 4. Collaborative staff development programme & research

						5. Tasks assigned 6. Additional proposal for collaboration with UNISA-OU team received
Task 9 Feedback on outcome and follow-up of collaborative workshop	Present report	12/7/2017	Dean	Vice-Chancellor; HODs and academic staff on development cadres	Stationery, refreshment	1. Report submitted to the Vice-Chancellor 2. Minutes of stakeholders' meeting
Task 10 Follow-up on collaborative proposal with UNISA-OU team with skype conference call	Conference participant	17/7/2017	Dean	UNISA-OU team: Ashley Gunter, Adelino Chissae, Parvati Raghuram	Internet access Skype app Laptop computer	1. Skype discussion set-up 2. E-mail communication trail subsequently 3. Proposal for collaboration 4. Proposal for training workshop
Task 11 Present proposal of UNISA-OU on training workshop to Vice-Chancellor	Facilitate	28/7/2017	Dean	Vice-Chancellor	Secretarial facilities	1. Report submitted to VC 2. Approval received through Director of Academic Planning (DAP) who was mandated to facilitate workshop for participants across all Faculties in the university
Task 12 Explore more opportunities for partnership with other institutions in global north	Facilitate	As opportunities arise	Dean	Vice-Chancellor, Partner institutions	Secretarial facilities, internet access	1. Communication trail: e-mail and WhatsApp, with would be partners
Milestone B: **Partnership secured in principle with STEM Faculty, OU and UNISA-OU team with MoU signed**						

Key Task C: **Plan and host Training Workshop on**	**My role?**	**When?**	**Who?**	**Who else?**	**Resources, materials, support**	**How to measure?**

Evaluating Learning Design in Blended and Online Courses						
Task 1 Submission of proposal of training workshop "Evaluating Learning Design in Blended and Online Courses" from UNISA-OUUK partners to the Vice-Chancellor	Package collaborative proposal workshop request	28/7/2017	Dean	Vice-Chancellor	Secretarial facilities	1. Proposal presented 2. Approval
Task 2 Informal discussion of workshop proposal with Director of Academic planning (DAP)	Present collaborative plan	2/7/2017	Dean	DAP	Informal official visit	1. e-mail follow-up 2. Undocumented consent and advise for intended collaborators
Task 3 Approval for collaboration received from Management and required task assigned to Deputy Dean	Assign task to Deputy Dean	5/9/2017	Dean	Deputy Dean DAP	Stationery	1. Approval letter with minute assigning task to Deputy Dean 2. Presentation (to Dean) of workshop requirements by Deputy Dean
Task 4 Presentation of proposal to Faculty Management /**Academic Board**	Chair meeting / Facilitate	12/9/2017	Dean	Faculty Board	Refreshment Secretarial facilities	1. Minutes of meeting 2. Reviewed workshop requirements
Task 5 Submission of workshop requirements to DAP for onward presentation for Vice-Chancellor's approval	Submit prepared requirements	13/9/2017	Dean	Principal Confidential Secretary Deputy Dean DAP	Secretarial facilities	1. Submitted workshop requirement
Task 6 UNISA-OU team interacts with FOS	Facilitate	23/10/2017	Dean	Faculty Management, UNISA-OU team	Secretarial facilities, refreshments, lunch and drinks	1. Notice of interactive session 2. Minutes of meeting 3. Photographs 4. Resolutions
Task 7 Training workshop on preparation of interactive course materials for effective science training in ODL	Facilitate and Co-organize	26/10/2017	DAP	Dean, UNISA / OUUK collaborators Deputy Dean	Tea break, lunch, multimedia facilities, projectors, Conference room, Electronic recording facilities	1. Video recording of workshop proceedings 2. Photographs taken during the workshop 3. Communiqué of workshop 4. Workshop report 5. Certificate of participation

Task 8 UNISA-OU team interacts with NOUN extended management	Co-Facilitator	27/10/2017	DAP	Extended NOUN-Management UNISA-OU team	VC's conference room	Programme of meeting Video Photographs
Milestone C: **Academic staff of the Faculty of sciences, NOUN are trained on the preparation of interactive learning / teaching material for open and distance learning in a workshop facilitated by the UNISA-OU team organized by and administered at the National Open University of Nigeria**						

Key task D: Ensuring hands-on science laboratory practical exposure for undergraduate students: Pilot Work	**My role?**	**When?**	**Who?**	**Who else?**	**Resources, materials, support**	**How to measure?**
Task 1 Laboratory Committee Constituted and approved by Faculty Board	Facilitate	1/8/2016	Dean	Faculty Board	Refreshment, Secretarial facilities	1. Minutes of meeting 2. Committee composition 3. Terms of reference
Task 2 Laboratory Committee presents proposal to assign weight to science practical to the Faculty Board	Facilitate	9 & 10 / 2016	Chairperson, Laboratory Committee	1. Laboratory Committee members, 2. Faculty Board	Refreshment Secretarial facilities	1. Minutes of meeting 2. Proposal
Task 3 Faculty Board recommends assigning weight to practical session for student assessment to Senate through Director of Academic Planning (DAP)	Facilitate	11 /2016	Dean	1. DAP 2. Senate	Refreshment Secretarial facilities	1. Minutes of meeting 2. Proposal submitted
Task 4 Proposal for assigning weight to practical session for student assessment presented to Senate through DAP	Facilitate	11/2016	Chairman, Committee of Deans & Directors	1. Dean 2. Senate	Tea break, Lunch, Secretarial facilities	Extracts of decision of Senate conveying approval
Task 5 Laboratory Committee presents a proposal to ensure all science students access laboratory facilities for science practical to Faculty Board	Facilitate	1 / 2017	Chairperson, Laboratory Committee	1. Laboratory Committee members, 2. Faculty Board	Refreshment Secretarial facilities	1. Minutes of meeting 2. Extract of Board's recommendation to have MoU with sister universities
Task 6 Develop practical manuals for students' practical sessions, and test on pilot scale in Faculty's established set of laboratories in Lagos	Facilitate and review some of the laboratory manuals developed	1/8/2017	Laboratory Committee members	Reviewers Manual Writers HODs Laboratory Technologists	Stationery Approved fund	1. Memos, 2. Draft document 3. Reviewed draft documents with reviewers' comments

						4. Video of practical sessions 5. Report of semester practical sessions 6. Student scores
Task 7 Review and Submit final manual manuscript to university for mass production, and payment of course writers and reviewers	Facilitate	24/8/ 2017	Manual writers	Reviewers, HOD Pure and Applied Sciences, Coordinator of facilitation and Course material Development, Vice-Chancellor	Stationery	1. Payment of writers and reviewers 2. Printed practical manuals 3. Manuals accessible as workbook to students
Milestone D: User-friendly science practical manuals for hands-on science practical are produced						

Key task E: Ensuring hands-on science laboratory practical exposure for undergraduate students: Partnership with sister universities	**My role?**	**When?**	**Who?**	**Who else?**	**Resources, materials, support**	**How to measure?**
Task 1 Laboratory Committee zones country into six by geopolitical divide to constitute six MoU negotiating teams, for ease of administration	Facilitate / Guide	22/3/2017	Chairperson, Laboratory Committee	1. Laboratory Committee members 2. MoU Committee	Secretarial facilities	1. Zoning plan with committee members listed and team leaders designated 2. Budget proposed
Task 2 Constitute MoU Negotiating Committee and sub-divided into six for the proposed six geopolitical zones academics, technologists and administrators as secretaries to zonal committees	Guide Committee	22/3/2017	Dean	Chair Laboratory Committee		1. Proposal for MoU with 36 sister universities spread across the six zones prepared with cost implication for travels for Vice-Chancellor's attention 2. Team Leaders assigned each of the six teams

Task 3 Proposal and budget approved by Vice-Chancellor	Present proposal to Vice-Chancellor and defend budget		Vice-Chancellor	Bursar	Disbursed funds	1. Vice-Chancellor's approval 2. Bank e-payment alert
Task 4 MoU draft collected from Legal unit of NOUN with advise	Facilitate	6-7/ 2017	Head, Legal unit,	Dean, Chair, Laboratory Committee	Stationery, secretarial personnel	1. Draft MoU customized for each of the proposed sister universities
Task 5 MoU committee meets for briefing and discusses action plan for the trips	Coordinate		Dean	HODs, Laboratory Committee members, Laboratory Technologists and Administrators (as Zonal Teams Secretaries) in the Faculty	Secretarial facilities Funds to move staff from Lagos to Abuja for meeting	1. Minutes of meeting 2. MoU Committee considers and ratifies movement plan
Task 6 Teams set out for the MoU visits to sister universities each led by a pre-determined zonal leader	Direct process and also lead a team	3/7/2017	Dean	MoU Negotiating Committee members	Secretarial facilities	1. Reports of different teams 2. Photographs of meetings 3. Feedback from sister universities visited with defined terms for partnership
Task 7 Review of terms of sister universities and legal advice given	Facilitate	14-29/9/2017	Head, Legal Unit, NOUN	MoU Negotiating Committee, Faculty Board Vice-Chancellor,	Secretarial facilities, refreshment	1. Harmonized draft MoUs ready
Task 8 Estimate charges accrued each student for practicals based on bills from sister universities presented to FOS Board for consideration	Facilitate		Dean	MoU Negotiating Committee, FOS Board,	Secretarial	1. Minutes of last meeting of MoU Negotiation team 2. Minutes of FOS Board meeting and recommendation for presentation of estimate to university management

Task 9 Proposal of estimated charges presented to the Vice-Chancellor for university management's approval	Present submission		Dean	Vice-Chancellor Management	Secretarial	Request for approval of Estimate forwarded to the Vice-Chancellor for Management approval
Task 10 Harmonized report on terms and conditions of partner institutions presented to the Vice-Chancellor	Discuss report		Dean	Vice-Chancellor Head, Legal unit	Secretarial facilities	Report on MoU negotiation visits
Task 11 MoU signed by both parties; NOUN and host institutions	Facilitate	31/10/2017	Vice-Chancellor	Registrar Vice-Chancellors and Registrars of sister universities	Secretarial Facilities Souvenir Funds for trips / Courier services	MoU signed by Vice-Chancellor and Registrar of NOUN and the 36 partner institutions Hence, signed agreements available with the selected universities
Milestone E: Science students of the National Open University of Nigeria undertake hands-on practical across Nigeria in laboratories of the 36 sister university with memoranda of understanding.						

Key task F: Ensuring hands-on science laboratory practical exposure for undergraduate students: Commencement of science practical sessions nationwide	**My role?**	**When?**	**Who?**	**Who else?**	**Resources, materials, support**	**How to measure?**
Task 1 Set up of Laboratory facilities at Faculty of Sciences (FOS) at the Headquarters, Abuja	Facilitate	1/8/ 2017	Dean	Vice-Chancellor, HODs Laboratory Committee	Funds for laboratory equipment, facilities and consumables	Request forwarded to VC Submission of procurement unit Supply of items by contractor with weigh bill
Task 2 NOUN Science students' practical sessions in partner universities	Coordinate	Every semester	Dean	Laboratory Committee Monitoring team	Funds for trips	1. Records in Student practical workbook 2. Records of student scores 3. Claims from sister

						universities through respective Directors of NOUN Study Centres in the host university's towns / cities 4. Proof of payment by NOUN
Task 3 Practical sessions in already established FOS Laboratories in Lagos	Facilitate	6/11/2017	Dean	1. Chairperson, 2. Laboratory Committee, 3. FOS Lagos Liaison Officer	Budget for consumables, 4 weeks DTA and academic staff and their transportation to Lagos from Abuja and honorarium for additional technical support	1. Proposal with budget presented to the Vice-chancellor, 2. Approval and proof of release of funds 3. Video recordings of practical sessions 4. Still photos 5. End of practical session reports 6. Records in Student practical workbook 7. Records of student scores
Task 4 Plan to commence student practical in Abuja conceived and discussed with stakeholders	Facilitate	5/10/2017	Dean	Vice-Chancellor, HODs and Laboratory Committee Faculty Driver Director of NOUN Model Study Centre, Abuja	Secretarial support and facilities, Fuel for faculty vehicle	1. Proceedings of meeting with HODs and Laboratory Committee 2. Sub-committee constituted for exploratory assessment of NOUN model Study Centre, Abuja, proposed venue 3. Report and recommendation of sub-committee 4. Proposal and Budget presented to Vice-

						Chancellor for approval
Task 5 Sub-Committee undertake exploratory visit to the Model Study Centre, Abuja	Facilitate	11/10/2017	Chairperson, sub-committee	Committee members Faculty Driver	Official vehicle Fuel	Memo of notification to the Model Study Centre
Task 6 Sub-Committee submits report, well prepared proposal with budget	Facilitate	27/10/2017	Chairperson, sub-committee	Committee members	Stationery	Submitted Report
Task 7 Proposal presented to the Vice-Chancellor for funding	Discuss proposal	31/10/2017	Dean	Vice-Chancellor	Secretarial facilities	Submitted proposal
Task 8 Approval of budget received		3/11/2017	Vice-Chancellor	Bursar	Stationery	Approval notice
Task 9 Temporary sets of laboratories set-up at Model Study Centre, Abuja	Facilitate	15/11/2017	Chairperson Laboratory Committee	DPW&S Laboratory Committee	Funds Rooms at the Model Study Centre, Abuja	Photographs and videos
Task 10 Commence Laboratory practical in NOUN Model Study Centre Abuja	Facilitate	20/11/2017	Chairperson, Laboratory Committee	Laboratory Committee members; HODs, Director, NOUN model Study Centre, Abuja; students	1. Mobile laboratories set up at Model Study Centre, Abuja 3. Funds for relocating of Technologists from Lagos laboratories to Abuja	1. Video recordings of sessions, 2. photographs 3. Records in Student practical workbook 4. Records of student scores 4. Reports of end of semester practical sessions
Milestone F: **Two regional laboratories out of six proposed as mid-term intervention by the Faculty of Sciences now functional.**						

Key task G: **Reduce work load of academic staff in order to allow more time for development focused-research**	**My role?**	**When?**	**Who?**	**Who else?**	**Resources, materials, support**	**How to measure?**
Task 1 Reduce courses assigned lecturers to maximum six to provide more time for meaningful research	Facilitate	1/9/2017	HODs	Academic staff	Stationery, support staff	1. Documents of assigned courses from each department 2. Better research focus and empirical research
Task 2 Follow-up on request for staff recruitment earlier submitted to university Management	Present reminder Vice-Chancellor's approval	1/9/2017	Dean	Vice-Chancellor	Informal discussion with Vice-Chancellor	Update on ongoing recruitment exercise
Task 3	Serve on interview panel	11/9/2017	Dean	Constituted interview panel HoDs	Secretarial facilities	1. Notice of interview and file

Interviews for shortlisted candidates for different departments in the faculty						2. Shortlisted Candidates' application letters and other documents
Task 4 Additional academic staff members report to Faculty	Documentation	10/2017	Recruited academic staff	Faculty Officer HODs Monioluwa	Secretarial facilities	1. Documentation of newly recruited academic staff in the faculty and departmental secretariats
Task 5 Assign courses to new academic staff members	Direct	10/2017	HoDs	New academic staff members	Stationery	List of assigned courses against each staff
Milestone G: Academic staff strength increase and they now have more time to be used for research work						

Key task H: Define research focus for the Faculty and stimulate interest in applied research	**My role?**	**When?**	**Who?**	**Who else?**	**Resources, materials, support**	**How to measure?**
Task 1 Faculty Board sensitized on vision for applied research	Motivate	17/8/2017	Dean	Faculty Board	Refreshment Secretarial facilities	1. Minutes of meeting 2. Proposal
Task 2 Strategic plan committee constituted by Faculty Board	Facilitate	17/8/2017	Dean	Chairperson, Faculty Strategic plan Committee; Departmental Representatives serving of Strategic plan committee	Refreshment Secretarial facilities	1. Minutes of Board meeting 2. Strategic Plan Committee members formed (comprises representative of each Department)
Task 3 Informal discussion with Director, Directorate of Research Administration and Advancement (DRA&A)	Host	14/9/2017	Dean	Director, DR&A and Head, Linkages unit	Office reception	Informal interactive session
Task 4 Director, DRA&A officially presents activities of Directorate to Faculty Board	Facilitate	21/9/2017	Director, DRA&A	Faculty Board	Refreshment Secretarial support	Minutes of Board meeting
Task 5 Seminar on Tertiary Education Trust Fund (TETFund) for research	Resource person	13/10/2017	Dean	Deputy Dean, Heads of Departments	Refreshment, Secretarial support	1. Report of Seminar 2. Slide presentations
Task 6 Each Department defines research focus	Coordinate	17/10/2017	HODs	Departments	Refreshment, Secretarial support	Minutes of meeting of departmental strategic plan committee Strategic plan document of each department
Task 7 Research focus from departments harmonized into a faculty document and Strategic plan for Faculty of Sciences	Facilitate	20/11/2017	Chairperson, Faculty Strategic plan committee	Departments		1. Minutes of Board meeting 2. Faculty Research focus defined

2018-2023 presented to Faculty Board for review and adoption						3. Draft strategic plan, FOS 2018-2023 available
Task 8 Reviewed and corrected strategic plan document, FOS submitted to DAP	Facilitate	17/11/2017	Dean	DAP	Secretarial facilities	Strategic plan document, FOS 2018-2023 submitted to DAP
Task 9 Monitoring and Evaluation of research Strategy	Coordinate	1/12/2017 to 2022 (done annually)	Dean	Chairman, Monitoring and evaluation committee, HODs	Office, stationery, secretarial personnel	1. Set up Monitoring and evaluation committee 2. Evaluation instruments developed 3. Annual report
Milestone H: Strategic plan document with defined research focus for the Faculty, strategies for achieving set goals are mapped out and plans for execution and regular monitoring are put in place (Roadmap FOS 2018-2023).						

Key task I: Develop research facilities and skills of academic staff	**My role?**	**When?**	**Who?**	**Who else?**	**Resources, materials, support**	**How to measure?**
Task 1 University Management support for laboratory establishment	Facilitate with Management and supervise facility delivery	10/7/2017-date	Vice-Chancellor	Governing Council HoDs	Laboratory space, Funds provided by university Management for laboratory equipment and consumables	1. Physical structure with equipment and consumables 2. Functional laboratory 3. Continuous provision / servicing of equipment 4. Students carrying out research projects in the laboratories
Task 2 One day in-house workshop on preparing grant winning-research proposal	Facilitate and plan	7/12/2017	Dean	Invited facilitator, HODs, Faculty Research / Seminar committee	Administrative staff support, Secretarial support Refreshment, lunch, stationery Management approved funds	Presentation slides Report of seminar Photographs of sessions
Task 3 One day in-house workshop on academic matters and developing interactive learning materials for practical science	Direct	11/2017	Deputy Dean	HODs, Academic staff	Administrative staff support, Secretarial support Refreshment, lunch, stationery Management approved funds	1. Report of workshop 2. Workshop communiqué 3. Still photos 4. Video coverage of proceedings / opening ceremony

						5. Communiqué of workshop
Task 4 Subscription to academic funding bodies like African Network of Scientific and Technological Institutions (ANSTI)	Facilitate	30/7/2017	Vice-Chancellor	Dean	University funds	1. Faculty registered with ANSTI
Task 5 Encourage and motivate staff to secure exchange placement and capacity development	Facilitate Management's approval and registration with relevant collaborating bodies	9/2017 to 01/02/2018	Academic staff	Partner institutions	Secretarial support, refreshment, internet subscription	1. Minutes of meeting 2. Staff secure sponsorship for staff-exchange for research 3. Result of research delivered in scientific conferences 4. Staff participating in staff exchange programmes across IDC2017-2018 member institutions
Task 6 Academic staff in the faculty supervise student projects tailored towards faculty's research focus	Facilitate	1/8/2017	All academic staff	Final year students		1. Student project report 2.
Task 7 Academic staff members access grant opportunities	Facilitate	2/2018	Academic staff	Committee of Deans and Directors Dean	Secretarial facilities, stationery TETFund Other funding agencies	1. Individual research grant proposals submitted by academic staff members 2. Faculty (groups) research proposals submitted
Task 8 Encourage academic staff to attend scientific meetings and present research results	Motivate and Facilitate	2017 to 2018	Academic staff	Vice-Chancellor, Committee of Deans and Directors	Secretarial facilities	1. increased number of national and international conferences attended by staff 2. increased number of publications in more highly rated scientific outlets

Task 9 Establishing specialized research laboratories	Facilitate & coordinate activities	11/2017 - 2018	Dean	Vice-Chancellor Philanthropists Faculty Research / Seminar Committee	Funding from University Management, Philanthropists Research grants	1. Advocacy call on identified philanthropists 2. Donation of funds by philanthropists 3. Erection & equipping of physical structure
Task 10 Institute reward systems for academic excellence	Facilitate and present to university management	8/1/2018	Dean	University Management Faculty Management	University, funding with counterpart funding sourced from industry and philanthropists	Award plaques, certificates, photographs and video coverage of award ceremony
Milestone I: Ensure perennial research facilities and infrastructure of international standard are available in the Faculty of Sciences of the National Open University of Nigeria						

Key task J: Establishing culture of applied science research	**My role?**	**When?**	**Who?**	**Who else?**	**Resources, materials, support**	**How to measure?**
Task 1 Institute faculty seminar series for the presentation of research results and constitute Research / Seminar Committee	Facilitate; Chairperson, Research & Seminar Committee	1/9/2016	Dean	Research and Seminar Committee	Secretarial facilities, refreshments	1. Minute of Board meeting where proposal and committee was approved
Task 2 Committee presents proposals for monthly seminar series to Faculty Board	Facilitate	29/8/2016	Dean	Research and Seminar Committee, Faculty Board		1. Minutes of meeting where proposal was presented 2. Presentation roaster
Task 3 Monthly seminar series commenced	Facilitate	6/9/2017	Seminar Coordinator	Authors / Presenters, Faculty Board	Stationery, refreshment	1. Minutes of seminars 2. Powerpoint slide presentations 3. Manuscripts of presentations
Task 4 Publish seminar series	Facilitate	1/12/2017	Editor / Deputy Dean	Authors / Presenters, Reviewers, University Management	Secretarial support	1. Published Proceedings of annual monthly seminar presentations of the Faculty
Task 5 Harmonized university Journal for science-based faculties proposed	Facilitate	23/8/2017	Chairman, University Harmonized Journals committee	Dean, Deans of Agricultural Sciences and Health Sciences Faculties	Stationery, refreshment	1. Minutes of meeting where proposal was presented Deans 2. Editorial Board for constituted 3. Letter of appointment as

						Chairperson for team
Task 6 Sub-Committee meeting to Constitute editorial board of harmonized journal	Chair sub-committee	5/10/2017	Dean	Dean, Faculty of Agricultural Sciences; Dean, Faculty of Health Sciences, Administrative officer (secretary to sub-committee)	Secretarial support	1. Notice of meeting 2. Minutes of meeting 3. Journal name defined 3. Document submitted to Chairman, University Harmonized Journal committee
Task 7 Call for contribution sent out for the Journal of Physical and Life Sciences (JPLS) and faculty encouraged to submit manuscripts	Facilitate	3/11/2017	Editor-in-Chief (Dean)	Subject Editors	Secretarial support, internet access	1. Call for contribution circulated
Task 8 Manuscripts received, processed and compiled	Editor-in-Chief	15/1/2018	Dean	Reviewers, authors, Chairman, University Harmonized Journal Committee (UHJC)	Secretarial support	1. Reviewers' comments 2. Updated accepted manuscripts 3. Editor-in-Chief compiles manuscripts and does necessary layout 4. Camera ready draft submitted to Chairman, UHJC
Task 9 Draft of JPLS submitted to TETFund for funding	Facilitate	12/2/2018	Chairman, UHJC	Chairman Committee of Deans and Directors, TETFund	Secretarial support	1. Minutes of meeting where draft was submitted 2. TETFund approval and fund released
Task 10 Maiden edition of JPLS printed and launched	Facilitate	1/3/2018	Vice-Chancellor	Deans of faculties of Agricultural Sciences, Health Sciences and Sciences	Tertiary Education Trust funds (TETFund)	1. Copies of Journal of Physical and Life Sciences
Task 11 Exhibition of research results and innovations	Facilitate, supervise logistics	5 to 9/3/2017	Science based faculties	EXPO 2018 Committee Vice-Chancellor	Funds from university	1. Certificate of participation in national exhibitions like EXPO 2018 of the Federal Ministry of science and Technology 2. Exhibition of products during

						Faculty's Science & Technology week documented in video and photographs 3. Patent of science products and inventions
Milestone J: Series of Faculty publications including Proceedings of annual faculty seminar, annual public lecture, proceedings of annual faculty week and Faculty journal are produced						

Key task K: Mid-term review of PAP and processes	**My role?**	**When?**	**Who?**	**Who else?**	**Resources, materials, support**	**How to measure?**
Task 1 Assess level of progress made with my PAP	Review tasks accomplished so far	16/10/2017	Dean		My PAP, report of activities	Milestones achieved
Task 2 Identify likely challenges to executing / finishing plan	Critical environmental scan	18/10/2017	Dean		My PAP	Feedbacks from stakeholders
Task 3 Define line of action to solicit for support of PAP to ensure its success						Plan to interact with Vice-Chancellor
Task 4 Book appointment with the Vice-Chancellor to present an update on my PAP and solicit support on progress	Secure appointment	21/10/2017	Dean	Vice-Chancellor		Verbal appointment for Tuesday 24th October, 2017 by 11:00a.m. received
Task 5 Request for media coverage from Media and Publicity unit of the university	Direct Faculty Officer to handle	21/10/2017	Faculty Officer (FO)	Director, Media and Publicity	Secretarial facilities	Request memo
Task 5 Interactive session with the Vice-Chancellor to present update on progress with my PAP; seek his opinion to help guide further actions	Anchor	24/10/2017	Dean	Vice-Chancellor, Faculty Officer FOS, Media and Publicity crew	Stationery, recording equipment, still photo camera, video camera	1. Report of interactive session 2. Photographs 3. Video record of session 4. Affirmation of support 5. Vice-Chancellor's promise to serve as one of the resource persons at FOS' in-house research workshop 6. Lessons learnt during the interactive session 7. Recommendation to learn more on legal issues with

						MoU with the Head, Legal Unit
Task 6 Send appreciation letter to Director, Media and Publicity and request for media coverage of a session with the Head, Legal unit	Direct Faculty Officer to execute the task	25/10/2017	FO	Director, Media and Publicity	Stationery	1. Appreciation letter 2. Request memo
Task 7 Interactive session with Head, Legal unit on legal issues with MoU and different aspects of my PAP	Anchor and Facilitate	27/10/2017	Dean	Head, Legal unit and his team, Chairperson, Laboratory Practical Committee	MoU drafts, feedback from sister universities, Media crew, recording equipment and cameras	Photographs of session
Milestone K: Support of management re-affirmed, a better understanding of Management's position and action plans following from my PAP hence the assurance of its success.						

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AN EVALUATION OF TIME COMPLEXITIES OF BAYESIAN BASED AND HYBRIDIZED WORD STEMMING TECHNIQUE FOR FILTERING ADVANCED FEE FRAUD EMAILS

Okunade Oluwasogo Adekunle

Department of Computer Science, Faculty of Sciences, National Open University of Nigeria,

Abuja, Nigeria.

ABSTRACT

Challenges day in out occupied electronic mail classification processes, as a result of dynamism in spam attacks. Different techniques has being implemented to combat this attacks to the extent of using combined techniques, called hybridized spam filter techniques. However, time execution variance of hybridized filtering techniques against an individual technique need to be carefully examine in spam filtering processes. To avert the further manipulation and reoccurrence of scammers and implementation of their enterprises, to prevent future reoccurrence. Time execution of content based spam filter is being described using the Bayesian statistical algorithm versus Bayesian statistical algorithm incorporated with a word stemmer algorithm. The execution time interval for the two algorithms implementing the two techniques were evaluated by subjecting the filters to manipulated and non-manipulated spam and ham mails. Result of the tested time variance of the two algorithm signify that ordinary Bayesian statistical technique (single filter) took one quarter (¼) of the entire time used by Bayesian statistical integrated with word stemmer classifier algorithm (hybridized spam filter techniques). The implication is that when a word stemmer is incorporated with other Bayesian statistical classifiers, email classification is optimized and improved in performance, but with significant increased in execution time.

Keywords: Time execution, Classification, Spam, Ham, Suspicious terms, Word stemmer.

INTRODUCTION

Electronic mail also known as Email is the cheap and fast means of communication, among the individual and cooperate organizations. It is efficient, simple and accessible means of communication at the availability of internet (Ahmed & Hani, 2017). Email availability, simplicity and cheapness are prone to a lot of threats among which is spam (Cormack, Smucker & Clarke, 2011 in Ahmed & Hani, 2017 and Zahra & Seyyed, 2017). Email has a peculiar challenges that turns its expediency burdensome among the users, called spam. Spam is unsolicited massive number of commercial bulk and harmful e-mail sent to multiple recipients, that are irrelevant to the specified recipients. Spam also called Jung mail is one of the major internet challenges, that contributed to today's internet step back in various ways, such as financial lost to individuals and cooperate organizations and annoyance to individual users. Managing these emails becomes a significant challenge to individuals and cooperate organizations, since most of the traffic comprises of unsolicited bulk email according to (Karthika & Visalakshi, 2015). Spam filtering technique methods are categories into two: methods that avoid spam distribution at the origin and methods that avoid spam at destination point (Saadat, 2011).

Various attempt have being taken to prevent, reduce and even eliminate spam existence, but as they are being prevented in one way, they are coming up in several ways. Several techniques have being applied to address this challenges among which are Naïve Bayes Classifier, K-Nearest Neighbour classifier, Support Vector Machine, Decision Tree, Fuzzy logic and so on (Upasana, 2010). This methods had been applied and re-applied in several ways due to their manipulations by scammers in order to implement their enterprises. Among several re-use is the combination of Word Stemmer with Bayesian classifier to form a stronger hybridized classifier. This is a type of classifier that will firstly exposed the real mail content to its actual original, by eliminating the manipulations within the keywords used to thwart the filters by the scammers. And latter apply the proper Bayesian based classifier for proper and accurate filtering and mail classification. However, hybridized classifier algorithm complexity need to explore for advancement. According to Lasmedi and Retantyo (2017) complexity of the algorithm is divided into complexity of time and space. This paper focused on time complexity of an improved algorithm (hybridized Bayesian based and word stemming filtering techniques algorithm (Spam filter with additional function) against the existing filtering techniques (ordinary Bayesian based filtering techniques algorithm). Measuring time complexity of an algorithm is computing the number of stages required to run the algorithm as a function of a number of data n (size of the input), against the execution time of the tested data. Execution time needs to explore to test for variances in execution time of Bayesian based filtering technique algorithm against the hybridized filtering technique algorithm. This prevent execution time variance manipulation by scammers that may further used for advance spam attack.

The rest of this paper is structured as follows: Literature review, discusses and analyse other researchers write up on ham and spam mails, combined and individual filtering techniques, and current research on content-based spam filter execution time variance. While methodology and material discusses the method of approach applied in measuring the execution time variance of ordinary Bayesian based filtering technique algorithm against the hybridized word stemming plus Bayesian based filtering techniques algorithm. Result show the outcome of the experiment and discussion displayed and analyze the outcome of the research and paper then concludes in the conclusion.

LITERATURE REVIEW

Hybridization, combined and process two categories of spam filtering techniques, with the aims of integrating their both advantages over their disadvantages, to come up with a new hybridized idea with better and improved performance. Any of the two combined filtering techniques may apply to a particular segment of the hybridized technique operational process to perform a certain designated function. And the other technique to perform another designated function in another segment that may later combined the result, each of the two designated functions to get an expected end result.

Otherwise combined and use the two techniques side by side to generate the expected end result (Abdullah, Abdul, Azuraliza & Mohd, 2015). According to Subhana and Pramod (2016) each algorithm is only suitable for filtering specific spam. It is not reliable and inefficiency to use a single algorithm to separate spam out rightly, in this case hybridized filtering techniques is highly appropriate and recommended for effective filtering collaboration. The author proposed hybridization of two different algorithms, Bayesian classifier and back propagation neural network, and tested variants of the hybridized algorithm on numbers of different data sets against the individual traditional filtering algorithm. This show that combined algorithm performed and achieved very good and accurate results, with poor time consumption. The time complexity of the proposed data model is on the high side, despite of it accurate performance.

Mail classification Techniques

Mail classification techniques are techniques presented as a means to identify, differentiate and separate between the legitimate (Ham) and spam mails. It help to avert the scammers from successful achievement of their enterprises. Email classifications were being used to present spam to the recipient as a spam and ham as ham within the set of received buck mails. It is technical ideologies that prevent one from individual physical rigorous of identification and separation of ham from spam within the set of buck mail received. There are various types of mail classification techniques, among are:

Support Vector Machine

Support Vector Machine (SVM) is one of the most commonly used filtering algorithms for spam detection (Subhana, Nadir, Othman & Waheeb, 2014). Support Vector Machine (SVM) is a statistical learning method for pattern recognition. It applied Kernel function method that does not increase the computational complexity. According to Priyanka, Rajesh and Sanyam (2010) in their experiment, stated that spam: ham is ratio 1:3 given as their appropriate result that the classification is appropriate for more legitimate mails compare to that of spam mail. Then concluded that SVM is a good classifier compared to Decision Tree classifier, that have large memory requirement, because of its poor data format. However, Subhana, Nadir, Othman & Waheeb (2014) further stated that it was shown in many cases that it takes a long processing time and at the same time provides a less accurate rate for classification due to the content volume (size).

Decision Tree mail classification

Decision Tree is a common data mining classification. The principle idea of a decision tree is to split data recursively into subsets so that each subset contains more or less homogeneous states of targeted variable. All input attributes are evaluated for their impact on the predictable attribute, at each split in the tree, and then for a decision tree having completed the recursive process (Akhilesh, & Rahul, 2015). Priyatharsini and Chandrasekar (2017) implement different various decision tree classifiers for evaluation, and stated that decision tree filters are easy to implement and understand. It provides an overall satisfactory performance as far as spam mail detection is concerned. However, the algorithms takes more time to execute than other algorithms, despite its advantages, it short coming relied on time complexity.

Naive Bayesian Based Filter

Naive Bayesian based filter is the application of Bayesian statistical formula for mail classification with assumption of strong independence (Tang, Kay & He, 2016 in Priti & Uma, 2018). Nearly all the statistic based spam filters uses Bayesian probability calculation for classification of mail, according to Heckerman & Wellman (1995) in Kang & Zhenyu (2006). Similarly, Bayesian probability combination has been widely used successfully in various message classifications. Bayesian filter should be trained to work effectively, since every word has certain probability of occurring in either spam or ham email, in the given database, that further used to determine the total words probabilities. if exceeds a certain limit, the entire mail is classified as spam otherwise as ham (Awad & ELseuofi, 2011).

K-Nearest Neighbour classifier

The K-Nearest Neighbour (*K*-NN) classifier is a classifier that search for the most similar documents (neighbours), if a enough large proportion of the document

have been assigned to a certain classification category, similar thing may likewise apply to the new document. If not it categorize otherwise (Awad & ELseuofi, 2011).

Fuzzy logic

The concept of Fuzzy Logic was first proposed in (Zadeh, 1965). It is a flexible approach of mail classification, that give room for partial membership in a particular set of given mail. It stated that, it does not require precise, numerical information input, to get the expected output. If feedback controllers could be programmed to accept noisy, imprecise input, they would be much more effective in classification (Yeganeh, Bin and Babu, 2012).

METHODOLOGY

Bayesian Spam Filtering Technique

It employs the principle of Mathematical Probability formula to classified email messages to be ham (legitimate) or spam (unwanted). It identifies the suspicious terms within the email content, and pick from the database already assigned numerical values for the identified suspicious term. To calculate the email chances of becoming a spam or ham mail. The final calculated result is compared against the particular set threshold, if greater than the threshold value (the entire mail concluded spam and classified as spam) otherwise lesser (the entire mail concluded as spam and classified as ham). The threshold value (that could be any of 0.3, 0.4 or 0.5) figure 1.

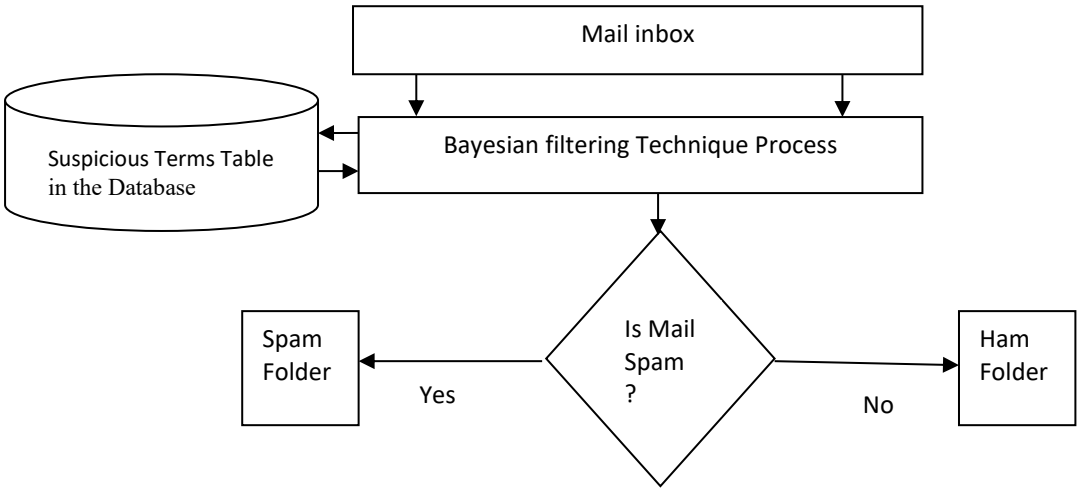

Figure 1: Pure Bayesian Spam filtering Technique Experimental setup

Hybridized Bayesian Filtering with Word Stemming Technique

Word Stemming removed all unwanted prefixes, affixes and suffixes within and around the suspicious terms to generate the suspicious terms actual root, placed by scammers to thwart the filters, in order to successful implement their enterprises. Having done this using the word stemmer, Bayesian filtering technique is then applied to actually filter the real mail content (Okunade, n. d).

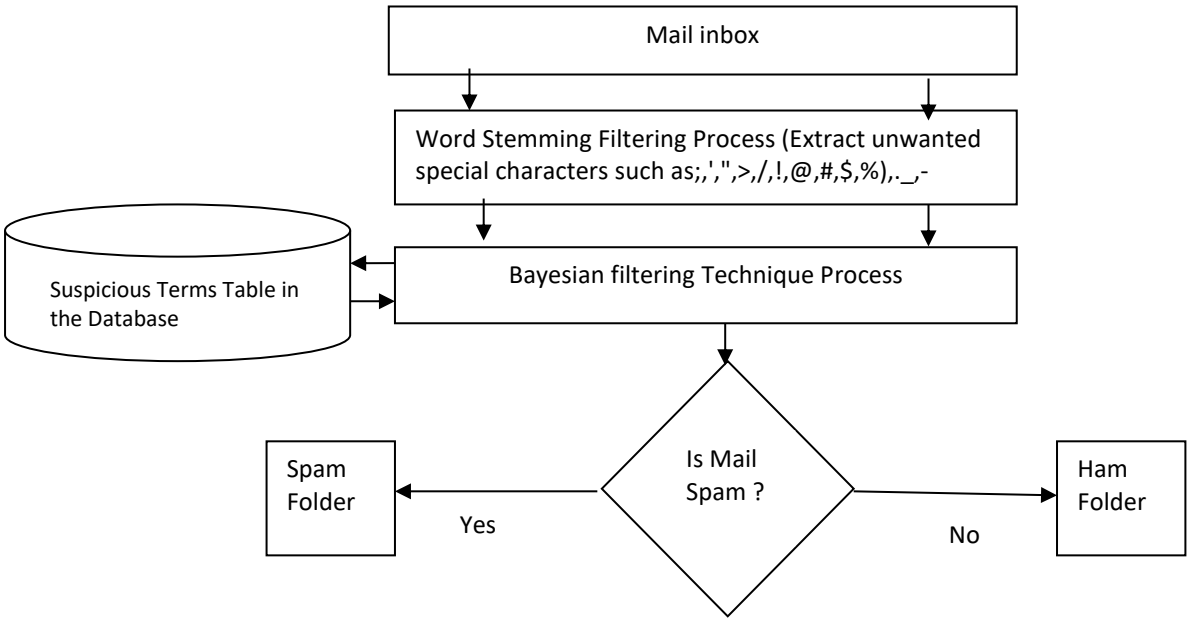

Figure.2: The Hybridized Algorithm (Bayesian Spam filter Technique Incorporated with Word Stemmer Technique) Experimental Setup data flow.

The experimental setup show in figure 1 and 2; Figure 1 is the execution process of pure Bayesian Statistical filtering technique process while the figure 2, is the execution process of Bayesian Statistical filtering technique incorporated with the Word Stemmer technique processes

RESULT

Chart 1 show the execution time variance of the experimental result of figure1 and 2 conducted. The x-axis signify mail size (volume) measured by words count make up the mail content. The y-axis measure time, it signify time taken an algorithm to complete circle of a particular mail execution, measure per seconds. In chart 1 x-axis, two bars contained same values (same numerical value of word count), first of the same two values, in each set of bars (1^{st}: 173, 199, ..., 448) in blue colour is for hybridized Bayesian filtering combined with Word Stemming techniques examined result. While the second same values in red colour is for ordinary Bayesian filtering technique examined result (2^{nd}: 173, 199, …,448). The first mail value (1^{st} 173) is the spam mail executed without manipulating the suspicious terms while the 2^{nd} mail with 173 numbers of words is the spam mail with manipulated suspicious terms, the third spam mail (1^{st} 199) is the spam mail without manipulated suspicious terms while the forth mail (2^{nd} 199) is the spam mail with manipulated suspicious terms and so on, up to the second to the last mail (1^{st} 448) is spam mail without manipulate suspicious terms and the last mail (2^{nd} 448) is spam mail with manipulated suspicious terms.

The execution time of each mail on y-axis is the time interval taken the algorithm to complete the execution. Time measured in blue colour (Bayesian algorithm with word Stemmer) taken larger time for the completion of the execution, against the time measured in red colour (ordinary Bayesian algorithm without word Stemmer) that take lesser time for the completion of the execution. Also the chart indicate that the experiment take lesser time in executing mails with suspicious terms manipulated using any of the two algorithm rather than executing the mail with suspicious terms not manipulated except the mail contained 404 words where the execution of the manipulated offensive words is a little bit increased by 0.03 seconds)

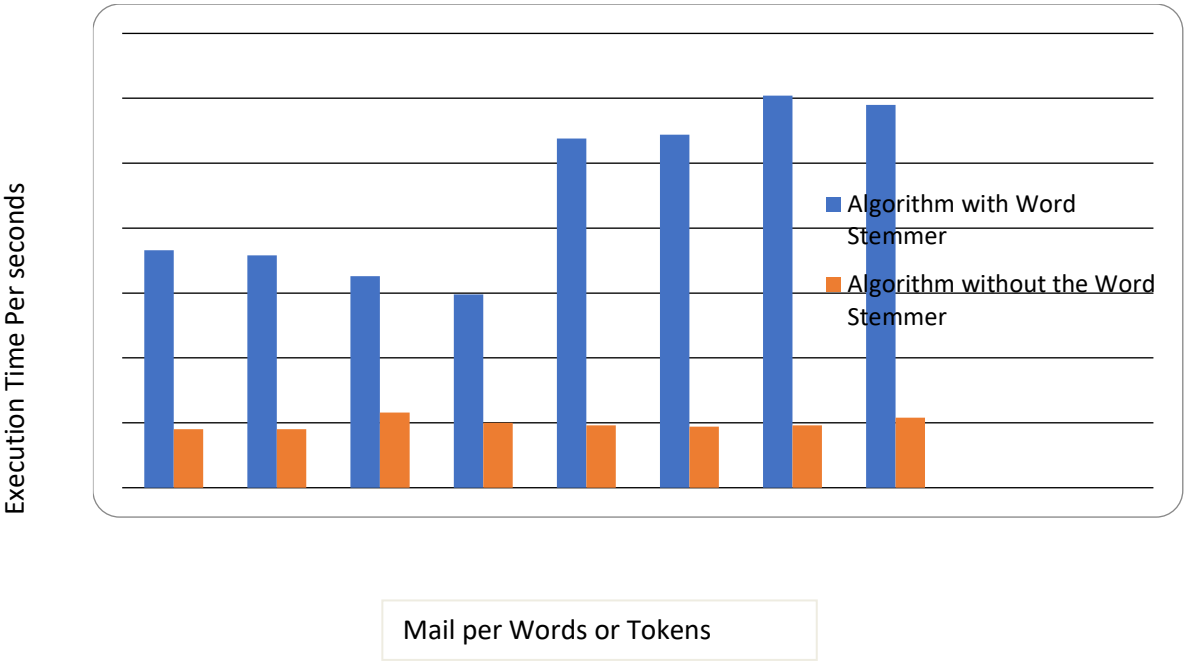

Chart 1: The result of The Execution Time comparison of Bayesian Statistical Spam Filter Against The Bayesian Statistical Incorporated with Word Stemming Spam Filter.

DISCUSSION

Result of execution time comparism of the two algorithm experiments show that the execution time of the Bayesian incorporated with Word Stemmer was far larger/higher compared to that of ordinary Bayesian mail classification. Result of the tested time variance of the two algorithm signify that ordinary Bayesian statistical technique took one quarter (¼) of the entire time used by hybridized Bayesian statistical integrated with word stemmer classifier algorithm. Also, spam with suspicious terms manipulated takes lesser time in execution compared with those without manipulated suspicious terms. Similarly, the work of Subhana and Pramod (2016) sited in the literature review, stated that, hybridization of Bayesian classifier and back propagation neural network show that combined algorithm performed accurately better than single traditional filtering technique. But with poor time consumption, high time complexity compared to single traditional filtering technique.

CONCLUSION

Experiment show that the execution of mail classifier using the Word Stemmer incorporated with the Bayesian mail filter takes larger time in execution compared to that of ordinary Bayesian mail classifier. However, hybridized filtering techniques performed more accurately better than ordinary single filtering technique, but having higher time complexity compared with ordinary single traditional filtering technique.

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VALIDITY OF CAPTURE-RECAPTURE METHODS IN ESTIMATING POPULATION SIZE OF FAKE DRUG SYNDICATES IN NIGERIA

Chinwuba E. Emeka

Department of Mathematics & Computer Science, Ebonyi State University Abakaliki, Nigeria
Chinwoba@gmail.Com or 08062371811

ABSTRACT

Capture-recapture method of analysis is a new phenomenon for Nigerian researchers, especially for researchers in the areas of public health, illicit and counterfeit drugs, and our attention drawn on its usage to estimate the population size of fake drug syndicates in Nigerian. How valid is the use of capture-recapture methods in estimating the population size of fake drug syndicates in Nigeria from NAFDAC records is the object of this study. NAFDAC, National Agency for Food and Drug Administration and Control, is an agency responsible for checkmating counterfeit drugs in Nigeria. Relying solely on capture-recapture methods of analysis without cross-validating its results may be misleading. This we believe could happen especially when the underlying assumptions validating the general use of capture-recapture (CR) methods are violated. Truncated models are therefore used to cross-validate its usage. The traditional CR analyzes data from two or more sources, while truncated model is used to analyze count or frequency data from a single or multiple sources. While some authors have used CR to estimate the population size of fake drug syndicates from NAFDAC records, we however apply truncated models to their data to validate the use of CR in estimate this difficult-to-reach population. Overall, they identified 542 cases of which 440 were from NAFDAC Onitsha zone, 270 were from at least 2 other zones of Lagos and Kano, and 136 were common to all the three zones. The sample coverage of CR estimate $\hat{N}$ is 560. We cross-validate the estimate on the same data with Zelterman, Chao and Binomial truncated models. Respectively they yielded 542, 577 and 559. These models showed an appreciable degree of unison with sample coverage of CR employed by other researchers. Falsified drugs were 336, while 206 were at least on expired, unregistered and banned drugs. Falsified, expired, unregistered and banned drugs were analyzed for internal validity. Their sample coverage of CR estimate yielded 346, 58, 96 and 60 respectively, while our corresponding Zelterman truncated model estimate yielded 336, 56, 92 and 58 respectively; Chao yielded 357, 60, 98 and 62 respectively; and Binomial yielded 350, 60, 98 and 60 respectively. Internal validity holds as no major discrepancy existed between the two methods, truncated models and the sample coverage. We therefore conclude that CR method is valid technique for the estimate of fake drug syndicates.

Key Words: Fake drug, capture-recapture, sample coverage, truncated models

1. INTRODUCTION

National Agency for Food and Drug Administration and Control (NAFDAC), an agency responsible for checkmating illicit and counterfeit drugs in Nigeria has allayed fears on the problem imposed on the Nigerian Healthcare system by fake drugs. As (Chinwendu, 2008) remarked; "the result of fake drug proliferation has led to treatment failures, organ dysfunction or damage, worsening of chronic disease conditions and the death of many Nigerians". And (Akunyili, 2004) added, "The situation became so bad that even when patients were treated with genuine drugs, there is no response due to resistance caused by previous intake of fake drugs".

The health problems associated with the consumption of fake and counterfeit drugs cannot be over stated (Osisiogu and Chinwuba, 2019). The authors stated that administering counterfeit drugs to patients has led to drug resistance, abuse or even death. Fake, adulterated and substandard drugs as (NAFDAC. 2007) reported, resulted to the death of over 150 children as a result of paracetamol syrup containing diethylene glycol in 2001 alone. While (Chinwendu, 2008) expressed fears that the problem of fake drugs was so severe that neighbouring countries such as Ghana and Serra, some time ago, officially banned the sale of drugs made in Nigeria; adding that the issue of fake drugs went to the extent that drugs were hawked even in commercial buses, open markets and streets.

In 1988, World Health Organization (WHO) Assembly urged countries all over the world to help combat the global health threat by counterfeit pharmaceuticals (Osisiogu and Chinwuba, 2019). The authors stated that WHO remarked that the prevalence of fake medicine is higher in countries with weak regulations, enforcement, and scarcity of supply of basic medicines, unregistered markets and unaffordable prices. While (Chinwendu, 2008) remarked that the high demand for medicines and low cost of production prompts counterfeiters to continue because adequate drug deterrent legislation is lacking. He said, "Around 70% of drugs in Nigeria are imported, and India is a major exporter of these drugs", stating that "Some Nigerian importers connived with some Indian manufacturers to produce fake and substandard drugs at a cheap rate with less active ingredient and sold at a cheaper rate". In order to checkmate the proliferation of fake drugs, NAFDAC therefore insisted that all drugs sold in Nigeria must have NAFDAC registration number; otherwise such drug is fake.

While the Nigerian government has been at war with fake drugs since at least the early 1980s, concern about fake drugs became especially intense in 2001, when NAFDAC started a toughest war against fake drugs. Seizure of fake drugs and arrests for fake drug possessions and sale skyrocketed. Media attention to fake drug increased and public increasingly saw it as one of the greatest problem facing Nigerian health sector. Concern about fake drug peaked in late 2005 and 2006, when NAFDAC established a special zone at the commercial city of Onitsha, where the inflow of fake drugs was high. But to us this is only part of the story; those who import the drugs, those who distribute them to various shops in Nigeria and those who market them on the streets, buses, and at the overhead bridges (we called syndicates) are also major contributors to the circulation of fake drugs. These syndicates are many and until something very serious is done to curtail its excess the fight against fake drug may be a fight in futility. The syndicates have no visibility of location, as they migrate from one place to another, especially in rural areas, looking for a place where they can sell their products without NAFDAC molestation whatsoever. Unfortunately, due to its illegality and criminalization it becomes really a big challenge to determine the population size of them by enumeration or any standard sampling technique. In other words, this hidden population requires a special technique to estimate its size. (Osisiogu and Chinwuba, 2019) looked at the dangers impose on the Nigerian health sector by these syndicates and proposed a technique known as capture-recapture analysis to estimate the population size of the syndicates of these fake drugs for the health officials and NAFDAC to visualize.

Capture-recapture (CR) method of analysis was used to estimate hidden or partial hidden populations, (McKegancy et al. 1992; Fisher et al. 1992; Fisher et al. 1994; Squires et al. 1995; Aaron et al. 2002). It was first used to estimate animal abundance (Amstrup, 2005) before it was recently applied to epidemiological studies (Post, 2013). In Europe, for instance, capture-recapture was the recommended method for estimating the population size of illicit drug users and in UK capture-recapture was used to monitor the effectiveness of drug policy (Jones et al. 2013). In non-academics, U.S government applied capture-recapture to control census undercount, (Nanan DJ and White F', 1997), while NASA used the technique to count the number of stars in the universe, and British Society of Statistics used this methodology to estimate the size of the World Wide Web (Fienberg and Stephen, 1998).

2. BACKGROUND OF STUDY

NAFDAC, the National Agency for Food and Drug Administration and Control is a Nigerian government agency responsible for regulating and controlling the manufacture, importation, exportation, advertisement, distribution, sale and use of food, drugs, cosmetics, medical devices, chemicals and pre-packed water (Osisiogu and Chinwuba, 2019),. According to them, the Agency was created following the World Health Organization Assembly resolution in the 1988 that countries all over the world should help in combating the global health threat posed by counterfeit pharmaceutical; and amidst growing concerns about the problem of fake and poorly regulated drugs circulating in Nigeria markets. They also noted that the Agency was created in 1994 and had its offices in the six geopolitical zones and the 36 state of Nigeria. As remarked by (Chinwendu, 2008), India is a major drug exporter to Nigeria. According to Chinwendu, these drugs are imported into Nigeria, sold to the wholesalers and retailers who may or may not know if these drugs are fakes or not. (Osisiogu and Chinwuba, 2019) reported that surveys on prevalence rate of fake drug at Onitsha market alone stands at 30% as against 10% in other parts of the country. They noted however that Crude method (aggregated cases divided by the observed population) was used to estimate the prevalence. Source of data collection was based on NAFDAC records of fake drug syndicates. But they use the state-of-art method called capture-recapture to estimate the population size of syndicates of these fake drugs. In our own case however we use truncated models. (Bohning et al. 2004) noted that conventional capture-recapture technique involves two sources (e.g., hospital and police) or three sources (e.g., treatment centre, survey and family doctors). As earlier noted by (Osisiogu and Chinwuba, 2019), NAFDAC has different offices in 36 states plus Abuja, the Nation's capital.

The choice of Onitsha, Lagos and Kano NAFDAC zonal offices, according to Osisiogu and Chinwuba was because these zones have heavy flow of fake drugs. They noted that this was to reduce the number of data sources which may result to increasing variation of estimates as (Van Hest et al, 2007) envisaged. An alternative to conventional capture-recapture is the truncated model. Truncated models were used on count data (Rob van Hest, 2007). We use unique identifier such as demographic information of the syndicates to identify who the syndicates are and how many times they have been apprehended (repeated entries), (Dankmar , 2004).

The aim of this research is to reexamine the data used by (Osisiogu and Chinwuba, 2019) to estimate fake drug syndicates with various truncated models for the purpose of cross-validating their use of CR to estimate population size of fake drug syndicates.

Truncated model is based on a single source data which makes it less dependent on matching entries from different sources (Dankmar, 2004). (Van Hest et al, 2007) used this idea to validate the use of capturer-recapture analysis in estimating infectious disease from different sources. If there is no discrepancy between the two approaches then the estimate of capture-recapture on fake drug syndicates from NAFDAC records by them is valid. But if there is disagreement, we can be sure that NAFDAC records alone is not sufficient enough to be used to estimate the population size of fake drug syndicates in Nigeria. This study will therefore help

Nigerian health workers and epidemiologists adopt a specific methodology for use in estimating the population size of fake drugs syndicates in Nigeria.

3. MATERIALS AND METHOD OF DATA ANALYSIS

3.1 Materials for Data Analysis

(Osisiogu and Chinwuba, 2019) extracted fake drug syndicates from NAFDAC records from January 2015 to December, 2015. In its newsletters (Consumer Safety Bulletins, Quarterly Magazines, websites) and in its press releases, NAFDAC published all the counterfeit drugs confiscated in various drug markets in Nigeria. The report also contained all violations and kind of offenses committed and arrest made during the period. In the literature we noted that the Agency was created in 1994 and it has offices in the six geopolitical zones and the 36 state of Nigeria. However, since the inflow of fake drugs are usually heavy at the commercial cities of Onitsha in Eastern Nigeria, Lagos in Western and Kano Northern Nigeria, (Osisiogu and Chinwuba, 2019) collapsed the multiple offices into three. (Rob van Hest, 2007) pointed out that, it is neither practical to have as many data sources as possible because of budgetary constraint, and too increasing number of source causes decreasing overlap which may result increase in variation of estimates, and cells in the multi-way contingency table may even contain zero cases.

Some of the syndicates after granting a bail by a court of law may migrate to other zones to commit the same offense as (Osisiogu and Chinwuba, 2019) noted. They also noted that some of them were rearrested the second or even the third times. They therefore constructed capture-recapture variables by counting the number of times a syndicate was arrested. The subscript Z_{111} showed the number of syndicates arrested in Onitsha, Lagos and Kano, as they noted. While Z_{110} means the number of syndicates arrested in Onitsha and Lagos but not in Kano. The number of fake drug syndicates not arrested in any of the three zones is indicated by Z_{000}. As shown in Table 1, they use the nature of offenses committed to construct capture history of fake drug syndicates. But because of the type of offenses committed, suspects arrested were stratified into four categories namely falsified, expired, unregistered and banned drugs as can be seen in Table 2. For data in Table 1, they counted 84 syndicates arrested in the Onitsha zone only, 44 syndicates arrested in Lagos only and 8 in Kano only. 130 syndicates were both arrested in Onitsha and Lagos but not in Kano. Similarly we interpret other records.

Table 1: Observed cases of fake drug syndicates

Onitsha zone (list 1)	Lagos zone (list 2)	Kano zone (list 3)	No. of arrest (Z_{iik})
1	1	1	Z_{111}= 136
1	1	0	Z_{110} = 130
1	0	1	Z_{101} = 90
1	0	0	Z_{100} = 84
0	1	1	Z_{011} = 50
0	1	0	Z_{010} = 44
0	0	1	Z_{001}= 8
0	0	0	Z_{000} = ?

List1= Onitsha zone; List2 = Lagos zone and List3= Kano zone

Source: (Osisiogu& Chinwuba, 2019).1 represents arrest, 0 represents no arrest

3.1.1 Sources of Case and Record-linkage

Three sources were used to identity syndicates arrested from January-December, 2015 (Osisiogu& Chinwuba, 2019). The first source was the arrest made by the officials of NAFDAC Onitsha special zone. The second source was the arrest made by staff of NAFDAC Lagos zone and third was Kano zone. The raids were made independently. Cases in various lists were merged and after correction for duplicate entries with the aid of 'excel software', the records of syndicate arrest were matched by a deterministic linkage procedure using identifiers such as full name of the syndicate, proximity of dates, address, geographical and demographic information. Overall, we identified 542 cases of arrest as presented in Fig 1 of which 440 were from Onitsha, 270 were through at least 2 other zones and 136 were common to all the three zones. Arrests were also stratified to distinguish offenses as presented in Table 2. Arrest made on falsified drugs was 336 while 206 arrests were made on other offenses combined.

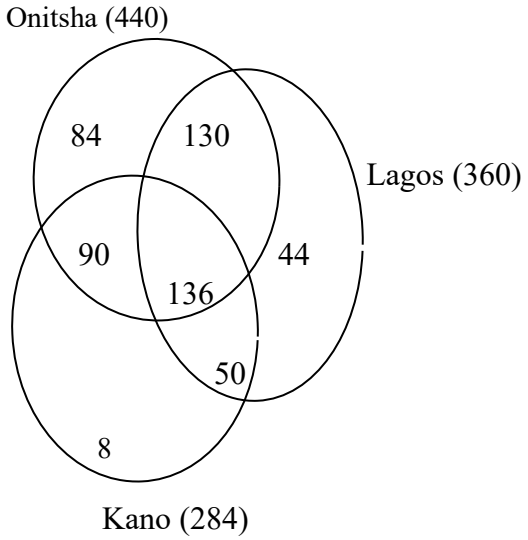

Fig 1: Vann diagram showing distribution of fake drug syndicates arrested in the investigated sources

Source: (Osisiogu& Chinwuba, 2019).1 represents arrest, 0 represents no arrest

Table 2: No. of fake drug syndicates stratified by kind of offense

Kind of Offense	Place of Arrest List1 (100)	List2 (010)	List3 (001)	List1&2 (110)	List1&3 (101)	List2&3 (011)	All list (111)	No. of Arrest
Falsified	56	25	3	81	59	28	84	336
Expired	9	4	1	13	10	5	14	56
Unregtd	11	10	2	21	13	12	23	92
Banned	58	5	2	15	8	5	15	58

List1=Onitsha zone; List2 =Lagos zone &List3=Kano zone

Source: (Osisiogu& Chinwuba, 2019).1 represents arrest, 0 represents no arrest

3.2 Methods of Data Analysis

"There exists a general belief that one knows something only when it has been counted" (Douglas, 1967). Numbers are increasingly involved in understanding and evaluating intersection of the social construction of drug problems (Himmelstein, 2013). (Osisiogu & Chinwuba, 2019) extracted fake drug syndicates as contained in NAFDAC News Magazines, NAFDAC Consumer Safety Bulletins, NAFDAC Public Alert notices, NAFDAC press releases and newsletters, and NAFDAC websites and so forth, and used CR on the data generated to estimate the population size of fake drug syndicates.

Assuming that the true population size of fake drug syndicates is N as (Osisiogu & Chinwuba, 2019) noted which may be indexed 1, 2,…., N; and suppose the observed cases of fake drug syndicates arrested is M. Then N-M is the number of syndicates not arrested. These individuals have capture history Z_{000} as shown in Table 1. Let Z_{s1}, $_{s2}$,…,$_{st}$ be the number of syndicates with records s_1, s_2, …, s_t, where $s_j = 0$ denotes absence in sample zone j and $s_j = 1$ denotes presence in sample zone j. For t = 3, there would be seven observed cells of arrested cases namely Z_{001}, Z_{010}, Z_{011}, Z_{100}, Z_{101}, Z_{110} and Z_{111}, where Z_{001} is the number of syndicates arrested in Kano zone only, Z_{110} is the number of syndicates arrested in Onitsha and Lagos zones but not in Kano. A similar interpretation follows other capture histories. Thus syndicates not arrested (missed) has cell Z_{000} = N-M. This is equivalent to predicating no arrest in all the three zones (i.e., Z_{000} = N-M). When we add over a sample zone, the subscript corresponding to that zone is replaced by a "+" sign (Chao et al, 2001). For example $Z_{+11} = Z_{011} + Z_{111}$ and $Z_{++1} = Z_{001} + Z_{011} + Z_{111}$ and $Z_{+++} = N$. Also $Z_{1+1} = Z_{101} + Z_{111}$ and $Z_{11+} = Z_{110} + Z_{111}$. If we let n_j j = 1, 2, ---,t be the number of individuals arrested in sample zone$j$. For t =3, we have n_3

$= Z_{++1} = Z_{001} + Z_{011} + Z_{101} + Z_{111}$ and $n_2 = Z_{+1+} = Z_{010} + Z_{110} + Z_{011} + Z_{111}$ while $n_1 = Z_{1++} = Z_{100} + Z_{110} + Z_{101} + Z_{111}$

3.2.1 Sample Coverage Approach

Sample coverage approach of capture-recapture was developed by (Chao et al, 2001) to estimate N. The concept of sample coverage was originally proposed by (Turing and Good, 1953) but was purified by (Chao et al, 2001). The basic idea is that the sample coverage can as well estimate the presence of two types of dependencies. Thus an estimate of population size can be derived via the relationship between population size and the sample coverage. Estimators of sample coverage as seen in (Chao A., Tsay PK, 1998) valid for this study are:

3.2.1 Sample Coverage Approach

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$$\hat{C}=1-\frac{1}{3}\left(\frac{Z_{100}}{n_1}+\frac{Z_{010}}{n_2}+\frac{Z_{001}}{n_3}\right) \quad (1)$$

which is the average (over three sample zones) of the fraction of cases found more than once. Z_{100}, Z_{010} and Z_{001} are the number of individuals arrested only in one sample zone, and thus have no information about overlap; while n_1, n_2 and n_3 are the number of identified cases of arrest in each sample zone. They are called independent sources. The following estimators seen in (Chao et al, 2001) are applied:

$$\mathrm{D}=\frac{1}{3}[(M-Z_{100})+(M-Z_{010})+(M-Z_{01})] \quad (2)$$

where $(Z_{100}+Z_{010}+Z_{001})/3$ represents the average of the non-overlapped cases and M denotes the total number of identified cases of arrest. Thus D can be interpreted as the average of the overlapped cases of arrest. When arrest in the three sample zones is independent, a sample population size estimator is derived as

$$\widehat{N}_0=D/\hat{C} \quad (3)$$

(Chao et al, 2001) noted that when dependence exists among the zones and the overlap information is large enough then

$$\widehat{N}=\left(\frac{Z_{+11}+Z_{1+1}+Z_{11+}}{3\hat{C}}\right)/\left\{\begin{array}{c}1-\frac{1}{3\hat{C}}\left(\frac{(Z_{1+0}+Z_{+10})Z_{11+}}{n_1n_2}\right)+\\ \frac{(Z_{10+}+Z_{+01})Z_{1+1}}{n_1n_3}+\frac{(Z_{0+1}+Z_{01+})Z_{+11}}{n_2n_3}\end{array}\right\} \quad (4)$$

They also noted that for relatively low sample coverage data where information about the syndicates is not sufficient enough to accurately estimate the population size of fake drug syndicates, the following estimators may apply:

$$\widehat{N}_1=\frac{D}{\hat{C}}+\frac{1}{3\hat{C}}\left[\begin{array}{c}(Z_{1+0}+Z_{+10})\left(\frac{DZ_{11+}}{\hat{C}n_1n_2}-1\right)+(Z_{10+}+Z_{+01})\\ \left(\frac{DZ_{1+1}}{\hat{C}n_1n_2}-1\right)\\ +(Z_{01+}+Z_{0+1})\left(\frac{DZ_{+11}}{\hat{C}n_2n_3}-1\right)\end{array}\right] \quad (5)$$

Simulation studies by (Chao et al, 1996) have suggested that the estimated sample coverage should be at least 55 percent to adequately estimate any population.

We prefer sample coverage to log-linear model because of two inherent advantages over log-linear; i.e., no model selection or model comparison is needed and no further difficulty arises when the number of lists increases overlap information.

3.3 Truncated Model

In epidemiological studies, violation underlying capture-recapture assumptions is unavoidable. This and other limitations call for cross-validation. Alternative models related to capture-recapture analysis have been suggested by (Van Hest et al, 2007). As stated in the literature, truncated models are used to cross-validate the use of CR. If a suspect is arrested and later released, there is likelihood he may be rearrested if he goes back to the same illegal business again. The number of such arrests helped estimate the total number of syndicates. Consider for example a population size of fake drug syndicates to be N and suppose a count variable Y taking values in the set of integers {0, 1, 2, 3, ---} is the number of suspects arrested. Also denote for example f_0, f_1, f_2, ---- the frequency with which a 0, 1, 2--- occurs in the population. Since a syndicate is only observed if he is arrested, y = 0 will not be observed in the list. Hence the list reflects a count variable truncated at zero which we shall denote by Y. Accordingly, the list has observed frequencies f_1, f_2, ---, but the frequency f_0 of zeros in the population is unknown. Since we do not know f_0, we form the zero-truncated Poisson distribution defined by a probability

function conditional on $y > 0$, as $P(y_i / y_i > 0, \lambda) = \dfrac{P(y_i / \lambda)}{P(y_i > 0 / \lambda)} = \dfrac{\exp(-\lambda)\lambda^{y_i}}{y_i!(1 - \exp(-\lambda))}$ (6)

with $p(y_i > 0/\lambda)\, 1 - \exp(-\lambda), \quad i = 1, \cdots, N_{obs}$.

(Van der Heijden et al, 2003) noted that if an estimator for λ is $\hat{\lambda}$, then the probability of an individual not arrested (unobserved) shall be $\hat{p}_0 = \exp(-\hat{\lambda})$. Thus, the number of unobserved individual denoted by $\hat{f}_0$ can then be calculated as

$$\hat{f}_0 = [\hat{p}_0/(1 - \hat{p}_0)]N_{obs} \tag{7}$$

where N_{obs} is the observed number of individual in the population. The estimated population size $\widehat{N}$ is then obtained by

$$\widehat{N} = \hat{f}_0 + N_{obs} \tag{8}$$

However, Zelterman and Chao have derived a simpler estimator for truncated model. In most cases, **λ** is known but if it is not it can be estimated. They said, with maximum likelihood under the assumption that Poisson distribution is homogeneous, **λ** can be estimated. However, instead of estimating **λ** under the assumption of a homogeneous Poisson distribution (Zelterman, 1988) argued that the Poisson assumption might not be valid over the entire range of possible values for Y but it might be valid for small ranges of Y such as from y to y_{+1}, so that it would be meaningful to use only the frequencies f_1 and f_{i+1} in estimating **λ**. Since for any i both the truncated and un-truncated Poisson distribution have the property that

$P_0(i+1|\lambda)/P_0(i|\lambda) = \lambda/(i+1)$ and $P_{0+}(i+1|\lambda)/P_{0+}(i|N) = \lambda/(i+1)$ respectively, λ can be derived as

$$\hat{\lambda} = \frac{(i+1)P_0(i+1|\lambda)}{P_0(i|\lambda)} = \frac{(i+1)P_{0+}(i+1|\lambda)}{P_{0+}(i|\lambda)} \tag{9}$$

An estimator for λ is obtained by replacing $P_{0+}(i|\lambda)$ by the empirical frequency f_i:

$$\hat{\lambda}_i = (i+1)\, f_{i+1}/f_i \quad (10)$$

If $i = 1$, $\hat{\lambda}_1 = 2f_2/f_1$, and this estimator is often considered for two reasons; $\hat{\lambda}_1$ is using frequencies in the vicinity of f_0 which is the target of prediction and in many application studies for estimating f_1 and f_2. As Zelterman noted, this estimator is unaffected by changes in the data for counts larger than 2, which contributes largely to its robustness. Various truncated model that will apply are:

Truncated binomial model:

$$\text{est}(N) = \text{obs}(N) + (f_1)^2/3f_2 \quad (11)$$

Truncated Poisson mixture (Zelterman) model:

$$\text{est}(N) = \text{obs}(N)/[1-\exp(-2f_2/f_1)] \quad (12)$$

Truncated Poisson heterogeneity (Chao) model:

$$\text{est}(N) = \text{obs}(N)+(f_1)^2/2f_2 \quad (13)$$

Out of many possible methods, we have chosen the above combinations of truncated models because according to (Hook & Regal, 1982; Hook & Regal, 1995) they are alternative to capture-recapture methods.

The ratio between the number of syndicate arrested once (f_1) and twice (f_2) plays an important role in the use of truncated models. When '1' represents arrest and '0' no arrest, and the three linked zones are used, frequency count f_1 is the sum of the cells 100, 010, and 001 in the 2x2x2 contingency table and frequency count f_2 corresponds to the sum of the cells 110, 101, and 011. Similarly, syndicates arrested in all the three zones, f_3 are donated as 111. We use the f_1/f_2 ratio to examine a possible relationship between this ratio and the performance of the truncated models. In Table 4 were sample coverage estimates while truncated model estimates were in Table 5. Comparison of the two approaches was in Table 6.

4. RESULTS OF DATA ANALYSES

Table 3 below depicts the results of sample coverage as $\hat{C}$ = 88.6 per cent and D = 496.667 (see eqns.1 &2). An estimate without possible dependency is $\widehat{N}_0$ = 561 (see eqn.3). Estimate when the source is dependent and sample coverage is adequate is $\widehat{N}$=560 (see eqn.4) while the estimate when the source is dependent and sample coverage is inadequate is $\widehat{N}_1$ is 547 (see eq. 5).

Table 3: Unstratified estimate of fake drug Syndicates

M	D	$\hat{C}$	est	cil	ciu
$\widehat{N}_0$	542	496.667	0.886	561	515 – 608
$\widehat{N}$	542	496.667	0.886	560	515 – 608
$\widehat{N}_1$	542	496.667	0.886	547	502 – 595

sample coverage =88.6% which is adequate (55% or more is adequate)

Definitions: We adopt similar notations used by (Chao et al, 2001)

M: number of individuals arrested in at least one sample zone

D: the average number of individuals arrested in at least one sample zone

$\hat{C}$: sample average estimate see eq. (1)

est: population size estimate of fake drug syndicates

se: estimated standard error of the population size estimation of fake drug syndicates

cil: 95% confidence interval lower limit

ciu: 95% confidence interval upper limit

$\widehat{N}_0$: population size estimate of fake drug syndicates for independent sample zone see eq. (3)

$\widehat{N}$: population size estimate for sufficiently high sample coverage cases see eq. (4)

$\widehat{N}_1$: one-step population size estimate for low sample coverage cases see eq. (5)

Table 4: Estimate of Fake drugs Syndicates by Sample-Coverage Method

Type of arrest	If source is dependent and sample coverage is adequate, estimates ($\widehat{N}$) in eq.4 are:	If source is dependent but sample coverage is inadequate, estimates ($\widehat{N}_1$) in eq.5 are:
Falsified	346 (95%CI = 310-384)	338 (95%CI = 303-376)
Expired	58 (95%CI = 44-75)	57 (95%CI = 43-74)
Unregistered	96 (95%CI =78-117)	93 (95%CI = 75-114)
Banned	60 (95%CI = 46-77)	60 (95%CI = 75-114)
*Fake	560(95%CI = 515-608)	547(95%CI = 515-608)

***Fake in general terms means of falsified, expired, unregistered and banned drugs; Estimates (N) = estimated population**

Source: (Osisiogu& Chinwuba, 2019).1 represents arrest, 0 represents no arrest

Table 5: Estimates of fake drug syndicates by truncated models and percentage

Type of Arrest	Obs (N)	Zelterman model est(N) eq.12	% Obs(N)/ est(N)	Chao model est(N) eq.13	% Obs(N) /est(N)	Binomial model est(N) see eq.11	% Obs(N)/ est(N)
Falsified	336	336	100	357	94.1	350	96.0
Expired	56	56	100	60	93.3	60	93.3
Unregistd	92	92	100	98	93.9	98	93.9
Banned	58	58	100	62	93.5	60	96.7
Fake	42	542	100	577	93.9	559	97.0

obs(N) = observed number of cases, est(N) = estimated number of case

Source: (Osisiogu& Chinwuba, 2019).1 represents arrest, 0 represents no arrest

Table 6: Comparison of estimates by sample coverage method and Poisson mixture model (Zelterman), truncated Poisson heterogeneity model (Chao) and truncated Binomial model

		Type of offense			
Type of analysis	Fake	Falsified	Expired	Unregistered	Banned
Sample coverage method from eqn. 1& 2	560 (547)	346 (338)	58 (57)	96 (93)	60 (60)
Truncated binomial model est(N) = obs(N) + $(f_1)^2/3f_2$	559	350	60	98	60
Truncated Poisson mixture model est(N) = obs(N)/[1-exp(-$2f_2/f_1$)]	542	336	56	92	58
Poisson heterogeneity model(Chao) est(N) = obs(N) + $(f_1)^2/2f_2$	577	357	60	98	62
f_1/f_2	0.5	0.5	0.5	0.5	0.54

obs(N) = observed number of cases, est(N) = estimated number of case; () = estimate by eqn. 2

5. DISCUSSION

5.1 Discussion

Assumptions underlying the use of capture-recapture in epidemiological studies include; (1) the population must be closed, (2) the capture sources must be independent, (3) all members of the population must have equal chance of being in the list and the capture history of each member must be accurate.

The closure assumption can only be reached to a reasonable extent, especially when the study period is short. In this study, NAFDAC records of fake drug syndicates were extracted from January to December, 2015. The second assumption which is source independent is also difficult to satisfy, but the source dependency is relaxed when sample coverage approach is employed. The third assumption that all members of the population shall have equal chance of being in the list is easy to satisfy. This is because all the syndicates faced the same risk of being arrested. The fourth assumption is that the capture history of each member shall be accurate; i.e., all true matches only are identified. Fake drug syndicates are matched by proximity of dates, address, name of the syndicates, and geographical information. Furthermore, we stratified them as falsified, unregistered, banned and expired drugs for internal validity.

Though the assumptions of CR to large extent are satisfied we still use truncated models to verify its validity in case some of the assumptions are violated. Overall, we identified 542 cases of which 440 were from Onitsha zone, 270 were from at least 2 other zones of Lagos and Kano and 136 were common to all the three zones (See fig 1). The sample coverage of CR estimate $\hat{N}$ is 560 (See Tables 3&6). We cross-validate the estimate with Zelterman truncated Poisson mixture model, Chao truncated Poisson heterogeneity model and Binomial truncated models. Respectively they yielded 542, 577 and 559 (Also see Table 5 & 6). These models showed an appreciable degree of unison with sample coverage. Falsified drugs were 336 while 206 were at least on expired, unregistered and banned drugs. Falsified, expired, unregistered and banned drugs were analyzed for internal validity. Their sample coverage estimate yielded 346, 58, 96 and 60 respectively (see Table 4), while corresponding Zelterman estimate yielded 336, 56, 92 and 58 respectively; Chao yielded 357, 60, 98 and 62 respectively; and Binomial yielded 350, 60, 98 and 60 respectively (see Table 5). The internal validity also holds as no major discrepancy existed between truncated models and the sample coverage, f_1/f_2 ratio is also same in the estimators, thus showing perfect agreement.

6. CONCLUSION

The population size of fake drug syndicates by capture-recapture analysis requires adequate data base register. In capture-recapture analysis small variations in the quality of data and record-linkage can lead to highly variable outcomes. NAFDAC News magazine, newsletters etc., may not contain all the fake drug syndicates and not including them may lead to underestimation. Truncated models were then used as a heuristic tool to identify possible failure in capture-recapture analysis models. Since there is no major discrepancies between CR analysis and truncated models, capture-recapture stands as a good statistical stool to be used to estimate the size of fake drug syndicates in Nigeria.

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IN VITRO ANTIPLASMODIAL ACTIVITY OF EXTRACTS AND FRACTIONS OF *LUFFA CYLINDRICA*

***Oluremi Aduke SALIU[1] and Adewumi Musbau AKANJI[2]**

[1] Department of Environmental Health, Faculty of Health Sciences, National Open University of Nigeria, Abuja, Nigeria
[2] Department of Biochemistry, Faculty of Life Sciences, University of Ilorin, Ilorin, Kwara State, Nigeria
*Corresponding author email**:** remisaliu@yahoo.com

Abstract
Malaria is one of the major important health challenges in developing countries and *Luffa cylindrica* is a medicinal plant use in Nigeria folk medicine to treat malaria. This study was embarked upon to investigate the *in vitro* antiplasmodial activity of the extracts (hexane, ethylaceatate, methanol and aqueous) and fractions of *Luffa cylindrica* on *Plasmodium falciparum* strain. Phytochemical screening was carried out on the extracts using standard procedures *P. falciparum* were cultivated and maintained in fresh O^+ human erythrocytes at 4 % haematocrit in complete medium (RPMI 1640 with Albumax II). The ring stage synchronized *P. falciparum* (*Pf3D7*) strain, 1% parasitemia, 2% hematocrit were incubated in a 96-well microplate for 96 h with different concentrations of plant extracts (0.05, 5 and 5 mg/ml) and fractions of the most potent extract (0.01, 0.1 and 1 mg/ml). 0.4% dimethy sulfoxide (DMSO) was used as negative controls; while WR-194,965 was used as positive control. Alkaloids, saponins, phenolics and flavonoids were among the secondary metabolites present in the extracts. The results on antiplasmodial study were obtained by the microtiter plate using SYBR Gold I fluorescence assay and of the four extracts tested, the highest antiplasmodial (IC_{50} of 2.75 ± 0.21 mg/ml) activity was observed with methanolic extract of the leaves of *Luffa cylindrica* and was later subjected to reverse-phase flash chromatography towards antiplasmodial activity guided purification of metabolites and isolation of the active fractions. Neighboring fractions were combined judiciously to ensure optimum purity and 10 pools were obtained. Among the 10 pools evaluated, the most potent fractions against the parasite growth were fractions F7-F10 with an IC_{50} of 2.23 ± 0.34, 2.30 ± 0.45, 2.31 ± 0.64 and 2.20 ± 0.62 mg/ml respectively and was comparable with WR-194,965 (2.31 ± 1.06). Our findings, therefore, confirm the acclaimed use of *L. cylindrica* as antimalarial in folk medicine of Nigeria.

Keywords: antiplasmodial, *Luffa cylindrica*, *Plasmodium falciparum*, chloroquine, artemisinin

Introduction

Malaria is one of the major important health challenges in Nigeria and the globe. About 500 million people are affected by malaria each year; mostly from sub-Saharan Africa and cause about 2.3 million deaths every year (WHO, 2013). The drugs resist *Plasmodium falciparum* cause the most virulent form of malaria in humans and it is declared as a public health disaster causing increased morbidity and mortality. The development and spread of drug resistant strains of the causative agent *P. falciparum* have mitigated the effectiveness of the commercially available anti-malarial drugs like chloroquine and the newly introduced artemisinin (Zofou *et al*., 2011; Inbaneson *et al*., 2012). The use of chloroquine which was the first line of treatment for malaria has been discontinued in some Africa countries like Kenya and Nigeria due to overwhelming presence of *P. falciparum* strains (Dianne *et al*., 2003). This creates the urgent need for new antimalarial drugs. Plants have always been considered to be a possible alternative and rich source of new drugs, and most of the antimalarial drugs in use today such as quinine and artemisinin were either obtained directly from plants or developed using chemical structures of plants-derived compounds as template. *Luffa cylindrica* commonly referred as sponge gourd provides a rich source of structurally diverse secondary metabolites. In Nigeria, it is locally called "Kankan oyibo" by Yoruba tribe, "Ahia mmla" by Igbo tribe, "Ihion by Edo tribe and "Soosoo" by the Hausa tribe. Several studies have demonstrated that *L. cylindrica* contain excellent source of chemical components such as alkaloids, flavonoids, saponins, phenolics, terpenes and tannins that have exhibited different biological activities (Salman *et al*., 2013**,** Sharma *et al*., 2014**,** Etim *et al*., 2018; Saliu *et al*., 2019). Ethno botanical survey also revealed that *L. cylindrica* is used to treat malaria (Partap *et al*., 2012; Azeez *et al*., 2013) by traditional health practitioners but studies to substantiate this claim is lacking. In this vein, the present study was carried out to investigate the *in vitro* antiplasmodial activity of *L. cylindrica* leaves using different solvent.

Materials and Methods

Collection of plant material and authentication

Leaves of *Luffa cylindrica* were collected from Zulle Farms, Suleja, Niger State, Nigeria and authenticated at the National Institute for Pharmaceutical Research and Development, (NIPRD), Abuja, where a voucher specimen (NIPRD/H/6650) was deposited at the herbarium of the institute.

Extract Preparation

Fresh leaves of *L. cylindrica* were washed with water to remove dirt and air-dried to a constant weight for three weeks. Leaves were milled into powder with an electrical blender (Mazeda Mill, MT 4100, Japan). 500 g of the dried leaf powder was extracted sequentially with n-hexane ethylacetate, methanol and distilled water by maceration method. The extracts were filtered using Whatman No 1 filter paper, concentrated in a rotary evaporator (RE-300B model, product of Henan Touch Science, China) and then with a water bath at 45^{o}C. The yield of each extract thus obtained was recorded. Portions of each extract were weighed and diluted in dimethyl sulfoxide (DMSO) to concentrations of 5% w/v. Solutions of each extract were transferred to a 96-well plate where a series of 10-fold dilutions were made into concentrations of, , and 0.5, 5 and 50 mg/ml. The extracts were then stored in a refrigerator at -4^{0}C till further use.

Reference drugs

WR-194,965 was used as the reference antimalarial drug for positive controls for *P. falciparum (Pf3D7)* strain while 0.4% DMSO was used as negative control.

Phytochemical screening

Phytochemical screening of the each crude extract was carried out adopting the standard procedures and tests of Trease and Evans (1989); Sofowora (1993) for phytochemical analysis to reveal the presence of chemical constituents such as alkaloids, flavonoids, tannins, terpenes, saponins, anthraquinones, phlobatannins and cardiac glycosides.

Fractionation of most active crude extract

The extract that exhibited the most effective antiplasmodial activity was subjected to reverse-phase flash chromatography in Wright laboratory at McMaster University;

Hamilton, Canada. Fractionation of the methanolic extract began with C18 reverse-phase flash chromatography using Teledyne Isco CombiFlash Rf 200 automated chromatography system with column pre-packed with C18-functionalized silica gel. The sample was initially pre-absorbed onto a solid support in order to improve resolution during chromatography in which 4 gram of C18-reverse-phase chromatography was added to a solution of the methanolic extract (1 g wet weight) in methanol (50 ml) and the suspension was concentrated under reduced pressure with a rotary evaporator (bath temperature 28-30ºC). The resulting powder was then transferred to an empty cartridge for chromatography. A portion of the methanolic extract (1g) was subjected to C18 reverse-phase chromatography on a 26 gram C18 column and a gradient of MeOH/H_2O from 10% to 100%. The eluent was collected in approximately 125 test tubes, but tubes were pooled to give 10 fractions (F1-F10) which were concentrated by rotary evaporation followed by Genevac (chamber temperature of 30ºC) in pre-weighed test tubes. Each fraction was re-suspended in DMSO (1.0 ml) to give the investigated concentrations (0.001, 0.01, 0.1 and 1mg/ml) used for the antimalarial testing.

Parasite cultivation

P. falciparum strain (*Pf3D7*) are cultivated *in vitro* in fresh O^+ human erythrocytes at 4% haematocrit in complete medium at 37ºC under reduced O_2 (gas mixture 5% O2, 5% CO2, 90% N_2) and was obtained from the Institute of Infectious Diseases, McMaster University, Canada.

Synchronization of *Plasmodium falciparum* parasite development using sorbitol

The cell culture was centrifuged at 1800 rpm for 5 minutes. After centrifugation, the supernatant was discarded and the pellet retained. Then, 10 pellet volume of 5% sorbitol solution was added. This solution was mixed and kept at 37ºC for 7 minutes. The sorbitol solution containing the cells was taken out of the incubator and centrifuged at 1800 rpm for 5 minutes. The supernatant (sorbitol) was discarded and the synchronized culture was suspended in fresh cRPMI and transferred to the Petri dishes. The parasite culture was incubated at normal cultures conditions (37ºC under reduced O_2). After one hour, a thin blood smear was prepared and stained slides were examined under a microscope at 100 X magnification for the parasites stages identification and parasitemia (Lambros and Vanderberg, 1979).

Antiplasmodial assay

The *in vitro* antiplasmodial activity of *L. cylindrica* extracts and the fractions from the most active crude extract against *Pf3D7*strain was carried out in Tim Gilberger laboratory, Hamburg, Germany using SYBR gold fluorescence assay which is a modified method of SYBR green fluorescence assay of Johnson *et al.* (2007) which measures the malarial growth or inhibition by quantifying DNA with a nucleic acid-binding florescent dye. Synchronized culture at 2% hematocrit and 1% parasitemia was aliquoted with test drugs (plant crude extracts, WR-194,965 at concentrations of 0.05, 5, 50 mg/ml respectively and fractions of active extract (0.001, 0.01, 0.1 and 1 mg/ml) to 96-well flat bottom tissue culture to a final volume of 100 µl. After 96 h of incubation, wells tested were supplemented with equal volumes of lysis buffer (Tris-20 mM, EDTA-5 mM, Saponin-0.008%, Triton-X 100 – 0.08%) containing 1X SYBR Gold I dye. After the addition of lysis buffer, the plates were incubated for another one hour. After this period, the plates were read using 96-well fluorescence plate reader (Victor, Perkin-Elmer), with excitation and emission wavelengths of 485 and 530 nm respectively. In order to validate the SYBR gold data, thin blood smears of treated and untreated wells were prepared and stained (Niharika *et al*., 2015). Negative control (DMSO group) was maintained with fresh red blood cells and 2% parasitized *P. falciparum* diluted with 2% haematocrit while positive control was maintained with parasitized red blood cells treated with WR-194,965. Average percentage suppression of parasitaemia was calculated using the expression:

Average % suppression of parasitaemia =

$$\frac{\text{Average \% parasitaemia in control} - \text{Average \% parasitaemia in test}}{\text{Average \% parasitaemia in control}} \times 100$$

The fluorescence readings were plotted against drug concentration, and fifty percent (50%) inhibitory (IC_{50}) values were determined using excel custom function software.

Statistical analysis

Data were analyzed by analysis of variance (ANOVA) procedures followed by Duncan Multiple Range test and statistical difference were achieved when $P < 0.05$.

Results

The phytochemical screening of the leaf extracts of *Luffa cylindrica* reveals that, the extracts contain variety of secondary metabolites (Table 1). Alkaloids were present in all the extracts (n-hexane, ethylacetate, methanol and aqueous) while cardaic glycosides were present only in the hexane, methanol and aqueous extract. Phenolics and saponins were present in the aqueous and methanolic extracts, flavonoids in methanol and ethylacetate extracts while tannins were present only in the methanolic extracts. Other secondary metabolites screened were phlobatannins, terpenes and anthraquinones but were absent in all the extracts (Table 1). The variation of the mean inhibition rate on the growth of *Pf3D7* strain of *P. falciparum* according to the different concentrations of extracts of *L. cylindrica* leaves is shown in Table 2. The assay indicated that WR-194,965 and the three organic extracts (hexane, ethylacetate and methanol) were all active against the parasite by inhibiting the growth of *Pf3D7* strain of *P. falciparum*. The inhibition of the parasite using a red blood assay by the WR-194,965, hexane, ethylaetate and methanol extracts was dose-dependent (Table 2). The methanol extract appeared to be more potent with IC_{50} value of 2.75 mg/ ml while the ethylacetate extract also showed a promising inhibitory effect of the parasite growth (wit IC_{50} 2.99 mg/ml), followed by the hexane extract (Table 2). Additionally, at 5 and 50 mg/ml investigated, both the methanol and ethylacetate extracts exhibited a significant higher ($p < 0.05$) inhibitory effect against *Pf3D7* strain when compared with the reference antimalarial compound (WR-194,965). The chromatographic trace for the fractionation of the methanolic extract of *L. cylindrica*, showing the colours of each fraction as it came off the column and the tubes that were pooled together into fractions F1-F10 at UV absorbance of 214 and 254 nm is presented in Figure 1. The colours of F1, F4 and F5 were dark yellow, F2 and F3 were light yellow, F6 and F7 were yellow brown, F8 and F9 were brown-green while F10 was green and yellow-green. Table 3 depicts the antiplasmodial activity of the fractions from methanolic crude extract of *L. cylindrica* leaves fractionated by reverse-phase flash chromatography. Fractions F1 and F3-F10 caused a significant reduction ($p < 0.05$) in the parasite growth with over 70% reduction at the highest concentration (1 mg/ml) investigated while fractions F7-F10 caused over 80% significant reduction ($p < 0.05$) in the parasite growth at concentrations 0.1 and 1.0 mg/ml and with IC_{50} values of which was similar to the reference antimalarial compound.

Table 1: Secondary Metabolites of *Luffa cylindrica* Leaf Extracts

Phytochemical	Extracts			
	Aqueous	**Methanol**	**Ethylacetate**	**Hexane**
Saponins	+	+	-	-
Tannins	-	+	-	-
Anthraquinones	-	-	-	-
Terpenes	-	+	+	+
Phenolics	+	+	-	-
Flavonoids	-	+	+	-
Alkaloids	+	+	+	+
Phlobatannins	-	-	-	-
Glycosides	+	+	-	+

Values are means ± SEM of three replicates

Table 2: IC_{50} values of *Luffa cylindrica* leaf extracts against *Plasmodium falciparum*

Extracts	0.5 mg/ml	5 mg/ml	50 mg/ml	IC_{50} mg/ml
	% Inhibition			
Aqueous	9.05 ± 0.45[a]	13.01 ± 0.17[ˇˇ]	13.01 ± 0.17[ˇˇ]	-
n. Hexane	25.06 ± 0.39[ˇ]	29.00 ± 0.16[ˇ]	88.00 ± 0.26[ˇ]	25.97 ± 0.11[ˆˆ]
Ethylacetate	13.04 ± 0.33[ˇ]	79.05 ± 0.23[ˇ]	85.02 ± 0.31[ˇ]	2.99 ± 0.31[ˇ]
Methanol	15.02 ± 0.21[ˇ]	86.01 ± 0.21[ˇˇ]	88.97 ± 0.24[ˇˇ]	2.75 ± 0.21[ˇ]
DMSO	2.05 ± 0.11[ˇˇ]	2.07 ± 0.11[ˇ]	2.06 ± 0.11[ˇˇ]	-
WR-194,965	70.05 ± 0.22[ˇ]	75.08 ± 0.12[ˆ]	77.05 ± 0.10[ˇˇ]	3.45 ± 0.24[ˇˇ]

Values are means of three replicates ± SEM. Values with different alphabet superscript down the column are significantly different at $p < 0.05$.
DMSO – Dimethyl sulfoxide

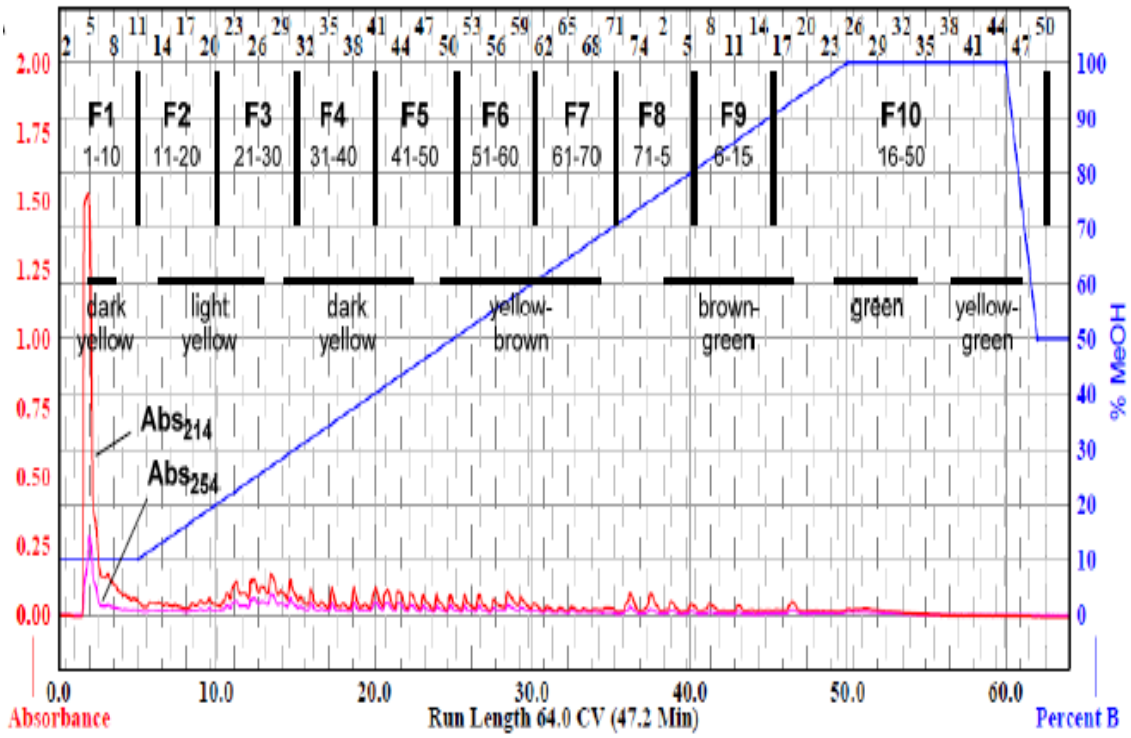

Figure 1: Chromatographic trace for the fractionation of methanolic extract of *L. cylindrica* by C18 reverse-phase chromatography using the Teledyne CombiFlash Rf 200 system

Table 3: *In vitro* inhibition of parasite growth by fractions of methanolic extract of *luffa cylindrica*

Fractions	0.001 mg/ml	0.01 mg/ml	0.1 mg/ml	1 mg/ml	IC_{50} mg/ml
	% Inhibition				
F1	20.04 ± 0.26[a]	19.00 ± 0.23[a]	11.95 ± 0.42[a]	76.99 ± 0.32[a]	NA
F2	20.05 ± 0.35[a]	13.99 ± 0.42[b]	23.02 ± 0.33[b]	42.99 ± 0.42[b]	NA
F3	20.99 ± 0.22[a]	21.00 ± 0.32[c]	27.99 ± 0.32[c]	85.99 ± 0.32[c]	NA
F4	20.99 ± 0.42[a]	12.95 ± 0.37[b]	26.95 ± 0.36[c]	87.00 ± 0.42[c]	NA
F5	14.025 ± 0.31[b]	22.99 ± 0.42[c]	23.99 ± 0.42[b]	89.01 ± 0.33[c]	2.48 ± 0.21[a]
F6	23.015 ± 0.31[c]	24.99 ± 0.42[d]	49.99 ± 0.42[d]	88.02 ± 0.23[c]	2.41 ± 0.44[a]

F7	20.99 ± 0.42^{a}	29.95 ± 0.22^{e}	88.02 ± 0.32^{e}	88.02 ± 0.33^{c}	2.23 ± 0.34^{a}
F8	26.02 ± 0.33^{d}	45.02 ± 0.44^{f}	89.02 ± 0.41^{e}	80.02 ± 0.34^{a}	2.30 ± 0.45^{a}
F9	23.02 ± 0.23^{c}	39.99 ± 0.42^{g}	85.02 ± 0.31^{f}	81.02 ± 0.33^{a}	2.31 ± 0.64^{a}
F10	24.02 ± 0.33^{c}	51.00 ± 0.43^{h}	89.02 ± 0.32^{e}	83.02 ± 0.41^{d}	2.20 ± 0.62^{a}
DMSO	2.05 ± 0.01^{e}	2.07 ± 0.01^{i}	2.06 ± 0.01^{g}	2.05 ± 0.01^{e}	NA
WR-194,964	21.22 ± 0.42^{a}	42.32 ± 0.33^{f}	85.04 ± 0.21^{e}	78.12 ± 0.35^{a}	2.31 ± 1.06^{a}

Values are means of three replicates ± SEM. Values with different alphabet superscript down the column are significantly different at $p < 0.05$.
DMSO – Dimethyl sulfoxide

Discussion

A number of assays for antimalarial activity have been developed for different stages of the malaria life cycle, but the assay used in this study has been developed for high-throughput screening for compounds that inhibit malarial growth in the human blood stage of the cycle. The lack of DNA and RNA in mature erythrocytes facilitates assaying malarial growth inside red blood cells by quantifying DNA with nucleic acid intercalating dyes. The assay (SYBR Gold) developed in the Gilberger laboratory is an adaptation of the malaria SYBR Green I-based fluorescence (MSF) assay reported by Johnson *et al*. (2007). The assay was modified to involve a 96-hour incubation period, rather than 48-72 hours, and uses SYBR Gold, rather than SYBR green to improve sensitivity. The *in vitro* antiplasmodial activity exhibited by both methanolic and ethylacetate extracts of *L. cylindrica* particularly with the methanolic extract which expressed the most efficacy maybe because it contain more metabolites than others. Anti-plaasmodial activities exhibited by plant extracts have been attributed to the presence of phenolics (Ravikumar *et al*., 2011), cardiac glycosides (Ene *et al*., 2009), alkaloids (Oliveira *et al*., 2009) terpenes (Moon *et al*., 2007), flavonoids and saponins (Ramazani *et al*., 2010) which are the secondary metabolites identified in this study. The mechanism of action might be by the inhibition of *P. falciparum* merozoites invasion into the red blood cells (Adams *et al*., 2005), inhibition of fatty acids biosynthesis (Tasdemir *et al*., 2007), inhibition of hemozoin biocrystallization by the alkaloids (Dubar *et al*., 2011), inhibition of proteins by terpenes (Kirby *et al*., 1989) and inhibition of β–haematin formation (Pabon *et al*., 2009). The significant reduction in *Plasmodium falciparum* growth observed in fractions F7-F10 of the methanolic leaves extract of *L. cylindrica* which also showed IC_{50} values close to the reference anti-malarial compound (WR-194,964) is an indication that these fractions (F7-F10) were more active in the red blood cell assay than other fractions (F1-F6). It is possible that the same class of the bioactive compounds is present in F7-F9 fractions since they show similar IC_{50} values. This therefore will warrant isolating and characterizing the active principle(s) in the F7-F10 fractions and conduct *in vitro* and *in vivo* anti-malarial studies in order to further substantiate anti-malarial claims of *L. cylindrica* as reported in folk medicine practice of Nigeria and as well to propose the possible mechanism of action. This is currently underway in our laboratory and will be provided in due course.

Conflict of interest

We declare there is no conflict of interest.

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PREVALENCE OF MALARIA PARASITES IN PREGNANT WOMEN IN ABAJI AREA COUNCIL , FCT ABUJA, NIGERIA.

RUNNING TITLE : MALARIA IN PREGNANCY IN ABAJI, FCT.

[1] OKOROIWU.G.I.A AND [2]UMAR.S.A

[1] Department of Public Health Science, Faculty of Health Sciences, National Open University of Nigeria, (NOUN). University village, Plot 91, Cadastral Zone, Nnamdi Azikiwe Expressway, Jabi Abuja.

[2] Department of Public Health Science, Faculty of Health Sciences, National Open University of Nigeria, (NOUN). University village, Plot 91, Cadastral Zone, Nnamdi Azikiwe Expressway, Jabi Abuja.

*Corresponding author**:** **oko**roiwugia@yahoo.com
*Phone number: 08036677539

ABSTRACT

Malaria infection during pregnancy is a significant public health problem with substantial risks for the pregnant woman, her fetus and the newborn child . This study was conducted to determine the prevalence of malaria parasite infection among pregnant women in Abaji Area Council, FCT, Abuja. A total of 300 pregnant women were sampled for malaria parasites infection using thick and thin film smears. Venous blood samples of 2mls were collected from pregnant women attending antenatal clinic in Primary Health Care Centres using needles and syringes to determine the presence of malaria parasite. Data was analysed using simple percentages and Chi-square analytical statistical tools. An overall prevalence of 111(37.0%; P= 0.171) was determined in the study, while the proportions of women infected were highest within the 36-40 years age cohort (80.0%) , followed by those in the age group of 21-25 years (43.0%) and 31-35 years (36.4%), those in 16-20 years and 26-30 years (28.6% and 25.0%) had the lowest. It is , however, believed that malaria infection is endemic (P=0.171) in the area council due to mosquitoe breeding grounds that abound in the council and poor environmental sanitation as noted during the study. Therefore, regular environmental sanitation and constant creation of awareness among the pregnant women will go a long way towards the reduction, if not total elimination of malaria in the area.

KEYWORDS:Malaria, Parasites, Pregnant, Bood, Woman, Abaji

INTRODUCTION

Malaria is a life-threatening disease caused by malaria parasites that are transmitted to people through the bites of infected female *Anopheles* mosquitoes (WHO, 2016). Nearly 600 million new infections and three million deaths each year are reported globally (Taura and Oyeyi, 2009). Burden of this disease falls heaviest among children below the age of five in sub-saharan Africa and 30% of the annual mortality in the populations attributed to malaria. In 2015 there were 212 million cases of malaria and 429,000 deaths and between 2010 and 2015, malaria prevalence among populations at risk fell by 21% globally (WHO, 2016); during the same period, malaria mortality rates among populations at risk decreased by 29%. An estimated 6.8 million malaria deaths have been averetd globally since 2001, and moreso, the WHO African Region continues to carry a disproportionate high share of the global malaria burden. And in 2015, the region was home to 90% of malaria cases and 92% of malaria deaths.

Approximately 35 million pregnant women are at risk of malaria infection each year in sub-Saharan Africa (McGregor,1984) . Adverse consequences of malaria infection during pregnancy include maternal anaemia, intra-uterine growth retardation (*McGregor et al.,* 1983), preterm delivery(*Bader et al.,* 2010), Still birth(*Yatich et al*., 2010); Brabin, 1983), and low birth weight(*Greenwood et al*., 1992). Low birth weight is associated with a marked increase in neonatal death (Guyatt and Snow, 2001).

Meta-analysis of malaria in pregnancy studies conducted in Eastern and Southern Africa between 1990 and 2011 showed that 32.0% of pregnant women attending antenatal care facilities had peripheral parasitaemia, and when the time period was restricted to studies conducted between 2000 and 2011, parasitaemia was 29.5% (*Chico et al*., (2012).

In Nigeria malaria is highly endemic being one of the countries in the tropical and sub-tropical zones, thus increasing the susceptibility of pregnant women in the country, thereby raising the rate of infections since transmission is stable and occurs throughout the year(*Onyenekwe et al*., 2002). Previous studies have reported a variation in the prevalence rates of malaria ranging from as low as 5% to as high as 99% depending on the location of study, sample size used or the method of screening (*Aliyu et al.,* 2011, *Wogu et al*., 2013, *Chukwuocha et al*., 2012), *Gunn et al.,* 2015).

National Malaria Elimination Programme (NEMP, 2015) states that Nigeria accounts for 25% of the global burden of malaria and has the highest number of cases of any country, highlitghting the need to focus on treatment as well as prevention. Nationwide, malaria prevalence varies widely, ranging from 14% in the South East Zone to 37% in the North West Zone (NEMP,2015). Prevalence of malaria varies across its range of distribution and is known to influenced by weather, which affects the ability of the main carrier of malaria parasites, *Anopheles* mosquitoes to survive or otherwise (*Mwangagia et al.,* 2007), and tropical areas including Nigeria have the best combination of adequate rainfall, temperature and humidity allowing for breeding and survival for *Anopheles* mosquitoes (*Okwa et al.,* 2009). Moreso, malaria transmission in Nigeria takes place all year round in the South but is more seasonal in the far Northern regions(WHO, 2010), and based on climatic parameters, the infection occurs between April and October in FCT, Abuja(*Ayanlade et al.,* 2010).

Malaria infection, during pregnancy is a significant public health problem with substantial risks for the pregnant woman, her fetus and the newborn child. Moreover, malaria-associated maternal illnesses and low birth weights are mostly the result of *Plasmodium falciparum* infection and occurs predominantly in Africa. Each year, 50 million women living in malaria-endemic areas become pregnant; one-half of these women live in Africa, and it is estimated that 10,000 women and 200,000 infants die as a result of malaria infection during pregnancy. Severe maternal anaemia, prematurity and low birth weight contribute to more than half of these deaths(WHO, 2017). Thus malaria infection in pregnancy continues to be a major health issue in endemic countries with clinical consequences including death of both mother and child. In Nigeria, statistics show that as many as 300,000

lives especially those of children and pregnant women are lost annually to malaria(Raimi and Kanu,2010).

A number of studies have been carried out on the prevalence of malaria parasite infection amongst pregnant women in Nigeria by different scholars and researchers (Alaku et al., (2015); Obianumba and Aribodor, (2012); Taura and Oyeyi, (2009); *Gajida et al.,* (2010); *Chimere et al.,* 2009) ; *Wogu et al.,* 1999).However, the report on this situation is scarce in Abaji area council , as well as in other five area councils of FCT Abuja, creating a very huge gap , and this is the rationale for this study in order to close the gap and present the updates and prevalence level in the area. For instance, *Alaku et al.,* (2015) and Obianumba and Aribodor, (2012) recorded 88.0% and 53.9% in their respective studies , while *Chimere et al.,* 2009) revealed 7.7% among pregnant women in Lagos South West of Nigeria. In Kano, Taura and Oyeyi, (2009) , got 51.7% as *Gajida et al.,* (2010) recorded 36.2% in the same state of Kano. Moreso, *Wogu et al.,* (1999) in their survey captioned malaria in pregnancy: Two-year prevalence among women attending antenatal clinics in a Nigerian Hospital reported 17.4% and 23.1% respectively in 2013 and 2014 among pregnant women, saying that the prevalences were higher among younger ones in their second and third trimesters.

Malaria infection has quite serious impact on the most vulnerable people in society which include pregnant women and girls, children less than 5 years, internally displaced persons and the homeless among others. Additionally, pregnant women have two to three times higher risk of suffering from malaria and this increases their risks of miscarriages, still birth, premature births, low birth weight and anaemia in pregnancy. All these complications may even lead to death(WHO, 2010). The protection of pregnant women living in malaria-endemic countries has been of particular interest to many National Malaria Control Programmes because of their reduced immunity(WHO,2017). The recent world malaria report (WHO, 2010), which indicated that Nigeria accounts for a quarter of all malaria cases in the 45 malaria-endemic countries in Africa, clearly showed the challenge of malaria in Nigeria. The principal impact of malaria infection is due to the presence of parasites in the placenta causing maternal anaemia (potentially responsible for maternal death when severe) and low birth weight. Despite considerable efforts to control malaria , it is still the most prevalent and devastating disease in tropical Africa with pregnant women and children below five years the highest risk groups (*Andy et al.,* 2018). The symptoms and complications of malaria during pregnancy have economic implications. Despite lack of evidence on the economic burden of malaria in pregnancy, it is likely that a substantial cost is imposed on the health services, household economy and the economy of the larger society(*Ayanlade et al.,* 2010).

With the interest of Nigerian government in controlling malaria through the various malaria control strategies and the theme for the 2016 world malaria day which is"End malaria for good with the slogan, it is Possible" and for the reason that report on the prevalence of malaria infection among pregnant women in Abaji Area Council is scarce and unavailable, it again becomes necessary to have this study "the prevalence of malaria infection among pregnant women attending antenatal clinic in Primary Healthcare Centres in Abaji Area Council" of the FCT Abuja, in orderto provide part of the much needed baseline data to effectively plan and control malaria infection in the area (among the population at risk, the pregnant women).

The Hypothesis for this investigation are:

(a) There is high prevalence of malaria infection among pregnant women in Abaji Area Council Abuja.
(b) There is low prevalence of malaria infection among pregnant women in Abaji Area Council Abuja.
(c) There is no malaria infection among pregnant women in Abaji Area Council Abuja.

METHODOLOGY

Study Area

Abaji area council is one of the six area councils that make up Federal Capital Teritory(FCT) Abuja. It borders with Toto

LGA in Nasarawa state to the EAST, Kwali area council to the north, Koton-Karfe LGA in Kogi state to the South and Niger state to the West. Abaji area council has a land mass of 1100Km^2 with an estimated total population of 169,896 (projected2006 census). Predominant tribes are Gbagyi, Ganagana, Bassa, Ebira, Hausa and other minority tribes. Their occupation is predominantly farming, trading, fishing and civil service .The area council is divided into 10 political wards and 27 primary health care centres or districts with 28 functional health facilities across the LGA.

Study Population
This study was carried out among pregnant women attending antenatal clincs in primary healthcare centres (Ayaura Primary Health centre; New Township clinic; Low cost clinic; Naharati Primary Health centre and Agyana Primary Health centre) of Abaji Area Council, FCT, Abuja.

Research Design
This is a cross-sectional descriptive study of the prevalence of malaria parasite infection among pregnant women in Abaji area council.

Sample Size Determination

A suitable sample size of pregnant women in Abaji area council was selected within the target population. Thus sample size was derived as follows:
A prevalence rate of 26.6% was chosen (*Naing et al.,* 2006) , margin of a sampling errror or precision tolerated was set at 5%, at 95% confidence interval using the formula:

$n = \frac{N^2P(1-P)}{d^2}$ n=sampla size, N= 1.96 (Statistical constant), P = 26.6% (Population based) d= 5% (marginal error or precision).

$$n = \frac{(1.96)^2 \times 0.266\ (1-0.266)}{(0.05)^2} = \frac{3.8416 \times 0.266 \times 0.734}{0.0025} = 300.01976 = 300$$

Sampling Technique
The blood samples from the pregnant women attending antenatal clinic in primary healthcare centres were randomly collected for laboratory tests to determine the presence of malaria parasites as the evidence of infection .

Sample Collection, Processing and Analysis.
A venous blood sample of 2mls was collected from the pregnant women using needle and syringe. Standard and careful laboratory procedures were adopted in collecting blood samples from the pregnant women. Thick and thin blood films of the blood samples were made on clean dry grease free slides, labelled and allowed to dry. The thin films were fixed in 70% alcohol to avoid lysis, allowed to dry and then stained with Leishmam stain for 10 minutes, while the thick films were stained with diluted Giemsa stain for 25-30 minutes and allowed to dry. The films were examined under the light binocular microscope using x100 objective lens, with a drop of oil immersion (Ochei and Kolhatkar, 2008; WHO,2000).
The presence of malaria parasite in either of the films is regarded as positive, either with one plus (+), two pluses (++) or three pluses (+++).

Data Analysis
Data obtained were analysed using simple percentages and Chi-square analytical method.

Ethical Consideration
Permission to carry out the study was obtained from the Committee in charge of health in the Area Council and informed consent was obtained from the pregnant women after explaining what they would gain by participating.

Results

Table.1 Prevalence of malaria parasite infection among the pregnant women

No. Examined	No. Positive(%)	No. Negative(%)
300	111(37.0)	189(63.0)

Table 1. shows the overall prevalence(37.0%) of malaria infection among the pregnant women in Abaji Area Council.

Table 2. Chi-square analysis of the data obtained.

				Monte Carlo Sig.(2-sided)		
			Asymptomatic Significance		95% Confidence interval	
	Value	Df	(2-sided)	Significance	Negative result	Positive result
Pearson Chi-Square	7.243[a]	4	0.124	0.110[b]	0.049	0.171
Likelihood Ratio	7.276	4	0.122	0.160[b]	0.088	0.232
Fisher's Exact Test	6.936			0.110[b]	0.049	0.171
N of Valid Cases	300					

Table 2 is the Chi-Square analysis of the data obtained showing the endemicity of malaria parasite infection among the pregnant women in Abaji Area Council.

In hypothesis one , there is high prevalence of malaria infection among pregnant women in Abaji area council Abuja, from the Chi-square test in table 2, the P-value for a positive result is 0.171 which is higher than the appropriate level of significance of 0.05, therefore, the hypothesis that there is high prevalence of the infection among pregnant women in Abaji area council is rejected. In hypothesis two, there is low prevalence of malaria infection among pregnant women in Abaji area council, but in table 2 the P-value for a negative result is 0.049 which is lower than the appropriate level of significance of P= 0.05, therefore , the hypothesis that there is low prevalence of malaria infection among pregnant women in Abaji area council Abuja is accepted. And in hypothesis three, there is no malaria infection among pregnant women in Abaji area council Abuja, however, the Chi-square analysis in table 2 shows that the P-value for a positive result is 0.171 which is higher than the appropriate level of significance of 0.05, and the P-value for a negative result is 0.049 which is lower than the appropriate level of significance of 0.05, there fore, this hypothesis is rejected. That is malaria infection among pregnant women in Abaji area council prevails and it is endemic.

Table 3 : The age distribution and prevalence of malaria parasite infection among pregnant women in Abaji Area Council FCT, Abuja.

Age group	No examined	No positive(%)	No negative(%)
16-20	21	6(28.6)	15(71.4)
21-25	123	54(43.9)	69(56.1)
26-30	108	27(25.0)	81(75.0)
31-35	33	12 (36.4)	21(63.6)
36-40	15	12 (80.0)	3(20.0)
Total	300	111(37.0)	189(63.0)

Table 3 showed that, pregnant women aged 36-40 years had the highest infection rate of 80.0% followed by 21-25 with 43.9% and others , 31-35, 16-20 and 26-30 years with 36.4%, 28.6% and 25.0% respectively.

Discussion

Malaria infection during pregnancy is a significant public health problem with substantial risks for the pregnant woman, her fetus and the newborn child. The result of this study showed that malaria infection is prevalent (P=0.171) among the pregnant women in Abaji Area Council (see table2). The overall prevalence of 37.0% (see table 1) observed in this study, though low, it is disturbing and constitute a major health threat among pregnant women in the area. Pregnancies in women living in malaria endemic region, particularly in Sub-

saharan Africa are associated with a high frequency and density of malaria parasite, with high rates of maternal morbidity (Niganda and Romero, 2003). This prevalence of 37.0% is low when compared with the results obtained from other parts of Nigeria. For instance, *Alaku et al.,* (2015), Obianumba and Aribodor, (2012); Taura and Oyeyi, (2009) and *Odikamnoro et al.,(*2014) recorded 88.0%,53.9%, 51.7% and 42.0% in their respective studies. It is however, high when compard with the studies reported in *Chimere et al.,* (2009) and *Gajida et al.,* (2010) who revealed 7.7% and 36.2% respectively. The relatively lower prevalence rates of malaria infection among pregnant women in the council, may not be as a result of the development of higher levels of the acquired anti-malaria immunity among them, but could be attributed to increased malaria awareness among women of child-bearing age in the council .

Moreso, other studies, for example *Adefioye et al.,* (2007) and *Nwagha et al.,* (2009) reported high prevalences of 72.0% and 60.0% respectively. The cause of high prevalence of malaria in pregnancy is unknown but studies by *Okpere et al.,* (2010) have explained this increased risk to be due to changes in the cellular immune responses that otherwise should offer protection, and increased attractiveness of the pregnant to mosquitoes. In addition, cellular immune responses change, result from the increased level of circulating maternal steroids in pregnancy. This has caused pregnant women to attract twice the number of mosquitoes compared with their non-pregnant counterparts (*Lindsay et al.,* 2000).

The variations in the reported prevalences is due to skill and experience of the laboratory personnels (Microscopists) involved in preparation of the films, staining and reading of the films (*Agomo et al.,* 2009) . Other factors that may have contributed to the differences could be due to several environmental factors such as socio-economic condition of the study population (*Worral et al.,* 2003) ignorance as well as level of education of the people (Anthonio-Nkonjio et al., 2006; Dicko et al., 2003) including level of exposure, disparities in nutritional status and unhygienic living conditions (*Worral et al.,* 2003) .The result of this work and others mentioned, showed the need for this group of women to always go for malaria check to avoid undesirable consequences arising from it.

The relationshp between the ages of the pregnant women and prevalence of malaria parasite is shown in table 3, there were more infections (80.0%) in the 36-40 years age group while 21-25 years age cohort recorded an infection rate of 43.9%. Meanwhile, 36.4% of those in 31-35 years age group were infected. 16-20 years age group had 28.6% while 26-30 years has 25.0%. This observation is in agreement with the statement made by WHO, (2000), that malaria infection is significantly high in pregnant women within the age bracket of 36-39 years and are more susceptible. However, this did not corroborate the work of *Anthonio-Nkonjio et al.,(* 2006), who posited that younger women appeared to be more susceptible to malaria infections by recording a prevalence of 68.8% among the age group of 21-25 years old , and this has the support of *Dicko et al.,* (2003) who opined that adolescents and young adult pregnant women were more susceptible to malaria infection than the older ones, due to continuous development of immunity against malaria in older women.

In conclusion, m**a**laria infection among pregnant women in Abaji Area Council is endemic, hence, effort should be geared towards improving their environmental conditions and educational backgrounds. Moreso, insecticide treated mosquito nets should be provided . Also government and area council should not only target the treatment of the age groups, but go further by creating more awareness on the importance of sleeping under insecticide treated nets . Nevertheless, early antenatal booking for effective monitoring and prompt treatment of malaria infection in pregnancy will contribute significantly in reducing maternal morbidity and mortality due to malaria infection.

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EXPERIENCES OF UNDERGRADUATE NURSING STUDENTS IN BAYERO UNIVERSITY KANO TOWARDS FACULTY AND CLINICAL BASED MENTORING

Abdulmaleek Musa Aliyu[1], *Danjuma Aliyu[2]. Emmanuel Ejembi Anyebe[3], Agaba Liberty Ozadiya[4], Sunday Oluwafemi Omoniyi[5], Mohammed Ramatu[6]

[1]Department of Nursing Science, Bayero University, Kano, Nigeria
[*2]Department of Nursing Services, A B U Teaching Hospital-Zaria, Kaduna State, Nigeria
*Correspondence: aliyudanjuma19@gmail.com; +2340835846627
[3]Faculty of Clinical Sciences, University of Ilorin, Ilorin, Nigeria
[4]Department of Nursing Services, Aminu Kano Teaching Hospital Kano, Nigeria.
[5]Department of Nursing Service, Federal Medical Centre-Bida, Nigeria,
[6]Department of Nursing Services, Pediatrics/Neonatology Unit, Barau Dikko Teaching Hospital, Kaduna State, Nigeria

Abstract

The study aimed at determining the experiences of undergraduate nursing students in Bayero University Kano on faculty and clinical based mentoring. Using a descriptive cross-sectional study design, the study deployed stratified and proportionate sampling methods to select students from the clinical level students. The sample size was 165 with a proportion of 77, 67, and 21 for 300L, 400L and 500 levels undergraduate students. A self-administered questionnaire (SAQ) developed by the researchers was used to collect data from the respondents. The data were analyzed using SPSS Version 20. The findings revealed that little above one-third of the study participants reported being mentored at both faculty and clinical settings. However, 52% of the students indicated the existence of mentoring structures put in place at both faculty and clinical settings but were not sure whether the structures are either formal or informal. Furthermore, significant relationship is found between faculty and clinical based mentoring satisfaction ($p< .009$), and overall rating of faculty mentoring with clinical based mentoring ($p< .001$). This study also highlighted divided opinions and effects of mentors' roles towards factors affecting both faculty and clinical based mentoring and the need to clarify mentors' roles in supporting student nurses learning process. It was therefore recommended that all involved in the training, supervision and mentoring of students should be up-to-date with current trends in nursing, mentoring, and research through higher degrees, seminars/conferences so that they can impart such knowledge on the students.

Keywords: Experience, clinical-faculty based mentoring, mentor, mentee, mentorship, nursing students

Background of the study

Mentoring has been identified in different researches, viewpoint, and countries as it increases levels of student nurses' academic success in a variety of ways. For instance, In the UK, Australia and Canada, nursing mentorship is specifically to supporting learning and assessment of students undertaking a Nursing and Midwifery Council program and there is a clear link between mentorship and engagement in clinical learning leadership skills, increased confidence and satisfaction (NMC, 2008; Theobald and Mitchell, 2002; CNA 2017).

As future professional nurses, nursing students are expected to acquire expert nursing knowledge and skills to prepare for the role transition as they move from the protective climate of school into the multidisciplinary and rapidly changing healthcare environments (Warren and Denham, 2010). Therefore, nursing education and training cannot succeed without proper correlation of theory with practice. To achieve this, nursing education and practice need to be structured to prepare student nurses for new responsibilities and challenges in healthcare environments (Benner *et al,* 2010).

Mentoring in nursing is part of the socialization process of the student nurse where the mentor is a source of inspiration, guide and role model that forms a bridge between theory and practice and ensures that students are fully functional when they qualify (Mabuda, *et al*, 2008; Booyens, 2000; Warren and Denham, 2010). Mentoring is a guided, non-evaluated experience, formal or informal, assigned over a mutually agreed-on period of time that empowers the mentor and mentee to develop personally and professionally within the auspices of a caring, collaborative, and respectful environment (Grossman, 2007). According to Spitzer & Miranda (2017), effective mentoring is an essential component in the development of future leaders in clinical practice.

Campbell & Campbell, 2007; Sherry 2016; Gichugi (2009) highlighted that; informal mentoring is the type of mentoring that occurs all the time and is a powerful experience. The problem associated with informal mentoring is that, it is often accessible only to a few students and its benefits are limited only to those few who participate in it whereas, formal or structured mentoring takes mentoring to the next level and expands its usefulness and corporate value beyond that of a single mentor-mentee pairing.

The mentor role in nursing is largely focused upon the stipulated competencies (NMC, 2006); however, this role is complex and multifaceted. Faculty and clinical based mentoring plays a major role in facilitating academic, clinical and professional competencies, particularly during training of undergraduate student nurses (Theobald & Mitchell, 2002; Royal College of Nursing, 2017). In effect, mentors provide support and encouragement by sharing academic, clinical resources and organizational tips to the mentees. Mentoring is a sustained collaborative relationship, which ensures assistance, support, and guidance for a less experienced person in the educational or professional setting (John *et al,* 2018) and in addition, it enhance, extend, empower the mentee (Edinburgh Napier University, 2011; Squires *et al,* 2017). A research on mentorship in academic medicine reported that mentorship has a significant influence on personal development, career guidance, career choice, and research productivity, recruitment, and retention (Sambunjak *et al,* 2006).

In addition to the vast amount of knowledge and skills students are expected to acquire during training, career planning is a significant challenge for nursing students near graduation or shortly thereafter (Sambunjak *et al,* 2006). Together, these factors can be quite stressful for nursing students, and it is important to provide guidance and support to help students navigate these challenges. There is increasing consensus among nursing educators regarding the need to provide adequate student mentorship and support (Dimitriadis *et al,* 2012).

In spite of several documented fact on the importance of effective mentoring, it remains unclear why many nurse researchers repeatedly report on the negative experiences of student nurses towards mentoring. For instance, Lekhuleni, (2004) reported in their research that student nurses displayed dissatisfaction

with their clinical learning experiences, indicating that both nurse educators and professional clinical nurses did not provide adequate accompaniment during student nurses' clinical placement in the Limpopo Province. John *et al,* (2018) reported in their study that, in Nigeria, some of the nursing training institutions only have informal mentoring in place while others have formal faculty based mentoring without appropriate clinical-based mentoring structures setting.

Nursing training institutions are associated with many challenges with the potential for both positive and negative impacts on student performance (Frei *et al,* 2010). In Nigeria, mentoring is not a new concept in academic circles but it has recently been revived, as there is a growing concern about raising academic- professional standards and a desire for Nigerian professional nurses to compete favourably with their counterparts in other parts of the world. The present study therefore examines faculty and clinical based mentoring experiences among nursing students of BUK located in North-west Nigeria.

Aim

The aim of the study is to determine the experiences of undergraduate nursing students in Bayero University Kano towards faculty and clinical based mentoring.

Methods and Materials

Study area

The study area for this survey is the Department of Nursing Science, Faculty of Allied Health Sciences, College of Health Sciences, Bayero University, Kano. The College is domicile in Aminu Kano Teaching Hospital (AKTH) Kano campus. The Department of Nursing Science was established in the Year 2008. It currently has 17 academic and 12 non-academic staffers. The Department is accredited by National University Commission, Nursing and Midwifery Council of Nigeria, and West Africa Health Examination Board and graduated the first set of Bachelor of Nursing Science students in 2015. In addition, the Department has four Postgraduate Nursing Programmes Postgraduate Diploma in Nursing Education, Postgraduate Diploma in Nursing Science, MSc and PhD). The first set of Post Graduate students were admitted in 2017/2018 session. There are 280 undergraduate and 39 postgraduate nursing students currently undertaking courses in the Department.

Study design

A descriptive cross sectional study design was utilized for the study.

Target population

The target population of the study comprised all the 280 clinical undergraduate students of Department of Nursing Science, Bayero University Kano.

Sample size

The sample size was calculated using Yamane formula (1967)

$$n = \frac{N}{1+N\,(e)^{\wedge 2}}$$

Where:

n= sample size

N = population size

e= sample error (e.g., .05, .01 acceptable error)

Therefore:

$$n = \frac{280}{1+280 *(0.05)^2}$$

$$n = \frac{280}{1+(280 *0.0025)}$$

$$n = \frac{280}{1+0.7}$$

$$n = \frac{280}{1.7}$$

$$n=165$$

Therefore, the sample size for this study is 165.

Sampling technique

The study deployed stratified and proportionate random sampling method to recruit the representative participants of 165 drawn from 300L, 400L, and 500 levels under-graduate students' nurses with a proportion of 77 (46%), 67 (41%), and 21 (13%) been allotted to three strata respectively.

Instrument for data collection

A self-administered questionnaire (SAQ) developed by the researchers was used to collect data from the respondents. The questionnaire comprised of five sections; Section A Socio-demographic data, Section B contains information on awareness of mentoring, Section C is on experiences of student nurses regarding faculty-based (departmental) mentoring while Section D is on experiences of student nurses regarding clinical-based mentoring and E contains questions on roles of mentors respectively.

Validity and Reliability of the instrument

The researchers constructed the tool after reviewing current literature. It was then presented to three nursing research scholars for scrutiny using face and content validity. To establish the reliability and stability, the questionnaire was pilot tested in a different but similar institution with 20 under graduate student nurses selected purposively.

Data Analysis

Data from the study was entered into Statistical Package for Social Sciences (SPSS) version 20 and analyzed using descriptive statistics. Findings of the study were presented using simple frequency tables and percentages. The mentors roles and effects of mentoring on students training was scored from real, perceived, and neutral. Association between categorical variables was expressed using Chi square ($\chi 2$) and test of statistical significance (p-value) was set at p=0.05.

Ethics consideration

Ethical approval was obtained from the Research Ethics Committee of the College of Health Sciences, Bayero University, Kano. An informed consent was sought from the respondents for voluntary participation in the study in line with Helsinki Declaration.

RESULTS

Table 1: Frequency distribution of the respondent as regards to Socio-demographic characteristics (n=165)

Socio-demographic data	n	%
Gender		
Male	78	47.3
Female	87	57.7
Age group		
18-24	114	69.1
25-34	49	26.7
35-44	2	1.2
Religion		
Islam	97	83.6
Christianity	19	16.4
Ethnicity		
Hausa/Fulani	129	78.2
Yoruba	7	4.2
Igbo	3	1.8
Others	26	51.8
Academic levels of the students		
300L	107	64.8
400L	39	23.7
500L	19	11.5
Level of starting clinical posting		
100L	8	4.8
200L	157	95.2

As indicated in Table 1, more than half (57.3%) of the participants were female, aged between the age of 18 and 24 years(72.4%)(mean age: 23.4; SD(± 2.6 years). More than four in every five (83.6%) participants are Muslims, and mostly Hausa/Fulani ethnic extraction (78.2%). Most participants 64.8% noted their academic level at 300 levels and an overwhelming majority (95.2%) of them mentioned that they started their clinical posting at 200 levels.

Table 2: Respondents' Awareness of mentoring (N=165)

Awareness	n	%
Heard about mentoring before		
Yes	126	76.4
No	33	20.0
Unsure	6	3.6
Were you mentored in your current training		
Yes	113	68.5
No	46	27.9
Unsure	6	3.6
Setting of been mentored		
Clinical	38	23.0

Faculty	26	15.8
Both	60	36.4
Unsure	41	24.8
Collaboration between faculty and clinical setting		
Yes	125	75.7
No	15	9.1
Unsure	25	15.2

As indicated in Table 2, most of the participants (76.4%) have heard about mentoring before and most (68.5%) indicated that they are being mentored in their current training as students' nurses. Regarding the settings of mentoring, more than one-third (36.4%) of the participants indicated that they were both mentored at faculty and majority (75.7%) reported that there was a collaboration between their faculty of training and clinical setting.

Table 3: Participants experiences with faculty and clinical based mentoring (n=165)

Experiences	**Faculty n (%)**	**Clinical n (%)**
Availability of structure mentoring plan		
Yes	79 (47.9)	85 (51.5)
No	66 (40.0)	56 (33.9)
Unsure	20 (12.1)	24 (14.6)
Types of mentoring structure plans at the settings		
Formal	52 (31.0)	52 (31.5)
Informal	28 (17.5)	33 (20.0)
Unsure	85 (51.5)	80 (48.5)
Are you satisfied with the level of mentoring received?		
Yes	111 (67.3)	112 (67.9)
No	54 (32.7)	53 (32.1)
Were you assigned to a mentor?		
Yes	56 (33.9)	74 (44.8)
No	109 (66.1)	91 (55.2)
Were the mentors committed to their work?		
Yes	89 (53.8)	101 (61.2)
No	76 (46.2)	64 (38.8)
Were you helped to build self-confidence?		
Yes	112 (68.0)	107 (64.8)
No	53 (32.0)	58 (35.2)
Were you guided to navigate through complex problem solving?		
Yes	105 (63.6)	107 (64.8)
No	60 (36.4)	58 (35.2)
Was there mutual respect between you and the mentors?		
Yes	129 (78.2)	134 (81.2)
No	36 (21.8)	31 (18.8)
Were the mentors open-minded?		
Yes	138 (83.6)	128 (77.6)
No	27 (16.4)	37 (22.4)

The result of the study as shown in Table 3 indicates that less than half (47.9%) of the participants reported that, there is availability of structure mentoring plan at the faculty of their training and little above half (51.5%) were not sure of the type of mentoring structures put in place at their faculty of their training. More than two-third (67.3%) and (67.9%) of the participants in this study indicated that they were satisfied with the level of mentoring they experienced at both faculty and clinical settings and on the other hand, (66.1%) reported that, they were not assigned to any mentor at the faculty to mentor them. Table 3 also shown that, little above half (53.9%) of the participants reported that, their faculty mentors were committed with mentoring process and more than two-third of the participants depicts that their mentors helped build their self-confidence at both faculty and clinical settings. Similarly, (63.6%) and (64.8%) reported that, they were guided to navigate through complex problems in the course of their training. The results of the study further revealed that a good number (78.2%) and (81.2%) of the participants' agreed that there was a mutual respect between them and their mentors at both settings and (83.6%) and (77.6%) reported that, most of the mentors were open-minded at the faculty and clinical settings.

Table 4: Distribution of the mentors' roles as experienced by the students (n=165)

S/N	Roles	Real n (%)	Perceived n (%)	Neutral n (%)
A	Mentors assess learning needs and supervised students	102 (61.8)	38 (23.0)	25 (15.2)
B	Mentors demonstrate effort in putting themselves out to help students	80 (48.5)	52 (31.5)	33 (20.0)
C	Empower students to achieve proficiency in tasks	77 (46.7)	48 (29.1)	40 (24.2)
D	Strengthen professional competence and efficiency among the students	74 (44.8)	62 (37.6)	29 (17.6)
E	Mentors provide individualized support base on mentees' learning needs	68 (41.2)	66 (40.0)	31 (18.8)
F	Mentors have good interpersonal relationship with students	64 (38.8)	64 (38.8)	37 (22.4)
G	Motivate, inspire and build students confidence	64 (38.8)	64 (38.8)	37 (22.4)
H	Mentors are conscious of the mentee demands	57 (34.5)	79 (47.9)	29 (17.6)

Table 4 showed the distribution of the mentors' roles as experienced by the students. It is worthy to note that, there are divided responses from the participants as regards to their experiences with the mentors' roles been rated as either real or perceived. Notably, three in every five 61.8% participants rated that, mentors assess their learning needs and supervised students as real while 47.9% of them perceived that mentors are conscious of the mentees demands.

Table 5: Distribution of the effects of mentoring on participants training (n=165)

S/N	Effects of mentoring	Real n (%)	Perceived n (%)	Neutral n (%)
A	Improved intellectual capacities	73 (62.4)	36 (21.8)	26 (15.8)
B	Ability to communicate effectively	92 (55.7)	47 (28.5)	26 (15.8)
C	Improved motivation	89 (53.9)	47 (28.5)	29 (17.6)
D	Improved clinical practice	87 (52.7)	49 (29.7)	29 (17.4)
E	Promotes and encourages self-development	84 (50.9)	66 (40.0)	15 (9.1)

F	Self-responsibility for learning	79 (47.9)	54 (32.7)	32 (19.0)
G	Self-awareness and enhances problem solving skills	77 (46.7)	54 (34.5)	31 (18.8)
H	Prepared to foster a dynamic knowledge base	77 (46.7)	57 (34.5)	31 (18.8)
I	Supportive & evaluative actions	72 (43.6)	62 (37.6)	31 (18.8)
K	Prepared to be innovators	67 (40.6)	69 (41.8)	29 (17.6)
K	Application of research and theory to practice	67 (40.6)	54 (32.7)	44 (26.7)

The results of the effects of mentoring on the participants training (Table 5) revealed that more than half of the participants rated improved intellectual capacities 62.4%, ability to communicate effectively 55.7%, improved motivation 53.9% and promotes and encourages self-development 50.9% as "real" effects.

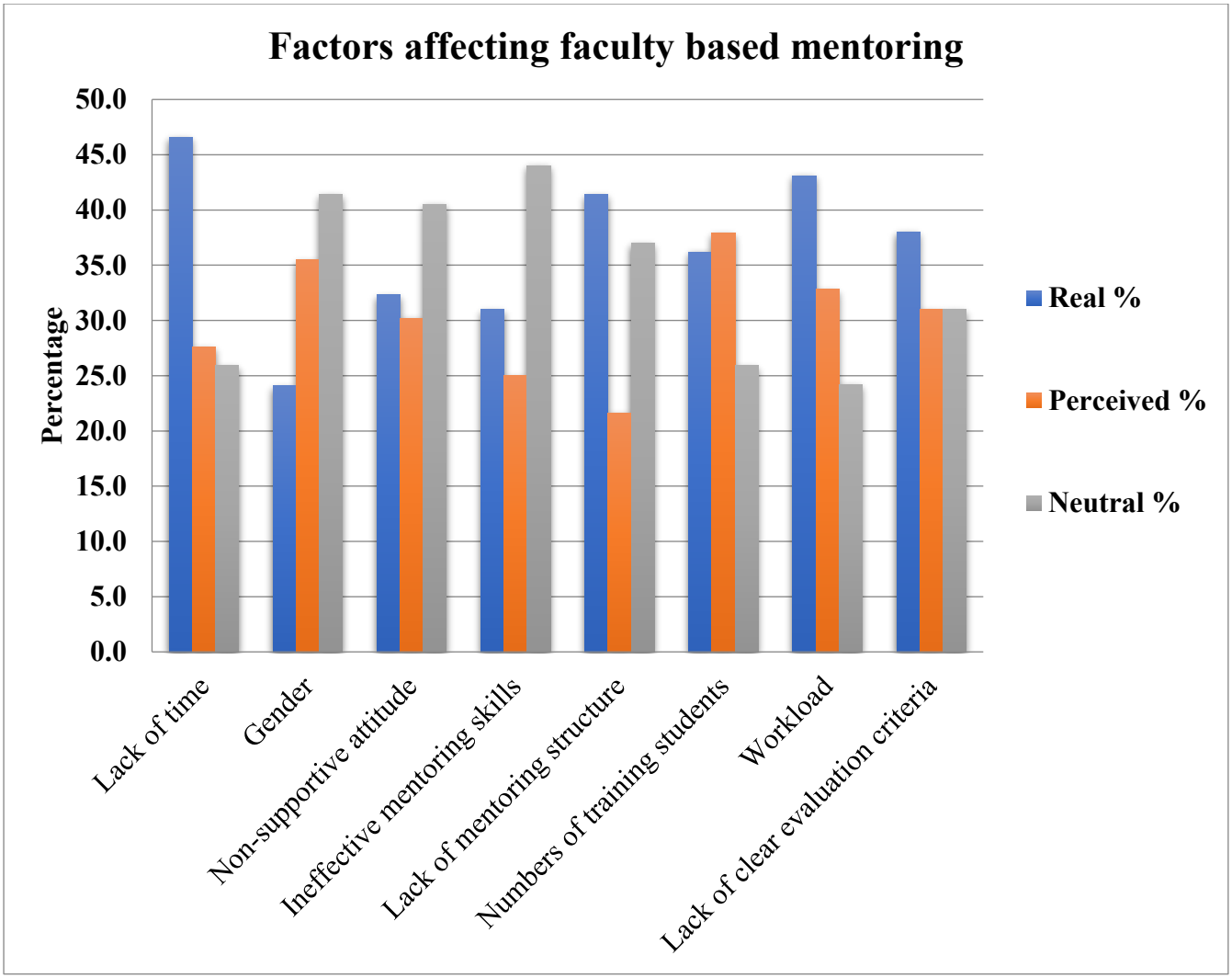

Figure 1: Factors affecting faculty based mentoring

Figure one displayed factors affecting faculty based mentoring as actual or perceived by the students. Lack of time (real 47%, perceived 28%) has the highest frequency among the factors responded to by the participants followed by workload (real 43%, perceived 33%), and lack of mentoring structure (real 41%, perceived 22%).

Figure 2: Factors affecting clinical based mentoring

The study showed comparable distribution among students experience when it comes to the factors affecting clinical based mentoring, and they noted specific factors (Figure 2). The main factor students indicated was lack of time - 49% of the students found this as actual and 31.9% establish this as perceived. The result of figure 2 also presents other factors reported by the participants as actual and perceived factors affecting clinical mentoring in priority order, are workload (real 46%, perceived 31%), number of students in training (real 43%, perceived 33%), lack of mentoring skills (real 38%, perceived 34%), non-supportive attitude of the mentors (real 29%, perceived 31%), gender (real 27%), perceived 30%) and lack of clear evaluation criteria affects clinical mentoring of students (real 26%, perceived 35%).

Overall rating of faculty and clinical based mentoring

The overall rating of faculty and clinical based mentoring that 72% of the participants rated the overall quality of mentoring received at the faculty as good while 66% rated clinical mentoring as good respectively.

Table 6: Correlation analysis of some selected variables

Variables	$\chi 2$	*P*
Faculty based satisfaction with clinical based mentoring	17.133	.009
Overall rating of faculty based mentoring with clinical based mentoring	22.043	.001

Participants mentoring were significant at both the faculty and clinical levels. Table 6 shows significant relationship between faculty based satisfaction with clinical based mentoring ($p<$ .009) and overall rating of faculty based mentoring with overall rating of clinical based mentoring ($p<$ .001).

DISCUSSION

The study provides the foremost evidence on faculty and clinical based mentoring and contributes to the existing knowledge on issues of mentoring of student nurses at both faculty and clinical settings. The study assessed and described the experiences of undergraduate nursing student in Bayero University Kano towards faculty and clinical based mentoring.

Socio-demographic data

The findings of this study revealed that majority (69%) of the respondents were between the ages of 18 and 24 years with the mean age of 23.4 (± 2.6) years. Eighty-four percent of the participants are Muslims and seventy percent were Hausa/Fulani by ethnicity. These results are similar with Garba *et al,* (2018) where they reported that more than half (59%) of the undergraduate students of Bayero University Kano were between the ages of 18-24 years with a mean age of 23+ 1.2 years. Furthermore, majority of the respondents (89%) in their study are Muslims and more than half of them (58%) are equally Hausas/Fulanis. The gender pattern of the participants in this study elucidates a new order compared to the findings in other studies where most of the participants were males.

Awareness regarding mentoring

The findings from the respondents showed that more than two-third of the participants have heard about mentoring before and little above two-third indicated that they were mentored in their current training as student nurses. In addition, the findings of this study revealed that, more than one-third (36%) of the participants indicated that they were both mentored at faculty and clinical settings while (23%) said they were only mentored at clinical setting and majority (76%) reported that there was a collaboration between their faculty of training and clinical setting. This agreed with the reports of Royal College of Nursing when they stated that, mentoring at both faculty and clinical based is critical in facilitating academic, professional, and social development, especially at the undergraduate student nurses training (Royal College of Nursing, 2012). The report further depicts that, mentoring of students especially at the undergraduate levels plays a vital role in preparing nursing students for professional roles and is therefore important during nursing students'

clinical placements (Royal College of Nursing, 2012; Moscaritolo, 2009).
The significance of effective mentoring of students requires fluent institutional relationships between the university and the clinical setting, besides pedagogic, clinical, and academic attributes of the mentors, which along with experience; improve the quality of the mentees learning and by extension, the formation of future nurses (Maciá-Soler *et al,* 2014). This finding is in congruence with the result of this study, which point out that, seventy-six percent of the participants reported that there was a good collaboration between their faculty of training and the clinical area of their posting.

Experiences with both faculty and clinical based mentoring

In relation to the items on participants' experiences with both faculty and clinical based mentoring, 48%, and 52% of the participants reported that, there are structured mentoring plans at the faculty and clinical settings of their training while most of them were not sure whether the structures were either formal (documented) or informal. This findings is in agreement with that of John *et al,* 2018 who established that, some of the nursing training institutions only have informal mentoring in place while others have formal faculty based mentoring without appropriate clinical-based mentoring structures setting.
Little above two-third of the participants acknowledged that they were satisfied with the level of mentoring they experienced at both faculty and clinical levels and on the other hand, about two-third and little above half of the study participants reported that they were not assigned to any mentor during the mentoring process. Despites the satisfaction with the level of mentoring received by the students, a good number of them reported that, they were not assigned to any mentor, this may be culture-driven considering the nature and religion background of the study area, mentors-mentees faiths. This is in spite of the emphasis made on the implementation and proper protocols to be put in place at various nursing institutions (Afe, 2001; Domike, 2002; Anderson, 2003; Knoeil, 2012). On one hand, this finding is not equally in line with the NMC guidelines (NMC 2006) which stated that, student nurses should be allocated a named mentor before starting a placement, half of the students (n=57/115, 50%) reported that this had been their experience, although a sizeable minority of 10% (n =12/115) indicated that they had 'never' been assigned a named mentor in advance of commencing a new placement.
Further discoveries from this study also revealed that little above half of the participants reported that, both the faculty and clinical based mentors were committed with mentoring process, more than two-third depicts that their mentors helps to build their self-confidence. Similarly, about two-third reported that, they were guided to navigate through complex problems while a good number 78% and 81% of the participants' affirmed that there was a mutual respect between them and the mentors at the faculty and clinical levels and 84% and 78% also reported that, most of the mentors were open-minded. These findings are in harmony with that of John *et al,* 2018 were the participants reported that they *"My mentor protects me from unnecessary goals & activities & makes me focused and committed", "My mentor helped to build my self confidence by her commitment and frequent feedback" and "My mentor inspires me and guides me to navigate complex problems during clinical posting".*

Mentors roles experienced by the students

Form the results of the questionnaire on mentors' roles as experienced by the students. About two-third (62%) of the participants rated that mentors assessed their learning needs and supervised students as real while 49% of them perceived that mentors are conscious of the mentees demands. This finding is congruent with the study of Adediwura & Tayo (2007) where they stated that, academic achievement and student behaviour are influenced by the quality of the teacher-student relationship since the more mentors communicate with their students and assessed their learning needs. Hence, the more likely they will help students learn at a high level and accomplish quickly (Merja, *et al,* 2010).

Effects of mentoring

Findings on the effect associated with students mentoring revealed a good number of the participants rated improved

intellectual capacities 62%, ability to communicate effectively 56%, improved motivation 55%, promotes, and encourages self-development 51% as real effect. This finding is not line with Sharif and Masoumi (2005) in Iran, Elcigil and Sari (2007) in Turkey and Safadi *et al,* (2011) in Jordan, where students reported disparities between what they learnt in class and simulation laboratory and the actual practice in clinical practice. Even though, theory forms the basis for learning which students have to apply in the clinical practice in order to make meaning from the theory.

Factors affecting both faculty and clinical based mentoring

The findings from this study on factors affecting both faculty and clinical based mentoring showed that four in every ten participants indicated that lack of time (47%), workload 43%, lack of mentoring structure 41%, and numbers of the trainees 43% were the real factors affecting both mentoring. This finding is in agreement with the report of Bray & Nettleton (2007) where they stated that, despite several studies on mentoring in nursing, there are still factors and confusion affecting the description of mentoring roles in the context of students.

Rating of the overall faculty and clinical based of mentoring

It is worthy to note that majority of the participants rated the overall quality of mentoring received at both the faculty (72%) and clinical (66%) as good and further revealed that there are significant relationship between faculty with clinical based mentoring satisfaction ($p< .009$), and overall rating of faculty mentoring with clinical based mentoring ($p< .001$). These findings are consistent with other studies (Wasserstein *et al,* 2007; Chew *et al,* 2003) which revealed that mentees were significantly more satisfied with their jobs compared to those without a mentor.

CONCLUSION

In conclusion, the study provided new insights into the exclusive experiences of nursing students towards faculty and clinical based mentoring. The findings of this study revealed that only little above one-third of the study participants reported been mentored at both faculty and clinical settings. However, a good number of the students indicated that there were mentoring structures put in place at both faculty and clinical settings but were not sure whether the structures are either formal or informal. Notably, this study has highlighted the alienated experiences and effects mentoring roles, factors affecting both faculty and clinical based mentoring and the need to clarified mentors' roles in supporting students' nurses learning process.

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Conflict of interest

The authors declare that no conflicts of interest exist.

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ANTI-NUTRITIVE FACTORS, MINERAL PROFILE, *IN VITRO* GAS PRODUCTION AND FERMENTATION CHARACTERISTICS OF SOME BROWSE FORAGE LEAVES

A. A. Njidda

Department of Animal Science and Fisheries, National Open University of Nigeria, KM4, Kaduna-Zaria road, Rigachukun, Kaduna State, Nigeria.
Corresponding author's e-mail: ahmednjidda7@gmail.com

ABSTRACT
The nutritive value of leaves from ten (10) different browse trees and shrubs were analyzed using the *in vitro* gas production. Crude protein (CP) contents in the browses ranged from 114.90 to 173.90 $g.kg^{-1}$ dry matter (DM). A range of 30.60 to 51.60 g kg^{-1} DM were recorded for EE values for the eight browse plants.. The NDF, ADF and ADL were 412.10 to 688.10, 211.60 to 265.60, and 88.30 to 140.30 $g.kg^{-1}$ DM respectively. The values reported for anti-nutritive factors range from 0.08 to 0.39 for TCT, 0.31 to 0.71 for phenolics, 1.08 to 2.99 for Saponin, 4.58 to 8.00 for Oxalate, 2.22 to 7.33 for phytate. The values reported for minerals showed significant different ($p<0.05$) for all the macro minerals, this follow a similar pattern for the trace minerals except for cobalt and nickel. The *in vitro* gas production was highest (28.33 ml/200 g DM) and lowest (3.66 ml/200 g DM). The fermentation characteristic a, b, a+b, c, t, Y were highest at (3.67, 25.00, 28.33, 0.057, 18.00, and 11.33 respectively. All the gas production parameters differ significantly ($P<0.05$). Based on chemical composition and *in vitro* gas production results, it showed that the leaves of the browse forages had nutritive value and therefore, may serve as potential supplements for ruminants in Nigeria.

Key words: *In vitro*, browse, semi-arid, anti-nutritive, forage

INTRODUCTION

Forages and grain-based diets have similarly energy contents, yet productivity of ruminants fed grains is often twice that from good quality forages. The principal difference between grains and forages is the presence of lignified cell walls that account for 300-500 g kg^{-1} forage DM. Cell walls are the dominant feed fraction for grazing ruminant. They comprise mainly cellulose and hemicellulose, and in legumes pectin, all of which are rapidly and extensively degraded by rumen micro flora when lignin is not present.

The use of *in vitro* gas produxtion method to estimate digestion of feeds is based on measured relationship between the *in vivo* digestibility of feeds and chemical composition (Menke and Steingass, 1988), *in vitro* gas methods primarily measure digestion of soluble and insoluble carbohydrate (Menke and Steingass, 1988). The amount of gas produced from a feed on incubation reflects production of volatile fatty acids (VFA)., which are major sources of energy for ruminants. Gas arises directly from microbial degradation of feeds and indirectly from buffering of acids generated as a result of fermentation. The aim of this research is to evaluate the nutritive value of some selected browse forage leaves available as livestock feeds.

MATERIALS AND METHODS

Description of site and the samples

All forages were harvested from Gwoza local government area of Borno State. The area is located at Longitude 11.05^0 North and Latitude 30.05^0 East and at an elevation of about 364m above sea level in the North Eastern part of Nigeria. The ambient temperature ranges between 30^0C and 42^0C being the hottest period (March to June) while it is cold between November and February with temperatures ranging between 19 - 25^0C (Njidda *et al.*, 2008).

Ten browse forages commonly found in the Semi-arid and derived Savannah zones were used in this experiment. The samples were sundried and milled and sub samples taken for analysis. The species included the following: *Adansonia digitata, Anageisus celecarpus, Analgeosus leocarpus, Batryospermum paradoxum, Buahinea nufescens, Ceiba pentendra, Celtis integuifolis, Khaya senegalensis, Kigalia africana, Poupartia sirrea.* The browse forages were harvested from at least 10 trees per species selected at random in four locations within the study area at the end of rainy season.

Sample Preparation

About 500g of the harvested samples pooled weekly from each plant was oven dried at 105^0C for 24hours, cooled and weighed. The weight difference between the initial weights and dried weights was taken as the moisture content of the leaves offered and then converted to percentage. Percent dry matter content was then obtained as the difference between 100 and percent moisture content (AOAC, 2002). The dried weekly samples were then bulked according to plant species and each shared into two portions. One portion was milled to pass through 1mm screen sieve, labelled and stored in sealed polythene bags for degradability and *in vitro* studies. The other portion was milled to pass through 1mm screen sieve, labelled and as well stored for proximate composition and anti-nutritional factor determinations.

Chemical Analysis

Triplicate samples of the thirty seven samples were analyzed for dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF), Oxalate, Fluoroacetate and ash according to AOAC (2002) procedures. The dry matter content of the samples was as earlier descrbed. One gram of each sample was used for the determination of ash by complete combustion in a furnace at 550^0C for 4hours. The fibre fractions was determined according to the method of Van Soest *et al.* (1991).

Mineral analysis

The mineral contents of the browse leaves used in this experiment were analysed using the standard method of AOAC (2002). Calcium, Magnesium, iron, copper, zinc Selenium, Nikel and manganese were analyzed using the atomic absorption spectrophotometery (Zohary, 1973). Phosphorus was determined according to the vanadomolybdophosphoric acid method (Shiou, 1996) using a spectrophotometer (Jenway 6100, UK) while the flame photometer was used to estimate sodium and potassium contents.

Anti-Nutritional Factors Assessment in the Samples

Some anti-nutritional constituents that were determined in the browses include Phytate estimated as phytic acid using the method prescribed by Maga (1982), while hydrogencyanide (HCN) was determined by the Knowels and Watkins distillation method as described by Pearson (1976). Saponins and total condensed tannin were determined as reported by (Babayemi *et al*., 2004a) and (Polshettiwar *et al*., 2007). Finally, Phenolics were determined using Folin Ciocalteu metho as described by Makkar (2000).

***In-vitro* gas production study**

Management of the Animals

Rumen fluid was obtained from three West African dwarf Sheep using a suction tube before morning feeding. The goat were fed 60 % concentrate (40 % corn, 10 % wheat offal, 10 % palm kernel cake, 20 % groundnut cake, 5 % soybean meal,10% dried brewers grain, 1 % common salt, 3.75 % oyster shell and 0.25 % fish meal) and 40 % Guinea grass (*Panicum maximum*).

Incubation of samples

The incubation procedure was as reported by (Menke and Steingass, 1988). The 120 ml calibrated syringes fitted with silicon tube at the mouth were used while the incubation was in three batch incubation. The incubation temperature was maintained at 39 ± 1 ºC. The buffer containing (9.8g $NaHCO_3$ + 2.77g Na_2 HPO_4 +0.57g KCl + 0.47g NaCl + 0.12g $MgSO_4$.$7H_2O$ + 0.16g 1 litre $CaCl_2.2H_2O$) (1:4, v/v) was used and kept in the incubator for warming. About 200 mg of the feed sample (substrate) was measured and introduced into the syringe after removing the plunger. The plunger was replaced by pushing the substrate upward the syringe. The rumen liquor was strained through a four layer cheese cloth. Rumen liquor and buffer were mixed together (1:4, v/v) as inoculums, all under continuous flushing with streams of CO2. Using 120 ml capacity syringe, 30 ml of inoculums was dispensed into the substrate through the silicon tube. The plunger was pushed upward by pushing the inoculums to the tip of the syringe. Thereafter, the silicon was tightened with a metal clip. The gas production was measured from the calibrated syringe at 3, 6, 12, 24, 48, 72 and 96 hour.

$G=a + b\ (1-e^{-ct})$

Where:

G = is the gas production (ml) at time t

a = is the gas production from the immediately soluble fraction (ml),

b = is the gas production from the insoluble but degradable fraction (ml),

a + b = is the potential gas production (ml),

c = is the rate constant of gas production (fraction/h).

Statistical analysis

Data obtained were subjected to analysis of variance. Where significant differences occurred, the means were separated using Duncan multiple range F-test of the SAS **(1988) options.**

RESULTS

Proximate composition

The chemical composition of the browse forage leaves determined in this study is presented in Table 1. Generally, the examined plant leaves had high crude protein content with values ranging from a low value of 114.90 g kg^{-1} DM in *Bauhinea nufescecens* to 160.00 g kg^{-1} DM in *Adansonia digitata.* The range for ether extract in the browse was 30.30 g kg^{-1} DM in *Khaya senegalensis* to 51.60 g kg^{-1} DM in *Poupartia sirrea.* Values obtained for organic matter content of the browse forages ranged from 742.60% in *Poupartia sirrea* to 868.70 g kg^{-1} DM in *Khaya senegalensis.* The highest neutral detergent fibre content of 595.90 g kg^{-1} DM was recorded in *Celtis integuifolis* while *Adansonia digitata* had the lowest value of 412.10 g kg^{-1} DM. The acid detergent fibre levels in the experimental leaves ranged from 211.60 g kg^{-1} DM in *Khaya senegalensis* to 265.60 g kg^{-1} DM in *Batryospermum paradoxum*. The least lignin content of 88.30 g kg^{-1} DM in the browse forages was recorded in *Anageisus celecarpus* while *Poupartia sirrea* had the highest value of 140.30 g kg^{-1} DM.

Anti-nutritional factor levels of semi-arid browse forages

The result of the anti-nutritional constituents in the browse forage leaves is shown in Figure 1. Total condensed tannin varied from 0.08 mg/g Dm in *Kigalia africana* to 0.39 mg/g DM in *Celtis integuifolis*. A range of 0.31 mg/g DM in *Analgeousus leocarpus,* and *Poupartia sirrea* to 0.71 mg/g in *Ceiba pentendra* was

obtained for phenolic. Saponin content of the experimental leaves range from 1.08 mg/g DM in *Poupartia sirrea* to 2.99 mg/g DM in *Ceiba pentendra.* Oxalate in the browses used ranged from 4.58 mg/g DM in *Ceitis integuifolis* to 8.00 mg/g DM in *Batryospermum paradoxum*. The highest value of 7.33 mg/g DM was obtained in *Kigalia africana* while *Ceiba pentendra* had the lowest value of 2.22 mg/g DM for Phytic acid in the browses studied.

Macro mineral concentration of semi-arid browse forages

The result of the macro mineral concentration is shown in Table 2. Leaves from *Analgeosus leocarpus* had the highest calcium amongst the browses with 13.20 g kg^{-1} DM which dropped to 7.60 g kg^{-1} DM in *Buahenia nufescens.* Phosphorus had the highest recorded level of macro mineral (271.80 g kg^{-1} DM) in *Ceiba pentendra* while *Kigalia africana* with 102.50 g kg^{-1} DM had the lowest level. The magnesium level was highest with a value of 10.40 g kg^{-1} DM in *Celtis integuifolis* and lowest with a value of 1.70 g kg^{-1} DM *Kigalia africana.* The sodium concentration in the browse forages were generally low with levels less than 1.50 g kg^{-1} DM for the browse forage leaves. Potassium concentration in *Poupartia sirrea* was significantly ($p<0.05$) higher (120.00 g kg^{-1} DM) than all the browses studied while *Bauhinea nufescence* had the lowest value (6.30 g kg^{-1} DM) amongst the browse forages.

Trace mineral concentration of semi-arid browse forages

Table 3. Showed the composition of micro minerals estimated in the browse forages used in this experiment. The iron content of the browse forages ranged between 1.216 mg/g DM in *Ceiba pentendra* to 16.24 mg/g DM in *Kigalia africana*. Significant difference ($p<0.05$) were observed among browse forages for zinc with *Adansonia digitata* having the highest while *Poupartia sirrea* having the lowest value of 1.064 mg/g DM. The cobalt and Nickel content of the browse forage leaves was generally low for all the browse forage leaves (below 0.012 and 0.032 mg g^{-1} DM) and showed no significant differences among browse forages. Among the browse forages, *Kigalia africana* having the highest value of 2.923 mg/g DM while *Poupartia sirrea* had the lowest concentration of 0.234 mg g^{-1} DM.

***In vitro* gas production**

The *in vitro* cumulative gas production after 96 h, potential gas production (asymptotics gas production; fraction b), and rate of gas production (fraction c) of the browse forges are presented in Figure 2. The forages significantly ($P<0.05$) differ in the gas production and fermentation characteristics. *Adansonia digitata* produced the highest gas production (28.33 ml/200 mg DM) throughout the incubation period from 3 to 96 h while *Analgeousus leocarpus* produced the least gas volume of 3.66 ml/200 mg DM at 96 h.

Fermentation characteristics of semi-arid browse forages

The gas production from the immediately soluble fraction ‘a’ as shown in Table 4 is generally low for all the browse forages with values ranging from 1.33 in *Analgeosus leocarpus* and *Buahenia nufescens* to 3.67 in *Anageisus celecarpus.* The fermentation of the insoluble but degradable fraction ‘b’ is shown in Table 4. The value for ‘b’ was highest in *Adansonia* 28.33 ml) and least in *Analgeosus leocarpus* (2.67 ml). The potential gas production ‘a+b’ was observed to be low for all the browse forages with the highest value (28.33 ml) in *Adansonia digitata* and the least value (4.00 ml) in *Analgeosus leocarpus*. The gas production ‘Y’ at time‘t’ ranged between 3.50 in *Analgeosus leocarpus* and 11.33 in *Adansonia digitata.*

DISCUSSION

The Crude protein (CP) content of *Adansonia digitata* is higher than the other species. The CP of the browse species ranged from 114.90 to 160.00 g kg^{-1} DM, which is above the 7% CP requirement for ruminants and could provide ammonia required for optimum microbial activity in the rumen (Norton, 2003). The values also falls within the range reported by Njidda *et al.* (2010) and Njidda *et al.* (2013c). The high CP content of browse species is one of the main distinctive characteristic of browse forages compared to most grasses. The NDF, ADF and ADL values of the experimental diets were higher than earlier reports on the tropical forage species (Njidda 2008, Njidda *et al.* 2012a; Njidda *et al.* 2012b and Njidda *et al.* 2016).

Difference in compositions may be due to variation in age, environmental and soil conditions and climatic factors. Although the NDF was slightly higher than the recommended value of 20–35% for effective ruminal degradation (Norton 1994; Bakshi and Wadhwa 2004; Njidda *et al.* 2013b), it was lower than 60% value at which feed intake is depressed (Meissner *et al*., 1991). This species also had a high lignin content ranging from 88.30 to 140.30 g kg^{-1} DM. Lignin is a component of the cell wall and deposited as part of the cell wall-thickening process (Boudet, 1998) and it is in generally higher in browse (Njidda 2010; Njidda *et al.* 2012b and Njidda *et al.* 2016) than in herbaceous plants (Boudet, 1998). Positive correlations were reported between contents of lignin and soluble or insoluble proanthocyanidins (Rittner and Reed, 1992; Njidda 2011). The total condensed tannins (TCT) ranged from 0.08 mg/g to 0.39 mg/g DM. The level is lower than the range of 60 to100g Kg DM that is considered to depress feed intake and growth (Barry and Duncan, 1984) and Njidda (2011) (*n*=37). However, in ruminants, dietary condensed tannins of 2 to 3% have been shown to have beneficial effects because they reduce the protein degradation in the rumen by the formation of a protein-tannin complex (Barry, 1987).

The values for the phenolic content were within the range reported by Njidda (2011) (*n*=37). Phenolic compounds are the largest single group of SPCs, and total phenolics in plants can reach up to 40% of the dry matter (Reed 1986; Tanner *et al*., 1990). In grasses, the major phenolic is lignin that is bound to all plant cell walls, and is a significant limiting factor in their digestion in the rumen (Minson, 1990).

Feedstuffs containing saponin had been shown to be defaunating agents (Teferedegne, 2000) and capable of reducing methane production (Babayemi *et al.* 2004b). Cheeke (1971) reported that saponin have effect on erythrocyte haemolysis, reduction of blood and liver cholesterol, depression of growth rate, bloat (ruminant) inhibition of smooth muscle activity, enzyme inhibition and reduction in nutrient absorption. Saponins have been reported to alter cell wall permeability and therefore to produce some toxic effect when ingested (Belmar *et al*., 1999). The values (1.08 to 99 mg g^{-1} DM) reported in this present study is low compare to values reported by other authors.

Oxalate content in this present study was low. It has been reported that 20g/kg oxalate can be lethal to chicken (Acamovic *et al*., 2004). Oxalate has been shown to deplete the calcium reserve, but these browse species were found to contain resonable amount of calcium, magnesium and phosphorus (Le Houerou, 1980; Akinsoyinu and Onwuka, 1988). The phytin levels reported in this study ranged from 2.22 to 7.33 mg g^{-1} DM for northeastern browse forages, which is lower than 13.80 to 25.20 mg/g DM reported by Okoli *et al.* (2003) for the southeastern browses in Nigeria. These levels are unlikely to have any adverse effects on ruminants.

Mineral composition

More than 90% of the browse forages had higher Ca than the recommended requirements (g kg^{-1} DM diet) for growing cattle (2.6 – 10.8), pregnant cows (2.1–3.5) and lactating cows (2.9–5.3), (Shamat *et al*., 2009). Variations in the levels of Ca from these present study could be partly explained by the mature forage species, species composition, and variations in soil characteristics due to location of the different browse forages. The browse forages had higher levels of P than values obtained from other parts of the world. Aganga and Mesho (2008) reported lower values of P for browse forages in Botswana and Shamat *et al*. (2009) for browses in Sudan. The variation in the content of observed P could be due to the available soil P and soil pH, browse growth stage and proportions of leaf and stem fractions harvested for mineral analyses and sampling season. Browse and forage plants had higher concentrations of P than the normal requirements of P (g kg^{-1} DM diet) of growing cattle (1.1–4.8), pregnant heifers and cows (0.9–2.0) and lactating cows (2.0 – 30), suggesting nutritional adequacy for livestock. Norton (1994) and Njidda *et al*. (2011) reported that browses are generally high in phosphorus. All the browse samples had sufficient Mg level as report in Khan *et al*. (2007). Based on Minson (1990) recommendation (2.0 g kg^{-1} DM) Mg in the diets of ruminants, the browse plants had higher levels of Mg. Shamat *et al*. (2009) reported that Mg was

not limiting in tropical forages, although Jumba *et al*. (1996) reported exceptionally low Mg concentrations in Kenya. Sodium level is adequate compared to normal levels (0.36 to 0.37% DM) reported in Shamat *et al*. (2009) for other browse forages of other regions. The level reported in this study was below the Na requirements (0.8 – 1.2% DM) for cattle. There seem to be a general agreement that Na is deficient in most tropical grasses (Areghoere, 2002). Sodium deficiency can be corrected by providing common salt *ad libitum* which can also satisfy the requirement for chloride (McDowell, 1985). The need for Na is particularly pronounced in hot weather to compensate for losses due to respiration and perspiration. Potassium is reported to be extremely mobile in plants and is translocated from the oldest to the fastest growing tissues (Gomide *et al*., 1969). However, it has been suggested that high producing ruminants may require K level above 10 mg kg^{-1}, under stress, particularly heat stress (Khan *et al.*, 2005). Potassium concentrations similar to levels found in this study have been reported by Ogebe *et al*. (1995) in Nigeria. The plant species had high concentrations of Fe that were comparable to high the levels (100- 700 mg kg^{-1} DM) reported for tropical grasses and legumes (McDowell, 1992). These species had higher levels of Fe than tabulated requirements for dairy and beef cattle (50 mg kg^{-1} DM) (Khan *et al*., 2009). Although its availability could vary because Fe is absorbed according to the need, and thus its absorption would depend on dietary factors, age of the animal and body Fe status. Forage Zn concentration was also above the requirements for ruminants during winter as earlier reported in Reuter and Robinson (1997). It has been suggested that 30 mg/kg Zn is a critical dietary level, although it has been recommended that concentrations of 12-20 mg kg^{-1} DM are adequate for growing ruminants (Anon., 1980). Almost similar results were reported by Tiffany *et al*. (2001) in North Florida. Cobalt is a serious mineral limitation to livestock because even when grazing is abundant, deficiency will lead to chronic starvation or wasting which is often indistinguishable from energy and protein mal-nutrition (McDowell *et al*., 1984). The concentration of Co observed in this study was comparable to that in most tropical grasses (<0.01 to 1.26 mg kg^{-1} DM) as reported by Minson (1990). The browse forages had higher levels of Co than the dietary recommended levels for cattle (0.06 – 0.7 mg kg^{-1} DM), (ARC. 1980) and sheep and goats (0.11 mg kg^{-1} DM) (ARC. 1980). The browses had moderate levels of Mn that were comparable to the contents of Mn in pastures and established legumes (14 – 148 mg/kg DM) (Minson, 1990). There was a high Mn concentration in the forage during the dry season possibly because of low rates of Mn translocation and accumulation of Mn in older tissues (Khan *et al*., 2009). All the plant species had higher levels of Mn than the normal dietary requirements of 20 – 40 mg kg^{-1} DM (NRC, 2001), although, its supply could be lowered by its low absorbability efficiency from forage. However, Mn may interfere with the metabolism of other minerals and may result in low reproductive rates of cattle (McDowell *et al*., 1984). Selenium is a very important trace mineral.

The level of selenium in the studied browses ranged from 0.012 to 0.410 mg g^{-1} DM. Reproductive problems, retained placenta, white muscle disease and an inadequate immune system (leading to mastitis and metritis) may result when selenium is deficient in livestock rations. Selenium levels of 100 to over 9000 mg/Kg can be found in selenium accumulator plants (Johnson and Larson 1999). Consumption of these plants leads to rapid death. Chronic toxicity can occur at 5 mg g^{-1} DM (Brooks, 1998). The level of nickel ranged from 0.006 to 0.042 mg g^{-1} DM with a low overall mean of 0.025 mg g^{-1} DM for the browses. Nickel concentration ranged widely from 0.08 to 0.35 mg g^{-1} DM with a low overall mean of 0.18 mg g^{-1} DM. The concentration is not influence by dietary nickel intake in animals. The values recorded for Ni were above toxic levels suggested for typical plants (Tokalioglu and Kartal, 2005).

Gas production on incubation of feeds in buffered rumen fluid is associated with feed fermentation, and carbohydrate fractions, the low gas production from *Analgeosus leocarpus* and other browse forages characterized with low gas production could be related to low feeding value of these feeds. These browse forages contains more than 40 % of its dry matter in the form of cellulose and hemicellulose but its

degradability is very low. One of the main reasons for this low degradability is the presence of lignin which protects carbohydrates from attack by rumen microbes. Incubation of feedstuff with buffered rumen fluid *in vitro*, the carbohydrates are fermented to short chain fatty acids (SCFA), gases, mainly CO_2 and CH_4, and microbial cells. Gas production is basically the result of fermentation of carbohydrates to acetate, propionate and butyrate (Steingass and Menke, 1986) and substantial changes in carbohydrate fractions were reflected by total gas produced (Deaville and Givens 2001). Gas production from protein fermentation is relatively small as compared to carbohydrate fermentation while, contribution of fat to gas production is negligible (Wolin, 1960). Other researchers have reported similar findings with plants that are known to contain plant secondary compound (PSC) that can affect rumen microbes when examined *in vitro* (Tefera *et al.*, 2008). While legumes are reported to contain tannins that can reduce fermentation parameters (Tefera *et al.* 2008) for others, such as the genus *Leptadenia*, the effect may be related to different classes of bioactive PSC (Ghisalberti, 1994).

Kinetics of gas production obtained from the exponential model is presented in Table 4. Both rate constants b and c showed significant differences among browse forages. Similarly, the extent (a + b) of gas volumes was higher for *Adansonia digitata* than for trees. Khazaal *et al*. (1995) indicated that the intake of a feed is mostly explained by the rate of gas production (c) which affects the rate of passage of the feed through the rumen, whereas the potential gas production (a + b), is associated with the degradability of the feed. Thus, the higher values obtained for the (c) and (a + b) parameters in the browse forages, may indicate a better nutrient availability for rumen microorganisms in animals grazing such vegetative species in semi-arid areas.

CONCLUSION

The browse species evaluated in the current study had high CP content which would make them good protein supplements to poor quality roughages, especially during the dry season in the semi-arid region of Nigeria. The macro and micro minerals are high and can meet the requirement of ruminant animal animals. The gas produxtion was significantly low for most of the browse forages despite the high CP content. The low degradation may be attributed to the high lignification of the browse plants.

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Table 1. Chemical composition of the browse forages (g kg^{-1} DM)

Browse Forages	CP	EE	OM	NDF	ADF	ADL
Adansonia digitata	160.00^{a}	30.60^{e}	809.70^{d}	412.10^{i}	219.70^{g}	116.30^{d}
Anageisus celecarpus	149.10^{d}	31.60^{d}	838.00^{d}	542.80^{e}	231.30^{f}	88.30^{i}
Analgeosus leocarpus	150.70^{d}	51.60^{a}	848.30^{c}	542.10^{e}	241.80^{e}	130.00^{b}
Batryospermum paradoxum	145.90^{c}	50.00^{a}	859.00^{b}	572.30^{d}	265.60^{a}	112.60^{e}
Buahinea nufescens	114.90^{h}	47.30^{b}	812.70^{f}	493.10^{g}	231.40^{f}	93.70^{h}
Ceiba pentendra	173.90^{a}	31.60^{d}	828.00^{e}	514.60^{f}	244.80^{d}	112.40^{e}
Celtis integuifolis	153.60^{c}	31.00^{d}	794.60^{g}	595.90^{b}	246.00^{c}	105.60^{f}
Khaya senegalensis	139.60^{e}	30.30^{e}	868.70^{a}	486.20^{h}	211.60^{h}	121.00^{c}
Kigalia africana	134.02^{f}	34.60^{c}	766.70^{h}	688.10^{a}	255.20^{b}	97.00^{g}
Poupartia sirrea	132.20^{g}	51.60^{a}	742.60^{i}	591.20^{c}	230.30^{f}	140.30^{a}
SEM	**1.25**	**1.35**	**2.64**	**3.25**	**2.07**	**1.86**

CP=crude protein; EE=ether extract; OM=Organic matter; NDF=neutral detergent fibre; ADF=acid detergent fibre; ADL=acid detergent fibre

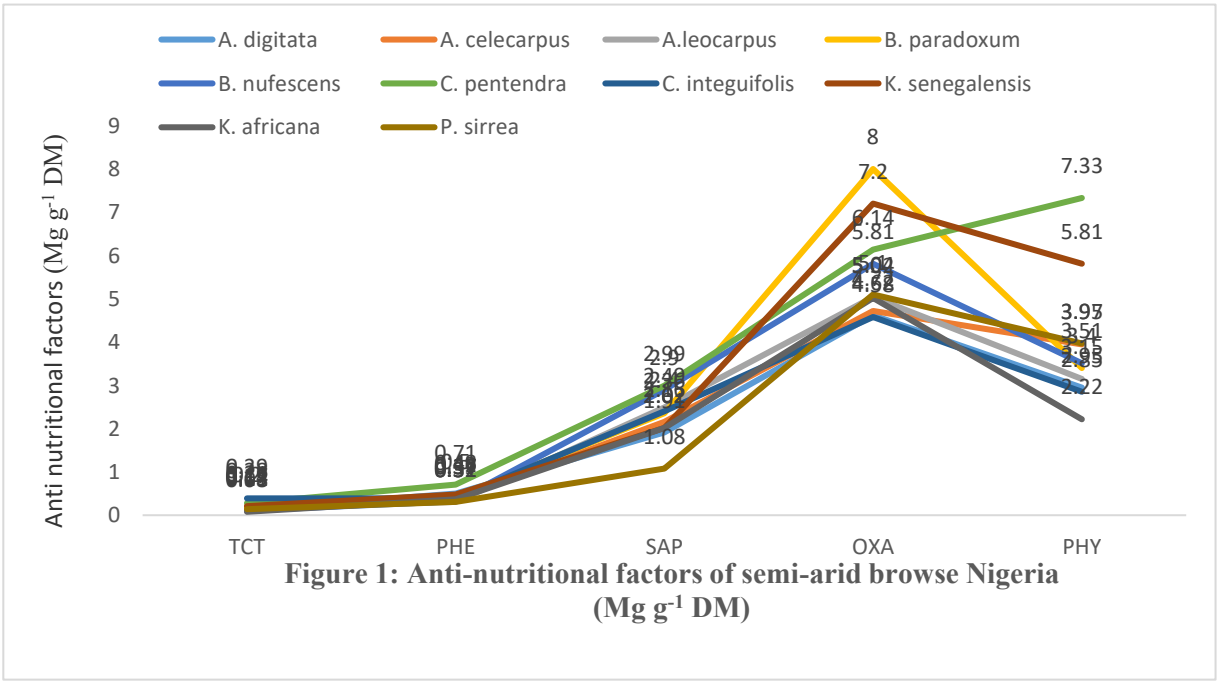

Figure 1: Anti-nutritional factors of semi-arid browse Nigeria (Mg g^{-1} DM)

Table 2. Macro minerals concerntration of semi-arid browses of Nigeria (g kg^{-1} DM)

Browse Forages	Ca	P	Mg	Na	K
Adansonia digitata	9.60^{d}	212.50^{d}	5.60^{c}	0.90^{b}	19.30^{f}
Anageisus celecarpus	10.80^{c}	203.70^{e}	5.30^{c}	0.50^{f}	14.80^{h}
Analgeosus leocarpus	13.20^{b}	203.30^{e}	3.10^{d}	0.60^{e}	18.50^{g}
Batryospermum paradoxum	12.00^{b}	110.70^{g}	3.10^{d}	1.10^{a}	30.00^{c}
Buahinea nufescens	7.60^{e}	211.70^{d}	6.00^{b}	0.60^{e}	6.30^{i}

Ceiba pentendra	10.40^{c}	271.80^{a}	2.50^{e}	0.70^{d}	27.50^{d}
Celtis integuifolis	19.30^{a}	112.80^{f}	10.40^{a}	0.80^{c}	25.00^{e}
Khaya senegalensis	7.80^{e}	265.70^{b}	2.50^{e}	1.10^{a}	11.50^{j}
Kigalia Africana	9.00^{d}	102.50^{h}	1.70^{f}	0.90^{b}	40.00^{b}
Poupartia sirrea	10.10^{c}	256.70^{c}	5.60^{c}	1.20^{a}	120.00^{a}
SEM	**0.06**	**1.94**	**0.05**	**0.04**	**0.44**

a,b,c,d=mean values along the same column with different superscripts are significantly different (P<0.05); Ca=Calcium; P=Phosphorus; Mg=Magnesium; Na=Sodium; K=Potassium;SEM= Standard error of means.

Table 3. Trace minerals concentration of semi-arid browses of Nigeria (mg/g DM)

Browse Forages	Fe	Zn	Co	Mn	Se	Ni
Adansonia digitata	4.840^{b}	7.110^{a}	0.007	0.507^{d}	0.145	0.026
Anageisus celecarpus	4.702^{b}	1.664^{e}	0.004	0.319^{f}	0.085	0.011
Analgeosus leocarpus	3.087^{c}	2.403^{d}	0.012	1.082^{c}	0.153	0.015
Batryospermum paradoxum	1.982^{e}	1.632^{e}	0.006	0.388^{f}	0.168	0.006
Buahinea nufescens	3.688^{c}	1.623^{e}	0.009	2.675^{b}	0.180	0.032
Ceiba pentendra	1.216^{f}	1.220^{e}	0.003	0.410^{e}	0.114	0.007
Celtis integuifolis	3.126^{c}	2.500^{d}	0.006	0.457^{e}	0.130	0.027
Khaya senegalensis	2.973^{d}	5.725^{b}	0.005	0.512^{d}	0.157	0.009
Kigalia Africana	16.24^{a}	4.240^{c}	0.012	2.923^{a}	0.062	0.023
Poupartia sirrea	1.618^{c}	1.064^{f}	0.007	0.234^{g}	0.149	0.085
SEM	**0.55**	**0.26**	**0.0006^{NS}**	**0.14**	**0.09^{NS}**	**0.008^{NS}**

a, b, c, d=mean values along the same column with different superscripts are significantly different P<0.05); Fe=Iron; Zn=Zinc; Co=Cobalt; Mn=Manganese; Se=Selinium; Ni=Nickel; SEM=Standrd error of means

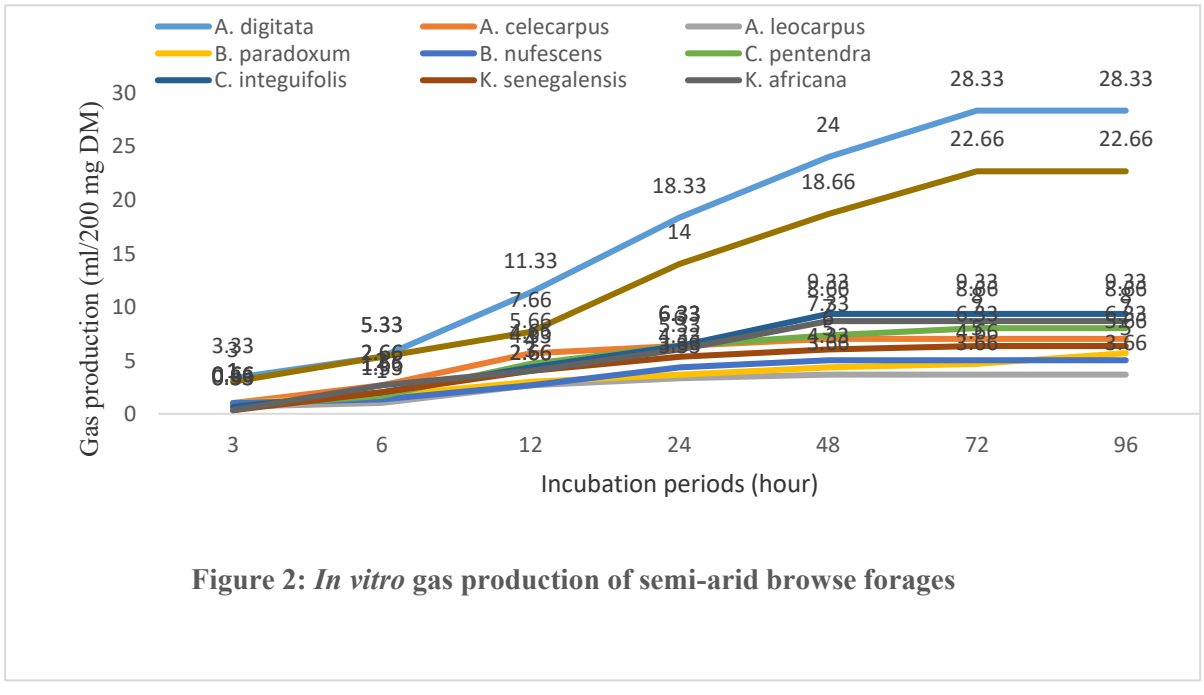

Figure 2: *In vitro* gas production of semi-arid browse forages

Table 4. *In vitro* fermentation characteristics of semi-arid browse forages

Browse Forages	**a**	**b**	**a+b**	**c**	**t**	**Y**
Adansonia digitata	3.33	25.00	28.33	0.032	12.00	11.33
Anageisus celecarpus	3.67	4.33	8.00	0.046	14.00	5.00
Analgeosus leocarpus	1.33	2.67	4.00	0.053	16.50	3.50
Batryospermum paradoxum	1.00	4.67	5.67	0.057	11.00	3.00
Buahenia nufescens	1.33	11.00	12.33	0.046	18.00	6.67
Ceiba pentendra	2.00	6.33	8.33	0.050	14.00	4.67
Celtis integuifolis	2.33	7.00	9.33	0.034	10.00	4.33
Khaya senegalensis	2.33	4.00	6.33	0.042	16.00	4.00
Kigalia africana	2.67	6.00	8.67	0.028	13.00	4.00
Poupartia sirrea	3.00	19.67	22.67	0.035	10.00	8.33
SEM	**1.21**	**2.67**	**2.12**	**0.019**	**1.37**	**1.21**

a,b,c,d=mean values along the same column with different superscripts are significantly different (P<0.05); SEM=Standard error of means

MORPHO-PHYSICAL PROPERTIES AND CLASSIFICATION OF SOILS UNDERLAIN BY ASU RIVER GROUP PARENT MATERIALS IN OHAOZARA, SOUTHEASTERN NIGERIA

Obasi S.N and Okorie A.P

Abstract

The study was carried out in Ohaozara Southern Ebonyi State in Southeastern Nigeria and aimed at studying the morphological and physical properties as well as classifying the soils underlain by Asu River group parent material. Study area was identified in a rice soil of about 120 hectares used by FGN/IFAD Value Chain Development program (VCDP). Three profile pits were dug on a transect line of about 100 – 200m apart. Soil colours ranged from yellow (5YR7/3) at the A horizon to reddish yellow (5YR7/8) at the Bt2 horizon of pedon in location 1 when measured under dry condition. Also at the location 1 when soils were measured under moist condition, the colours ranged from very pale brown (10YR7/3) at the topmost horizon to reddish yellow (7.5YR7/8) at the Bt2 horizon. At location 2, soil colour ranged from white (5YR8/1) at the topmost horizon to reddish yellow (10YR7/6) at the Bt2 horizon when dry. However, when moist it ranged from light grey (7.5YR7/1) to strong brown (7.5YR5/6) from top to bottom of the profile. Location 3 had colours ranging from light grey (5YR7/1) at the top to yellow (10YR8/4) at the bottom when dry and from very pale brown (10YR7/3) to yellow (5YR7/6) from horizon A to horizon Bt2 when moist. Silt:clay ratios decreased down the profile in all investigated locations and scored means of 0.95, 1.02 and 1.10 in locations 1, 2 and 3 respectively. Bulk density and porosity had an opposite trend as bulk density increased down the profile, porosity decreased down the profile. The means of bulk density were 1.34, 1.44 and 1.32 g/cm^3 while the means of the porosity were 49.34, 45.66 and 50.17 % in locations 1, 2 and 3 respectively. Therefore pedon 1 is classified as Typic Eutrudept (USDA) and Eutric Cambisols (WRB) while pedons 2 and 3 were classified as Aquic Eutrudepts (USDA) and Gleyic Leptosols (WRB).

Keywords: Morpho-physical properties, soil classification, Asu river group, southeastern Nigeria

Introduction

Morphological and physical properties of the soils are of great importance in understanding how the soils could be properly utilized. Soil morphology is studied from the *in situ* evaluation of the soil profile while the physical properties are measured by laboratory techniques. For agricultural purpose, physical properties of the soils are not easily modified in the plantation (Ugwa *et al.,* 2017). It is even harder to alter them than the chemical properties (Brady, 2002; Malgwi*, et al.,* 2000). Different workers (Orimoloye, *et al.,* 2010; Kamalu, *et al,* 2014), have associated yield decline to poor physical properties and these may include low soil depth, changes in water holding capacity and relatively light texture soils. Enwezor, *et al.,* (1981) had reported that most soils of southern Nigeria are inherently low in soil fertility, very susceptible to erosion and acidic with poor physical properties.

A long continuation of wetland soil cultivation often causes characteristic changes in soil morphology and properties, including surface gray coloring and the development of iron and manganese accumulation horizons. The major morphological features such as grey or low chroma (<3) colour, mottles are characteristics of this soils, and is an indication of soil wetness brought about by oxidation – reduction cycle due to ground water fluctuation inter-relationship between these features. The reduced Fe present in these soils impact grayish colour on the soil matrix (Malgwi *et al.,* 2000).

Soil characterization and classification provide a powerful resource for the benefit of mankind, especially in the area of food security and environmental sustainability (Esu, 2004). According to Ajiboye and Ogunwale (2010), studies conducted on the soils of some regions of Nigeria and subsequent classifications were based majorly on the soil parent materials at the higher category classes. Soil classification study is however a major building block in terms of understanding the soil, classifying it as well as getting the best understanding of the environment. Esu and Akpan-Idiok (2010), characterized the morphological and physico-chemical properties of alluvial soils and classified them according to the USDA Soil Taxonomy System (Soil Survey Staff, 1999) and the World Reference Base for Soil Resources (WRB) Classification System (FAO, 2001). Therefore USDA Soil Taxonomy (Soil Survey Staff, 1999) and the WRB for soil resources (FAO, 2001) are the two most used classification systems in Nigeria (Esu, 1999).

This study aimed at determining the morphological and physical properties of the soils derived from Asu River parent material as well as classify them for better management and agricultural sustainability.

The Study Area

Location

The study area is located near Umunaga – Uburu in Ohaozara Local Government Area of Ebonyi State Southeastern Nigeria, with the Latitude of 6º 01′ N and Longitude of 7º 78′ E. The study area is located within the partially modified low rain forest and wooded/ grassland derived savannah southeastern Nigeria and experiences rainfall between March - November with highest intensities occurring between June-September while about three months of dry season occur from December – February (Ogbodo, 2013). The area lies within the humid tropics with Ustic moisture regime. This concept is one of moisture that is limited but is present at a time when conditions are suitable for plant growth. The soil in moisture control section in ustic moisture regime is dry in some or all parts for 90 or more cumulative days in normal year (Soil Survey Staff, 2003). This location receives a mean annual rainfall of between 2250 mm in the South and 1500 mm in the northern part of the zone, average annual temperature of about 27ºC with relative humidity of 85% (Nwakpu, 2003).

Geology and Geomorphology

The study area falls within the Asu-River Geologic Group (Lower Cretaceous), Eze-Aku shale formation and Nkporo Formations. The Asu River Group is a major stratigraphic unit in the study area, consisting of dark micaceous shale, fine grained and calcareous sandstone bodies (Ogbodo 2013). The sediments later became folded given rise to two major structural features, the Abakalili anticlinorium and related Afikpo synclinorium (Esu, 2004; Ukaegbu and Akpabio 2009). It is made up mainly of hydromorphic soils which consist of reddish brown gravely and pale coloured clayey soil, shallow in depth, and of shale parent material (Ogbodo, 2013).

Field Work

Reconnaissance study was carried out and the study area identified near Umunaga in

Ogbuoma autonomous Community Uburu in Ohaozara Local Government Area of Ebonyi State. The study area was in a FGN/IFAD/ Value Chain Development Programme (VCDP) site having about 120 hectares of land. The study area has been subjected to rice farming over the years due its prevalent lowland nature. Three profile pits were dug at an appreciable interval of 100 – 200 m apart within the study area.

Laboratory Analysis

Soil samples were air dried, pulverized, and sieved through a 2 mm sieve mesh. The properties analyzed include particle size distribution determined by hydrometer method (Gee and Bauder, 1986). Soil pH was determined in a 1:1 soil/water ratio using digital pH meter and conductivity meter respectively. Exchangeable acidity was determined by the 1N KCl method. Exchangeable bases; Calcium (Ca), Magnesium (Mg), Potassium (K), and Sodium (Na) were determined using NH4OAc saturation method (IITA, 1979). Ca and Mg in solution were determined using Atomic Absorption Spectrophotometer, while K and Na were determined using Flame Emission Photometer. Organic carbon was determined by Walkley and Black dichromate wet oxidation method (Nelson and Sommers,1982). Total nitrogen was determined by micro-kjeldahl technique (Bremner and Mulvaney, 1982). The Effective Cation Exchange Capacity (ECEC) was determined summation method, while the available phosphorus was extracted by Bray II method (Olsen and Sommers 1982). Base saturation was calculated as the sum of all base forming cations, divided by cation exchange capacity and multiplied by 100.

Results and Discussion

The morphological properties of soils were as shown in table 1. The parent material is Shale/Alluvium derived from Asu River group (Ukaegbu and Akpabio 2009). The profiles were deep enough for rice cultivation and drainage indicated well drained for Ap and AB horizons and poorly drained for Bt1and Bt2 horizons. Soil colours ranged from yellow (5YR7/3) at the A horizon to reddish yellow (5YR7/8) at the Bt2 horizon of pedon in location 1 when measured under dry condition. Also at the location 1 when soils were measured under moist condition, the colours ranged from very pale brown (10YR7/3) at the topmost horizon to reddish yellow (7.5YR7/8) at the Bt2 horizon. At location 2, soil colour ranged from white (5YR8/1) at the topmost horizon to reddish yellow (10YR7/6) at the Bt2 horizon when dry. However, when moist it ranged from light grey (7.5YR7/1) to strong brown (7.5YR5/6) from top to bottom of the profile. Location 3 had colours ranging from light grey (5YR7/1) at the top to yellow (10YR8/4) at the bottom when dry and from very pale brown (10YR7/3) to yellow (5YR7/6) from horizon A to horizon Bt2 when moist. The coating of iron oxides often gives rise to yellow, brown or red colouration in the soil matrix and these may provide information on some soil properties. The low chroma observed in most of the epipedons may have resulted due to wetness situation of the studied soils, as FAO, (2006) noted that morphological feature such as low chroma is an indicative of soil wetness.

Table 1: Morphological Properties of Soils

Location 1	Colour (dry)	Colour (moist)	Structure	Consistence			Mottles	Root Abundance	Horizon Boundaries
				Wet	Moist	Dry			
A	5 YR 7/3, y	10 YR 7/3, vpb	2,bk,c	s	fi	vh	-	C,m	clear
AB	5 YR 7/4, y	5 YR 6/1, pg	2,m,vc	vs	Vfi	eh	f	Mf,f	clear
Bt1	5 YR 7/8,r y	5 YR 7/6, ry	2,abk,c	vs	vfir	eh	m	Vf,f	Gradual
Bt2	5 YR 7/8,r y	7.5 YR 7/8, ry	2,abk,vc	vs	Vfi	eh	m	Vf,f	-
Location 2									
A	5 YR 8/1,w	7.5 YR 7/1, lg	2,m,vc	s	Fi	vh	-	C,m	Clear
AB	5 YR 8/2,pw	7.5 YR 7/1, lg	2,abk,vc	vs	Vfi	vh	f	Vf,f	Abrupt
Bt1	10 YR 7/6, ry	2.5 YR 7/6, lr	2,sbk,c	vs	Efi	eh	m	Vf,vf	Clear
Bt2	10 YR 7/6, ry	7.5 YR 5/6, sb	2,m,vc	vs	Efi	eh	m	Vf,vf	-
Location 3									
A	5 YR 7/1, lg	10 YR 7/3, vpb	2,m,vc	ss	Fi	vh	-	C,m	gradual
AB	10 YR 7/6, ry	10 YR 8/6, y	2,m,vc	vs	Vfi	vh	f	Vf,vf	Clear
Bt1	10 YR 7/8, ry	5 YR 7/8, ry	2,m,vc	vs	Vfi	vh	f	Vf,vf	Abrupt
Bt2	10 YR 8/4, y	5 YR 7/6, y	2,m,vc	Ps	Efi	eh	m	Vf,vf	-

Colour: y = yellow, ry = reddish yellow, w = white, pw = pinkish white, lg = light grey, Lr = light red, sb = strong brown, vpb = very pale brown, pg = pinkish grey. **Mottles:** f = few, m = many; **Structure:** 2 = moderate, Bk = block, M = massive, abk = angular blocky, sbk = subangular blocky, c = coarse, vc = very coarse. **Consistence: S**= sticky. Vs = very sticky, ss = slightly sticky, Ps =

slightly plastic, fi = firm, vfi = very firm, efi = extremely firm, vh = very hard, eh = extremely hard, h = hard. **Roots:** C= common, vf = very fine, vf = very few, mf= moderately few, f=fine.

Mottles were absent at the epipedons in all investigated soils, few in the middle or AB horizons and many at the Bt1 and Bt2 horizons in all investigated soils although the Bt1 horizon at location 3 had few mottles. All the pedons had abundant redoximorphic features in form of strong brown mottles due to the reducing/waterlogged soil conditions. Researchers observed similar mottles respectively in subsoils of floodplains in southern Nigeria (Akpan-Idiok, and Ogbaji, 2013; Obasi *et al.,* 2015), surface-water grey soils in Bangladesh (Khan *et al.,* 2012) and pedological properties of typical alluvial soils in Tanzania (Asheri *et al.,* 2017).

Soil structure determination indicated that all the investigated soils had moderate structures; structure that is well formed and distinct peds, moderately durable and evident, although not distinct in undisturbed soil. In location 1, structure was blocky and coarse at the epipedon while at the Bt2 horizon it was sub-angular blocky in form and very coarse in its size. At location 2, the structure was massive in form and very coarse in its size at the A and Bt2 horizons. The same trend was observed at the location 3 where all horizons had massive and very coarse structure. This massive structure shows little or no tendency to break apart under light pressure into smaller units. This structure was due to relative presence of clay structure from the shale/alluvium parent material of the study area. This tends to bind the particles together with some sort of strong and cohesive forces which when dry forms coarse to very coarse or massive structure.

Soil consistence when wet ranged from sticky in locations 1 and 2 to slightly sticky in location 3 at their surface horizon and from very sticky in locations 1 and 2 to slightly plastic in location 3 at their Bt2 horizons. Consistence when moist ranged from firm to very firm from top to bottom of profile in location 1, firm to extremely firm from top to bottom of the profile in locations 2 and 3. When dry, consistence of the studied soils ranged from very hard to extremely hard from top to bottom in all locations. The stickiness of the consistence when wet reveals the fact that the investigated soils are of shale parent materials under Asu river group. The firmness when moist and hard to extremely hard when dry were as a result of clay properties which exhibited binding properties on the soil particles.

Root abundance indicated that the top (Ap) horizons had common and many roots while AB horizons had moderately few and fine roots at location 1, very few and very fine in locations 2 and 3. All other horizons in all locations ranged from very few and fine to very few and very fine in locations 1, 2 and 3. The roots were more on or near the epipedons of the studied soils. Most of the roots encountered were from the rice plant which decreased down the horizons in all investigated soils.

Horizon boundary attributes varied among and within pedons, whereby distinctness ranged from abrupt to gradual in all investigated soils, but topography was dominantly smooth.
The differentiation of horizons within the pedons was made on soil colour and textural variations similar to that of Orimoloye *et al.,* (2010)**,** implying that the soils are young. The overall, morphology of the studied soils were typical of shale/alluvial soil formation of the Asu river group. This is in line with the study of Asheri *et al.,* (2017) who stated that the morphology and genesis of Tanzanian lowland soils were of alluvia soil formation.

The physical properties of the studied soils are shown in table 2. Soils textural properties indicated that sand and silt had similar trends as they decreased down the profile in all studied locations. While clay took an opposite trend as it increased down the horizons in all locations. Sand had means of 46.24, 41.74 and 46.76%; Silt had means of 25, 28 and 22% while clay had means of 27.54, 27.76 and 26.76% all in locations 1, 2 and 3 respectively. The textural class of the studied soils ranged from sandy loam at the epipedons to clay loam at the endopedons of locations 1 and 2 while location 3 recorded sandy loam in all its horizons

Table 2: Soil Physical Properties

Location	Depth (cm)	Sand ←	Silt %	→ Clay	Silt/Clay Ratio	TC	BD g/cm^3	Porosity (%)
Pedon 1								
Ap	0 – 15	51.24	28.0	20.76	1.35	SL	1.28	51.69
AB	15 – 37	48.24	27.0	24.76	1.09	SL	1.31	50.56
Bt1	37 – 75	45.24	24.0	28.76	0.83	SL	1.36	48.67
Bt2	75 – 110	40.24	21.0	38.76	0.54	CL	1.42	46.42
Mean		46.24	25.0	27.54	0.95		1.34	49.34
CV		4.1	28.3	7.2	3.93		4.6	Nd
Rank		LV	MV	LV	LV		LV	Nd
Pedon 2								
Ap	0–75	44.24	31.0	24.76	1.25	SL	1.32	50.19
AB	17–43	42.24	30.0	27.76	1.08	SL	1.43	46.04
Bt1	41–83	40.24	27.0	32.76	0.82	CL	1.48	44.15
Bt2	83–124	40.24	24.0	25.76	0.93	CL	1.53	42.26
Mean		41.74	28.0	27.76	1.02		1.44	45.66
CV		4.4	57.7	13.3	4.33		6.2	Nd
Rank		LV	HV	LV	LV		LV	Nd
Pedon 3								
Ap	0–16	50.24	33.0	17.76	1.86	SL	1.20	54.72
AB	16–38	47.24	27.0	25.76	1.05	SL	1.28	51.69
Bt1	38–76	45.24	25.0	29.76	0.84	SL	1.34	49.34
Bt2	76–126	44.24	22.0	33.76	0.65	SL	1.46	44.91
Mean		46.74	26.75	26.76	1.10		1.32	50.17
CV		2.5	55.4	14.1	3.92		8.3	Nd
Rank		LV	HV	LV	LV		LV	Nd

Clay content increased with depth in all pedons providing some indication of clay eluviation-illuviation. Asheri *et al.,*(2017) observed consistent clay increase with depth as an indication of clay migration in an alluvial soils. Also, the relatively higher clay concentrations at locations 1 and 2 are indications that these areas would retain more moisture compared to location 3 since Kebeny *et al.,* (2015) reported that a pedon with high clay content have higher moisture retention capacity with a gradual moisture decrease as suction potential increased, compared to ones dominated by sand with a rapid decrease in moisture content as the suction potential increased.

Silt:clay ratios decreased down the profile in all investigated locations and scored means of 0.95, 1.02 and 1.10 in locations 1, 2 and 3 respectively. Silt/clay ratio (SCR) is an important criterion used in the evaluation of clay migration, stage of weathering and age of parent material and soil (Yakubu and Ojanuga, 2013). The more highly weathered a soil is, the lower the silt fraction. FAO, (1990) reported that silt/clay ratio less than 0.20 indicates a low degree of weathering. Ayolagha, (2001) on the other hand reported that old parent materials usually have a SCR below 0.15 while SCR above 0.15 is indicative of young parent materials. However, results of this study showed that all the soils had silt/clay ratios above 0.2 indicating a high degree of weathering potentials in all the soils. Higher SCR (0.95, 1.02 and 1.10) recorded in locations 1, 2 and 3 of soils underlain by the Asu river group indicated young parent material.

Bulk density and porosity had an opposite trend as bulk density increased down the profile, porosity decreased down the profile. The means of bulk density were 1.

34, 1.44 and 1.32 g/cm^3 while the means of the porosity were 49.34, 45.66 and 50.17 % in locations 1, 2 and 3 respectively. This trend has been observed by Obasi *et al.,* (2015) who worked on the rice soils of the region.

However, Esheri *et al.,* (2017) noted that the decreasing state of bulk density was due to the fact that subsurface layers are more compacted and have less organic matter, aggregation, and root penetration compared to surface layers, leading to less pore spaces. Bulk density therefore affects several processes in the soils including; infiltration, rooting depth, available water capacity, soil porosity, plant nutrient availability, and soil microbial activity, which in turn influence key soil pedogenic processes as well as productivity. USDA-NRCS (2016) suggested that bulk density values greater than 1.65 g/cm3 are unfavorable to root growth in sandy clay loams and clay loams. Thus, the observed bulk density values in Pedons of the studied soils are favorable in that regard.

The results of soil chemical properties of the study site are as shown in the table 3 below. The results indicated that soil pH had no particular trend in some part of the study area. This is because while the trend decreased in locations 1 and 2, it however increased in location 3. Mean pH were 5.25, 5.16 and 5.15 in locations 1, 2 and 3 respectively. Soil pH is one of the most essential chemical properties of the soil and has been rated as follow by Landon (1991); pH (H_2O) of 4.6 - 4.9 as very low, < 5.5 as low and 5.5 to 7.0 as medium. The pH of the studied locations were however low and may be attributed to low amounts of bases caused by leaching during fluctuations of water table and percolation of water during flooding periods, removal of bases through crop harvests and farming practices. The increase of pH down the profile in location 3 is in agreement with Khan *et al.,* 2012 who observed similar trend of pH increasing with depth in annually flooded soils of Bangladesh.

Organic carbon, organic matter and total nitrogen all decreased down the profile recording means of 0.715, 0.571, 0.468%; 1.108, 0.991, 0.568%; 0.068, 0.055, 0.044% for OC, OM and TN in locations 1, 2 and 3 respectively. The decreasing situation of OC, OM and TN down the profile were related and caused by reduction of litter deposits and organic substances down the profile. Available phosphorus increased in the first 3 horizons and decreased in the Bt2 horizon of location 1 while it decreased in the other locations. Available P scored means of 27.68, 24.18 and 20.3 mg/kg in locations 1, 2 and 3 respectively. The phosphorus content of the representative pedons is generally high (>15 mg/kg) based on the rating Tabi et al., (2012) who worked on the Chari flood plain of Cameroun. Researchers such as Enwezor *et al.*, (1990); Adepetu, (2000) corroborated this by stating that available P <15 mg/kg was low for Nigerian soils. Uzoho *et al*., (2004) believed high acidity (pH < 5.0) usually leads to low soil available P as P gets fixed in high acidic soils. However, the studied soils had pH > 5.0 < 5.5 which though not optimum pH (5.5 – 7.0) for good crop growth and sustenance leading to a medium to high P content of the studied soils.

Calcium had no particular trend in locations 1 as it tends to be highest in Bt2 horizon. It however increased progressively in location 2 although it dropped to the lowest at Bt2 horizon whereas it increased all through down the profile across all horizons in location 3. Ca had means of 1.79, 1.14 and 1.25 cmol/kg in locations 1, 2 and 3 progressively. The Ca content of the soils were very low (<2 Cmol/kg) according to Tabi *et al.,* 2012) in all investigated pedons.

Table3: Chemical Properties of Studied Soils

Location	Depth (cm)	pH	OC	OM	TN	C/N Ratio	Avail.P mg/kg	Ca	Mg	K	Na^+	H^+	Al^{3+}	TEA	TEB	ECEC	B. Sat %	Al Sat %
			←	%	→			←				Cmol/kg				→		
Pedons 1																		
A	0–15	5.55	1.084	1.876	0.103	10.52	28.3	1.86	0.93	0.079	0.056	0.53	trace	0.53	2.925	3.455	84.66	5.00
AB	1 –37	5.28	0.963	1.660	0.091	10.58	30.6	1.72	1.08	0.194	0.062	0.46	0.50	0.96	3.056	4.016	76.10	12.45
B ti	37–75	5.12	0.506	0.872	0.048	10.54	32.3	1.63	0.93	0.173	0.053	0.56	0.44	1	2.786	3.786	73.59	11.62
Bt2	75–110	5.08	0.308	0.531	0.029	10.62	19.5	1.96	0.71	0.162	0.051	0.71	trace	0.71	2.883	3.593	80.24	5.00
Mean		5.25	0.715	1.108	0.068	10.57	27.68	1.79	0.91	0.152	0.055	0.57	0.24	0.8	2.913	3.713	78.65	8.52
Cv		4.1	51.5	45.1	51.7	Nd	20.6	8.2	16.7	33.2	133.1	18.6	115.	27.6	3.8	6.6	6.2	Nd
Rank		LV	HV	HV	HV	Nd	MV	LV	MV	MV	HV	MV		MV	LV	LV	LV	Nd
Pedon 2																		
A	0–75	5.19	0.835	1.440	0.079	10.56	29.8	1.03	0.57	0.098	0.033	1.02	trace	1.02	1.731	2.751	62.92	5.00
AB	17–43	5.22	0.621	1.071	0.059	10.52	26.9	1.22	1.26	0.083	0.046	0.51	0.96	1.47	2.609	4.079	64.00	23.53
Bti	41–83	5.09	0.510	0.879	0.048	10.62	21.8	1.36	0.78	0.073	0.051	0.32	0.33	0.65	2.354	3.004	78.40	10.98
Bt2	83–124	5.12	0.352	0.607	0.033	10.66	18.2	0.95	1.01	0.062	0.056	0.65	0.69	1.34	2.078	3.418	60.80	20.19
Mean		5.16	0.571	0.991	0.055	10.59	24.18	1.14	0.82	0.079	0.046	0.63	0.41	1.12	2.193	3.313	66.50	14.93
Cv		1.2	35.0	35.0	35.4	Nd	21.4	16.3	16.7	19.4	21.3	47.4	84.5	32.7	17.2	17.5	12.1	Nd
Rank		LV	MV	MV	HV	Nd	MV	MV	MV	MV	MV	HV	HV	MV	MV	MV	LV	Nd
Pedon 3																		
A	0–16	5.06	0.615	1.060	0.058	10.60	22.5	0.91	6.63	0.086	0.063	0.44	0.71	1.15	1.759	2.909	60.50	24.41
AB	16–38	5.20	0.482	0.833	0.046	10.47	17.5	1.27	0.78	0.071	0.052	0.63	0.56	1.19	2.173	3.363	64.60	16.65
Bt1	38–76	5.22	0.409	0.705	0.038	10.76	19.8	1.32	0.88	0.097	0.043	0.69	0.43	1.12	2.34	3.46	67.60	12.43
Bt2	76–126	5.10	0.365	0.629	0.035	10.42	21.3	1.49	1.0	0.053	0.037	0.48	0.38	0.86	2.58	3.44	75.00	11.05
Mean		5.15	0.468	0.568	0.044	10.56	20.3	1.25	2.32	0.077	0.049	0.56	0.52	1.08	2.213	3.293	66.90	10.40
Cv		1.5	23.4	23.4	23.2	Nd	10.6	16.8	31.0	24.9	23.2	21.3	28.4	13.8	15.6	7.9	9.1	Nd
Rank		LV	MV	MV	MV	Nd	LV	MV	MV	MV	MV	MV	MV	LV	MV	LV	LV	Nd

OC = organic carbon, OM = organic matter, TN = total nitrogen, Av.P = available phosphorus, TEB = total exchangeable bases, TEA = total exchangeable acidity, ECEC = effective cation exchange capacity, B. Sat = base saturation, Al Sat. = aluminum saturation, CV= Coefficient of Variation, LV= Low variability, MV= Moderate variability, HV= High Variability

Magnesium had no particular in all locations and recorded high accumulation at the surface horizon of location 3. The means Mg were 0.91, 0.82 and 2.32 in locations 1, 2 and 3 respectively. Mg contents of locations 1 and 2 were low (0.5 – 1.5 cmol+/kg) while location 3 was medium (1.5 – 3.0 cmol+/kg). Potassium and Sodium did not have definite trend in location 1 while K also had no definite trend in location 3. However, K and Na decreased consistently in pedon 2 and Na in pedon 3. Means of K and Na were 0.152, 0.079, 0.077; 0.055, 0.046, 0.049 cmol/kg in locations 1, 2, and 3 respectively. Location 1 was low (0.1 – 0.3 cmol+/kg) in K scoring 0.152 cmol+/kg. All other locations were very low in K (<0.1 cmol+/kg). All investigated locations were very low in Na being <0.1 cmol+/kg according to Tabi *et al.,* (2012).

Total exchangeable acidity (TEA) was low compared to their total exchangeable bases (TEB) counterparts in all the investigated soils. Their means were 0.8, 1.12, 1.08; 2.91, 2.19, 2.21 cmol/kg for TEA and TEB at locations 1, 2 and 3 respectively. As a result the base saturation was moderate to optimum in the investigated soils compared to the Al saturation which was quite low. Mean base saturation and Al saturation were; 78.65, 66.50, 66.90%; 8.52, 14.93, 10.40% in locations 1, 2 and 3 respectively. This situation therefore suggests that Al toxicity may not be a challenge to the dominant crops grown on the investigated soils. Msanya *et al.,* (2001) suggested that soils with BS > 50% are fertile soils and vice versa although the following classes were recognized: BS < 20% as low, 20-60 as medium, and above 60% as high.

Taxonomic Classification

The diagnostic criteria for classification of soils of Ohaozara according to the USDA Soil Taxonomy (Soil Survey Staff, 2010) include an udic soil moisture regime and a hyperthermic soil temperature regime characteristic of semi arid to sub-humid subtropical climate. The investigated soils have their silt/clay ratios as <1.0 in location 1, and > 1.0 in locations 2 and 3, suggesting that the investigated soils were mostly young soils such as Inceptisol or Entisol. There was consistent clay increase in all studied soils leading to formation of argillic horizon in Bt1 horizon of location 2 and kandic horizons in locations 1 and 3. Organic matter contents and stratification qualified pedons in locations 1, 2 and 3 as Fluvents, since there was an irregular decrease in organic-carbon content (Holocene age) between a depth of 25 cm and either a depth of 125 cm below the mineral soil surface. Isohyperthermic soil temperature regime placed the investigated soils on the suborder Tropepts, The temperature regime and percentage base saturation were considered at the subgroup level in the soil taxonomy. A base saturation (by NH4OAc) of more than 60 percent or more at a depth between 25 and 75 cm from the mineral soil surface. There was presence of lithic contact in location 1, at a depth of 110 cm while water was encountered in locations 2 and 3 at a depth of 124 and 126 cm respectively. Therefore pedon 1 is classified as **Typic Eutrudept (USDA) and Eutric Cambisols (WRB)** while pedons 2 and 3 were classified as **Aquic Eutrudepts (USDA) and Gleyic Leptosols (WRB)**.

Conclusion

The parent material is Shale/Alluvium derived from Asu River group. The profiles were deep enough for rice cultivation and drainage indicated well drained for Ap and AB horizons and poorly drained for Bt1and Bt2 horizons. Soils textural properties indicated that sand and silt had similar trends as they decreased down the profile in all studied locations. While clay took an opposite trend as it increased down the horizons in all locations. Sand had means of 46.24, 41.74 and 46.76%; Silt had means of 25, 28 and 22% while clay had means of 27.54, 27.76 and 26.76% all in locations 1, 2 and 3 respectively. Therefore pedon 1 is classified as Typic Eutrudept (USDA) and Eutric Cambisols (WRB) while pedons 2 and 3 were classified as Aquic Eutrudepts (USDA) and Gleyic Leptosols (WRB).

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STUDY OF ANTIOXIDANT AND LARVICIDAL ACTIVITY OF ESSENSTIAL OIL OBTAINED FROM LEMON GRASS LEAVES (*Cymbopogon citratus*)

Musa Runde

Department of Chemistry
Faculty of Science
National Open University of Nigeria

ABSTRACT

Essential oil was extracted from leaves of Lemon grass (*Cymbopogon citratus*) and analysed for composition, antioxidant and larvicidal activities. the GC-MS analysis of the essential oil reveals the major compounds as β.-Myrcene(18.39%),.3,7-di-methyl-2,6-octadienal(16.28%),3,7-di-methyl-2,6-octadienal(citral)(15.12%),Bicyclo[3.1.1],4,6,6-trimethylhept-3-en-2-ol(5.19%),1,4-heptadiene(3.15%). The *Cymbopogon citratus* essential oil exhibited high larvicidal activity with 100% mortality and LC 50 at 37 and 19.0 ml respectively, after 24 hours. The strongest free radical scavenging activity (97.43%) was exhibited by 50 µL/ml *Cymbopogon citratus* essential oil whereas, free radical scavenging potentials of the standard (ascorbic acid) was determined as 98.74% at the same concentration of 50 µL/ml. xxxx

Keywords. Essential oils; phytochemicals; larvicidal; antioxidants; medicinal plant

INTRODUCTION

Medicinal plants are used by many tribal people as folk medicine to treat diseases and some metabolic disorders such as diabetes mellitus, rheumatism, bowel disorders and inflammation. Some are used for ameliorating insect poisoning. Many metabolites have been purely obtained from medicinal plants, such as saponins, flavonoids, terpenes and glycosides. Essential oils, Phenolic compounds and these compounds are reported to exhibit protective effects due to their chemical properties. (Manjamalai *et al*., 2012).

Cymbopogan citratus (commonly named, lemongrass) is an odoriferous shrub belonging to Phocaea family. It is an average heigh, clumped perennial grass growing to a height of 1 m. The leaf-blade is linear, tapered at both ends and can grow to a length of 50 cm and width of 1.5 cm (Mirghani *et al*., 2010). The tubular shaped leaf-sheath serve as frame for which the plant grows and acts as a pseudostem. The commercial value and its application in food industry of lemongrass essential oils confer on the plants great value and at the same, reason why the plant is of great interest (Payne*et et al*., 1991). Diseases such as diabetes mellitus and gout are among the chronic diseases affecting worldwide population. In-depth study is required in order to discover some alternative remedies for these diseases. Tea prepared from lemon grass leaves has served as antiseptic anti-fever, anti-dyspeptic, carminative and tranquilizer (Negrelle *et al.,* 2007).

Essential oils are liquid, generally colorless to slightly yellowish substances obtained from odoriferous plants. They are slightly soluble in water and dissolve fairly well in ethanol and other organic solvents, and can mixed very well with vegetable oils, fats and waxes. The odour of essential oil is similar to that of the portion of plant from which they are extracted from and may be relatively more intensive while their specific gravity varies from 0.84 to 1.18 (Carter *et al.,*2000).

Free radicals are not required because of their unwanted roles in human ageing process and in diseases progression. On the other hand, antioxidants provide major defence against free radicals' invasions, and are required for maintaining good health and wellbeing. The desire for antioxidant becomes even more important with increased risks for coming in contact with free radicals. Environmental pollutants such as cigarette smoke and other factors like drugs, illness, stress and even exercise can increase risk of free radical exposure (Mark, 1998).

Substances which target insect larvae in the breeding arears before they can mature into adult are called Larvicides. Application of Larvicides to mosquito breeding arears help in reducing the adult mosquito population around the environment. Substances which have larvicidal property can be in liquid, tablet, pellet, granular and briquette. Each formulation has a particular method of application (Das *et al*., 2007).

MATERIALS AND METHODS

The materials requirement for this study includes; Fresh leaves of *Cymbopogan citratus*, GC-MS Machine, Steam distillation apparatus, Heat source, Laboratory glass wares, reagents of analytical grade.xxx

SAMPLE COLLECTION, AUTHENTICATION AND PREPARATION

Fresh leaves of *Cymbopogon citratus* (lemon grass) were collected at American University of Nigeria Yola and were air dried.

SAMPLE EXTRACTION

Screening the extracts for bioactive components

Phytochemical screening for major constituents of the plant extracts was carried out using standard qualitative methods as described by various authors (Odebiyi & Sofowora, 1990 Fadeyi *et al*., 1989, Kubmarawa *et al*., 2007, Runde, *et al,* 2015) as follows:-

Test for Saponins

5ml of the extract was vigorously shaken for 2 minutes with 10 ml of water in a test tube. Frothing which persisted on warming was taken as an evidence for the presence of Saponins.

Test for Tannins

To a small quantity of the plant extract, 10ml of water was added followed by a

drop of ferric chloride. Green precipitate indicates the presence of Tannin.

Test for Flavanoids
To a small quantity of the extract, a small quantity of magnesium chips was added and a few drops of concentrated H_2SO_4 down the side of the test-tube. Reddish coloration indicates the presence of Flavanoids.

Test for Alkaloids
Picric acid was added to small quantity of the extract. Orange colouration was taken as an evidence for the presence of Alkaloids.

Test for Essential oils
Small quantity of the extract was dissolved in 90% alcohol and drop of ferric chloride added. Green colouration indicates the presence of essential oils.

Test for Glycosides
To 5ml of the extract, 25ml of dilute H_2SO_4 was added in a test-tube and boiled for 15 minutes. It was cooled and neutralized with 10 % NaOH and then Fehling's solution A and B was added. A brick red precipitate indicates the presence of Glycosides.

Test for Phenols
An equal volume of the extract was added to equal volume of ferric chloride, a deep bluish solution indicates the presence of phenols.

EXTRACTION OF ESSENTIAL OILS
500g of the pulverized form of each of the fresh samples was subjected to steam distillation in a modified steam distiller (as modified by Runde *et al.,* 2015) while other conditions were adhered to according to the British Pharmacopoeia (BP) method. The time taken for the isolation of the oil was 4 hours (Kubmarawa *et al*., 2013).

GAS CHROMATOGRAPHY MASS SPECTROMETRY (GC/MS) ANALYSIS
GC-MS analysis was performed as adopted by Runde *et al.* (2015) on a J and W Scientific gas chromatography directly couple to the mass spectrometer system (model GC Agilent S/N 20102969, polarise Q S/N 210729) HP 5ms 5% pheny! Methyl] silox: 469.56. Capillary Colum (30M x 250m) was used under the following condition: ovum temperature 50^0 C for 1 min, then 10 and 20 min to 300^0C for 2 min and the descriptions is as follows.

Injector temperature 230^0C carrier gas He, flow rate 1m/min; the volume of the injected sample was 0.2L of diluted oil in hexane. Split less injection techniques, ionization energy 70ev. In the electron ionization (EI) mode, ion source temperature 230^0 C scan mass range of M/Z 60-335; the constituents of the essential oils were identified base on comparison of the retention indices and mass spectra of most of the compound with data generated under identical experimental conditions by applying a two dimensional search algorithm considering the retention index as well as mass spectra similar with those of authentic compounds available in NBS75K Library.

The retention indices (RI) are in relation to a homologues series of n-alkanes on the GC column under the same chromatographic condition components relative concentration will be obtained by peak area normalization (Ramzi *et al*., 2013).

DPP FREE RADICALS SCAVENGING ASSAY OF ESSENTIAL OIL
The 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging assay was carried out for the evaluation of the antioxidant activity of the various essential oils. The purple color, typical for free DPPH radical fades, and the change in absorbency at λ = 517 nm is measured spectrophotometrically.

The method was carried out as described previously by Kubmarawa *et al*. (2013) and adopted by Runde *et al.* (2015). The essential oil was dissolved in methanol, and various concentrations (2, 6, 12, 24, and 50µL/mL) was used. The assay mixture contained in a total volume of 1 mL, 500 µL of the oil, 125 µL prepared DPPH (1mM in methanol), and 375 µL solvent (methanol). After 30 min incubation at 25°C, the decrease in absorbance was measured at λ = 517 nm. The radical scavenging activity was calculated from the equation below: % or radical scavenging = [(Abs control – Abs Sample) ÷ Abscontrol] x 100 (Runde *et al.,* 2015).

LARVA SUSCEPTIBILITY TEST

The assay for larvicidal activity of the essential oils of *Cymbopogan citratus* was done according to the standard WHO protocol for larval susceptibility test. A stock solution was prepared by adding 525 micro litre of the essential oil in 100ml of Normal saline using DMSO as the emulsifier and final concentration of 38.0ml, 28.5ml, 19.0ml, 9.0ml and 4.0ml of the essential oil was tested. The chamber containing the control larvae received 1ml of DMSO served as the negative control and the positive control containing the control larvae also received 1ml of commercial pesticide in 100ml of deionized water. Four replicates were carried out for each dilution and for the control.

After 24hrs of contact, living and dead larvae were counted. The results of susceptibility testing were expressed in percentage of mortality versus concentrations of essential oils used. The percentage of mortality were calculated using Abbott's formula (% test mortality - %control mortality observed) / (100-%control mortality) x 100 (Kihampa *et al.*, 2009).

RESULTS

Table 1: Phytochemical screening of *Cymbopogan citratus* (Lemon grass)

Alkaloid	Essential Oil	Flavonoid	Glycoside	Phenols	Saponnins	Tannins	Terpenoids
+	+	+	+	-	-	+	+

Key += Present, **-** = Absent

The phytochemical screening of *Cymbopogon citratus* reveals the presence of Alkaloid, Essential oil, Flavonoids, Glycoside, Tannins and Terpenoids whereas, Phenols and Saponnins were absence.

Table 2: Chemical Composition of Essential oil of *Cymbopogon citratus* (Lemon **grass)**

Constituent	RT	Area %	MW
β.-Myrcene	2.779	18.39%	140
Cyclohexene	3.154	0.94%	82
Bicyclo[3.1.1],4,6,6-trimethyl- hept-3-en-2-ol	3.254	1.10%	150
.3,7-di-methyl-2,6-octadienal (citral)	5.372	15.42%	151
.3,7-di-methyl-2,6-octadienal	5.879	29.28%	152
2,6-octadien-1-ol.3,7-di-methylacetate(E)	4.317	0.60%	`54
3, 7, 11-trimethyl Dodecatriene.	6.906	0.13%	204
2,6-octadien-3-ol	3.914	0.65%	154
1,6-octadiene	4.317	0.60%	138
1,4-heptadiene	4.481	3.15%	96
,Caryophyllene	6.342	0.05%	204
1,6-octadien-3-ol	3.930	0.61%	140
Bicyclo[3.1.1],4,6,6-trimethyl- hept-3-en-2-ol	5.532	5.29%	151

The GC-MS analysis of the essential oil obtained from the leaves of *Cymbopogon citratus* shows the presence of the following compounds shown in Table 1. However, the major components were β.-Myrcene (18.39%),.3,7-di-methyl-2,6-octadienal(16.28%),3,7-di-methyl-2,6-octadienal(citral)(15.12%), Bicyclo[3.1.1],4,6,6-trimethylhept-3-en-2-ol(5.19%),1,4-heptadiene(3.15%), Bicyclo[3.1.1],4,6,6-trimethyl- hept-3-en-2-ol(1.10%).

Table 3: DPPH Radical scavenging activity

Sample	% Scanverging property/µL				
	2	6	12	24	50
Cymbopogon citratus	85.51	85.83	86.29	86.83	97.43

Ascorbic acid	80.22	83.06	85.01	92.44	98.74

From the result, the scavenging ability of the essential oils showed a concentration-dependent activity profile (Table 3). The strongest free radical scavenging activity was exhibited by 50 µL/ml *Cymbopogon citratus* essential oil (97.43%). Free radical scavenging potentials of the standard (ascorbic acid) was determined as 98.74% at the same concentration of 50 µL/ml.

Table 4: Result larva Susceptibility Testing using Dimethyl sulfoxide (DMSO)

Extracted Essential oil	Concentration(ml)	%mortility	LC50
Cymbopogon citratus	37.0	100	
	28.5	80	
	19.0	50	19.0ml
	9.0	10	
	4.0	0	

The larvicidal susceptibility of all the plants essential oils tested at various concentration were found to be effective against the larvae of Anophele mosquito. At lowest concentration of 9.0 ml, 10% of the larva were inactive whereas, at the concentration of 37 ml, the larva motility reached 100 %. The Lethal Concentration at 50 (LC 50) was observed when the concentration of the essential oil was increase to 19 ml. No larva motility was observed in the negative control (DMSO) but motility was observed in the positive control. (insecticide). The results on the use of different concentrations of the plant essential oils were recorded in term of motility against the larvae of Anophele mosquitos under laboratory condition were shown in table 4 above.

DISCUSSION

Phytochemical screening of *Cymbopogan citratus* (Lemon grass)

The phytochemical screening of *Cymbopogon citratus* is presented in table 1 above. Other researchers revealed that phenolic compounds such as phenolic acid, flavonoids, tannins, stilbenes, quinines and others, have anticarcinogenic and antioxidant activities (Huang and Cai, 2010) whereas, saponin are reported to have anti-imflamatory, hypocholesterolemic and immune-stimulating properties (Yukuyoshi *et al.*, 2012).

Phytochemical screening of *Cymbopogon citratus* conducted by Ewansiha, *et al*, 2012, also revealed the presence of essential among other metabolites. This essential oil is responsible for specific aroma in lemon grass as confirmed by Bonjar and Farrokhi, 2004. The pleasant aroma in lemon grass also qualifies the plant for application in cosmetics, food and beverages and pharmaceutical industries (Seenivasan, *et a*l, 2006).

Chemical Composition of Essential oil of *Cymbopogon citratus* (Lemon grass)

The GC/MS analysis of essential oils of *Cymbopogon citratus* revealed the presents of various compounds as shown in table 2. Another author revealed that lemongrass' stalk essential oils consist of geraniol (5.40% and 7.75%), limonene (5.71% and 5.92 oil while the essential oil of lemongrass' leaves revealed that geranial (32.10% and 29.64%), neral (22.36% and 21.73%), %) and β-myrcene (2.20% and 2.28%), were the major constituents of the stalks and leaves' lemongrass essential oil respectively (Mirghani *et al.,*2012). From the GCMS analysis on the standard essential oil lemon grass, it revealed that the major constituents of the essential oil are higher compared to the essential oil extracted in this study, with the total of geranial (44.29%),neral (31.36), geraniol (10.01%), limonene (6.09%) and β-myrcene (3.56%), comprising 95.31% of the total oil. Most of the studies and literature found on lemongrass were focused only on the leaves part. Based on literature data, it appears that geranial, neral, geraniol, limonene and β-myrcene have been found as major compounds in many other Cymbopogan species with the main chemical component of lemongrass oil is citral (Luiz *et al*., 2001; Huynh, 2008). Citral or 3, 7-dimethyl-2, 6-octadienal is the name given to a natural mixture of two isomeric acyclic monoterpene aldehydes:

geranial (*trans*citral, citral A) and neral (*cis*-citral, citral B) (Huynh, 2008).

DPPH Radical scavenging activity

Similar work shows that the antioxidant activities of the essential oils of *cympobogon citratus* examined using DPPH scavenging test and the highest inhibition was obtained from the essential oil extracted from the stalk (89.5%)and the major components are geranial (32.10% and 29.64%),neral (22.36% and 21.73%), geraniol (5.40% and 7.75%), limonene (5.71% and 5.92%) and β-myrcene (2.20% and 2.28%), were the major constituents of the stalks and leaves' lemongrass essential oil respectively, (Mirghani *et al*,. 2012). A plot of % inhibition against concentration (µL/ml) is shown in the figure below.

Larva Susceptibility Testing using Dimethyl sulphur (1V) oxide (DMSO).

.*Cymbopogon citratus* exihibited high larvicidal activity with 100% mortility and LC50 at 19.0ml concentration after 24 hours. This result is comparable with the earlier reports of the work x Beena (2013), who observe the larvicidal activity of the essential oils of *cymbopogon flexeous* and *Tagetes erecta* against Aedes aegypti larvae which showed that the LC50 of value of *cymbopogon flexeous* are 136.8, 52.7 and 24.056 ppm after 12, 24 and 48hrs of exposure and that of *tagetes erecta* were 81.765, 48.951 and 17.729 ppm after 12, 24 and 48 hrs of exposure respectively (Beena, 2013). A similar research also reported that LC50 of *Citrus sinensis* and *Citrus paradise* against Anopheles gambiae are 73ppm and 76 ppm respectively (Okunowo *et al*., 2015).

CONCLUSION

From the results obtained, it shows that the essential oil of *Cymbopogon citrates* contains compounds which have strong antioxidant activity and is comparable with the antioxidant activity of ascorbic acid available in the market. The larvicidal activity of the oil shows that it can be harnessed for use as agent for control of mosquitoes in the environment. Further research to establish the toxicity of this essential oil is encouraged and its effects on all the stages in the lifecycle of mosquito be analysed.

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RURAL FARMERS CREDIT SUFFICIENCY FROM INFORMAL FINANCIAL SELF-HELP GROUPS: IMPLICATIONS FOR AGRICULTURAL PRODUCTION IN DELTA STATE, NIGERIA

Peter Ifeanyichukwu Nwandu

Department of Agricultural Economics and Eextension
Faculty of Agricultural Sciences
National Open University of Nigeria
pnwandu@noun.edu.ng
+23408055154274

Abstract

The study investigated how the indigenous informal financial methods, the Non-rotating self – help groups were being used by the rural farmers to support their agricultural production. The study area was Delta state. Multi – stage random sampling procedures was used to select 148 respondents, made up of farmers and officials used for the study. Data was collected with structured questionnaire, oral interview schedules, and group discussions. Data was analysed with descriptive statistics of percentages and means. Results show that the Non- rotational self –help groups have a simple organizational structure and operates two types of fund _the non-rotational fund and the contingency and emergency fund, from where members obtain credit. Problems of the Non-rotating self-help groups include delay in releasing their fund by the banks and inadequate record keeping. It was recommended among others that the self –help groups be allowed to exist as part of the rural financial inclusion. However in order to help the system there should be a follow up with regulation frame work and enlightenment on self-help group activities.

Keywords: Rural farmers Credit sufficiency Self-help- groups

Introduction

Agriculture in Nigeria is sustained by rural small- holder farmers who constitute about 70% (Nigeria Bureau of Statistics – NBS -, 2017). Some of them are engaged in farm supply, majority are engaged in farm production while others are involved in product processing, marketing and distribution to the final consumers. These small-holder farmers encounter many problems in their agricultural production; among them is access to finance. In an attempt to solve the financial problem of the small-holder farmers, the government adopted a variety of strategies to provide access to credit to the rural farmers. Among the programmes introduced were the Agricultural Credit Guarantee Scheme (ACGS) and the Rural Banking Scheme as operated by the commercial banks, and Bank of Agriculture (BOA). Other more recently introduced institutions and supposedly more grassroot oriented include Micro Finance Banks (MFBs) and Micro Finance Institutions (MFIs) owned by Non-Governmental Organisation (NGOs). The interventions are intended to provide financial and banking services and inculcate banking habits to rural dwellers. The financial intermediations are supposed to evolve strategies that will facilitate institutional sustainability which will make for participation of a majority of the rural small-holders or serve purposes that are perceived to indirectly benefit most rural dwellers. However the services of these formal financial institutions has made the indigenous informal self-help groups (SHG) existing in the rural areas of great importance to the farmers both in terms of capital accumulation and credit availability.

According to Subramanian (2010) Self-help groups are small informal economically homogenous affinity associations of the rural poor created at the grassroots level for the purpose of enabling members achieve the following: saving small amount regularly; mutually agreeing to contribute a common fund and meeting their emergency needs. Other purposes include: collective decision making; solving conflicts through collective leadership and mutual discussions; and providing collateral free loan with terms decided by the group at meetings. Self-help groups have been able to mobilise small savings either on weekly or monthly basis from persons who are not expected to have any savings. SHGs have been able to effectively recycle the resources generated among the members for meeting their productive needs and emergency credit needs.

Kaira,Anil, Tonts and Siddique (2013) observed that the wide range of services provided by these informal SHGs, the techniques they employ and the cultural contest they represent all have critical implications for rural finance in the country. Experience in rural development has shown that efforts at expanding the economic base of the rural areas almost always flounder because of scarcity and restrictive access to loanable funds. The rural small-holder farmers financial constraints and limited access to formal credit sources may have necessitated their increased participation in savings and credit systems that rely on traditional pattern of social relations and control. The resistant nature of these indigenous associations despite the existence of the formal financial institutions point to the possibility that they may contain desirable elements that are conducive to local resource accumulation. These desirable elements seem to be lacking in modern financial institutions.

Problem Statement

Nigerian Government aware of the role the rural small-holder farmers play in the country's agricultural production has been advancing credit through the formal financial institutions to the farmers. The credit hardly gets through to the farmers due to official bureaucracies and financial leaks. On the other hand the Micro Finance Banks (MFBs) and Micro Finance Institutions (MFIs) which are mostly owned by communities and Non- governmental Organisations (NGOs) respectively are not faring any better in advancing credit to the rural small-holder farmers. In a survey conducted by Central Bank of Nigeria – CBN – (2004) over 78 percent of the MFIs financing was for trading activities while 14.1 percent was for farming activities. This is because of the quick and high returns that come from investment in trading compared with the long gestation periods and lower returns that are associated with farming.

Among the indigenous financial associations is the Non-rotating Self-help group which have been described in

ethnological literature (Sachel and Damachi, 1982) but have rarely been isolated and studied independently to explore their use as a source of capital accumulation and credit delivery to small-holder farmers. The study was therefore undertaken to explore among others how these indigenous informal financial Non-rotating SHGs accumulate capital and meet the credit needs of their members for farm production without depending on formal loanable fund and other informal rural financial sources.

Objectives of the Study

The study investigated how rural farmers achieve credit sufficiency for agricultural production from informal financial non-rotating self-help groups in Delta State, Nigeria. The specific objectives were to:

- determine the organisational structure and method of operation of the indigenous informal financial non-rotating self-help groups in the study area;
- examine and analyse the techniques used by the indigenous informal financial non- rotating self-help groups to accumulate capital;
- ascertain the strategies employed in disbursing and extending credit to members;
- identify constraints that limit the operations of indigenous informal financial non-rotating self-help groups; and
- make useful recommendations that will help improve the services of the indigenous informal financial non-rotating self-help groups to the rural small-holder farmers.

Materials and Methods

Study Area

The study area was Delta North Agricultural Zone of Delta State. The rural areas of Delta North were predominantly farmers who were engaged in different indigenous informal financial self-help savings and credit groups. However only the non-rotating self-help groups were studied.

Sample and Sampling Procedure

Multi stage stratified random sampling procedure was used to select the sample. The first stage was the selection of 3 Local Government Areas (LGAs) from the 9 LGAs that made up Delta North Agricultural Zone. The LGAs selected were Oshimili South, Aniocha North and Ndokwa West. The second stage was the selection of 3 villages from each LGA giving a total of 9 villages used for the study. The LGAs and villages include: Oshimili South – Oko-Anala, Okwe, and Ogbele; Aniocha North – Idumuje Uno, Ugbodu and OnichaOlona; Ndokwa West – Ewulu, Ishiagu and Ossissa. The third stage was the selection of 2 indigenous informal financial non- rotating self- help groups giving a total of 18 non-rotating self-help groups. Finally purposive sampling technique was used to select the respondents. Because of the small number of members in each group, all the group members were sampled giving a total of 148 member respondents used for the study. The communities, the SHGs and the member respondents are given in Table 1 below:

Table 1. Self – Help Groups and Members in Each Community

Community	Name of Group and No of Members in the Group		Total Group Members in Each Community
OkoAnala	Ofuobi	8	15
	Faith	7	
Okwe	Udoka	10	18
	Ezaifakaego	8	
Ogbele	Jesus	8	16
	God's time	8	
IdumujeUnor	Goodluck	6	15

	God's time	9	
Ugbodu	Reighners	10	17
	Successful	7	
OnichaOlona	Aku	10	20
	Prosper	10	
Ewulu	Rock of Ages	6	14
	Uba	8	
Ishagu	Winners	9	17
	Nwanneka	8	
1. Ossissa	Wisdom	9	16
	Progress	7	
	Total		**148**

Data Analysis

Data was analysed using descriptive statistics of frequency distributions, percentages and mean.

Findings and Discussions

Organizational Structure

Findings revealed that the indigenous informal financial non rotating self-help groups have an elected executive of 3 members in 16 of the groups studied whose tenure span over 4years. However in many of the groups the executive can stay for more years if their performances are commendable. In most cases firmness, honesty and fairness to members are what prolong the executives stay. The executive was headed by a Chairman followed by a Secretary and a Treasurer who also act as the financial secretary. In the remaining 2 groups there were only two member executives, the chairman and the treasurer who also doubles as the secretary.

The Chairman presides over meetings, listens to all components and with the members of the executive disciplines, sanctions, fines, approves and disburses funds to members. The secretary keeps the minutes of the proceedings while the treasurer collects contributions and disburses contributions or loans to members after approval has been granted. The treasurer also works out the amount each farmer (member) will have to pay to meet the target sum required for the seasonal farm, activities. In all the groups studied, the post of secretary and treasurer were occupied by members that were literate in English Language. They were mainly retired teachers or civil servants who have returned to the village and have taken to farming as an occupation. The treasurer in addition must have knowledge of banks operation systems.

There were 2 types of meetings usually held. The first one was in the evenings of every market day. The market days were usually every four days. The main objective of choosing the market day was to reduce default as regards to member contributions since most often members have something to sell on market days. Meeting on market days also help members to escape sanctions and fines that will come for defaulting in their contributions. The market day meetings were usually brief it was for members to pay up their contributions or indebtedness. Sometimes members do not physically attend but send their contributions by proxy. The procedure was

not taken as an offence and fines were not usually collected.

The second type of meeting was usually held once a month in 66.7 percent of the groups studied and once every two months in 33.3% of the remaining groups studied. This is the general meeting in which every member is expected to be present. Proxy is not allowed and fines were collected. Absenteeism must be with cogent reason. In this meeting, matters concerning the Association was discussed ideas were pooled on how to make the association progress.

Techniques Used for Capital Accumulation

There were two types of savings fund operated by the group namely, the non-rotational savings and the contingency and emergency savings.

The Non Rotational Savings Fund

This was the main savings of the groups. It was also the main objective for setting up the association. At the end of the farming season and approaching harvest, the executive calls for estimates for the next farming season from individual members. The estimates include cost of renting land, land preparations, inputs to be used, labour, purchase of implements, transport, processing, marketing, repairs and erection of farm buildings and structures. The estimates usually include size, quantity, type and number of items required from a prepared price list. The treasurer works out the total amount that members will pay in order to meet the financial farm requirement. The final figure that, the member will pay was projected a little above the total estimate worked out for the member. The main purpose was to ensure that the farmer does not fall below the real estimated amount. Other reasons include price changes and unforeseen contingencies.

Table 3. Mean Amount Mobilized for the Contingency and Emergency Fund, Registration, Fines, Levies and interest

Community	Mean Amount Mobilised and Savings	Mean Amount Mobilised from Registration Fines, Levies and Interest	Total Amount Mobilised for Contingency Fund
	₦	₦	₦
Oko- Anala	97,160.48	48921.60	146082.00
Okwe	98602.00	16600.00	115202.00
Ogbele	131906.40	24840.56	156746.96
IdumujeUnor	144524.00	36044.40	180568.40
Ugbodu	187524.40	51200.00	238724.40
OnichaOlona	47062.00	29246.40	76308.40
Ewulu	85720.40	24080.40	109800.80
Ishagu	123241.20	24940.72	148181.92
Ossissa	70,766.40	32524.80	103291.26

Total	**986507.28**	**288398.88**	**1274906.16**

Table 2 showed mean amounts mobilized from savings, registrations, fines, levies and interests. Observations showed that savings mobilization in all the groups were higher than mobilization from registration, fines, levies and interests. During the focus group discussions, members gave reasons such as the registration fee being low and members hardly attract fines since they know the constitution guiding the group and try to avoid them. Levies were organized during celebrations like marriages, births, deaths and title taking among others. Again levies were low since the celebrating members usually provide enough entertainments for the group. The group only provides gift. Loans also attract low interest rate of between 2 to 3 percent per annum of monthly equal installments. Furthermore a member could use all or part of the contingency savings to offset the loan.

Strategies Employed in Disbursing Fund and Extending Credit to Members.

Disbursing the Non-Rotational Savings Funds.

The disbursement from the non-rotational savings funds from the different groups are discussed in Table 4 below.

Tabie 4. Annual Amount Contributed and Disbursed From Non – Rotating Funds

	Community	Mean Actual Amount Contributed	Mean Actual Amount Disbursed ₦	% of the Mean Actual Amount Disbursed and Amount Contributed	Different between the Mean Amount Contributed and the Mean Amount Disbursed ₦
1.	Oko – Anala	381363.00	367044.85	95.0	19,318.15
2.	Okwe	149873.34	149873.34	97.0	4635.26
3.	Ogbele	226380.24	215061.23	95.0	11319.01
4.	IdumujeUnor	221162.36	210104.26	95.0	11058.10
5.	Ugbodu	295304.64	280539.41	95.0	14765.23
6.	OnichaOlona	187112.52	181499.16	97.0	5,613.36
7.	Ewulu	143622.36	139313.69	97.0	4308.67
8.	Ishagu	292127.72	277521.33	95.0	14606.39
9.	Ossissa	195516.64	189651.14	97.0	5865.50
	Total	**2102098.08**	**2010608.43**		**91489.65**

The actual estimates were disbursed but the percentages projected estimates were kept back if there were no price changes for the season farming. The entire savings were not disbursed once to members. The disbursements were made installmentaly as the farm operations approaches. Reasons given include that the farmers may use it for other contingencies instead of using it for farm production which was the purpose of the contribution. The farmers may also really have the intention of using the contribution for farm purpose but since some of the farm operations for which the contribution were meant to serve were still some distance away they

may be able to hold on to the full amount if disbursed. In 8 of the groups there were monitoring committees that check the use of the fund by the farmer. However from observation and participation majority of the members use the fund for the purpose they were meant to serve.

Total 5. Annual Sectorial Disbursement to the Different Farm Operations from Non – Rotating Saving Fund

Farm Operations	Mean Amount Disbursed	% of Mean Total Amount Disbursed
1. Renting Land	125663.63	6.20
2. Land Preparation	251326.05	12.50
3. Inputs	653447.73	32.50
4. Labour	226193.45	11.25
5. Implements	251326.05	12.50
6. Transport, Processing and Marketing	125663.03	6.25
7. Repairs/Erection of Farm Structures and buildings	376989.07	18.75
Total	**2,010608.43**	**100**

Table 3 showed sectorial disbursements to the different farm operations from the non-rotating fund.The costs of the farm operations were disaggregated to ascertain the contribution of each sector to the total cost of production. Table 3 also revealed that farm inputs (32.50), repairs/erection of farm structures and buildings (18.75%), land preparation (12.50%), implements (12.50%) and labour (11.25%) were farm operations that demand most of the funds. Fund demand for labour was observed to be low. This was probably due to the fact that family and community labours were common among the farmers.This finding is in line with NBS (2017); Akanni and Dada (2012) and Takane (2008)

Disbursing and Extending Credit and Repayment of the Contingency and Emergency Fund

Part or whole of the contingency and emergency funds contributed by a member could be requested for by the member and it is granted. However, a member cannot withdraw more than what was contributed. Any additional withdrawal was granted as loan with interest. The interest rates of the group studied ranged from 2 to 3% per annum on the amount borrowed at equal installment basis. To discourage too much borrowing in 80% of the group studied, a member cannot borrow more than double the amount that stands as a member's balance. The total amount given as loan to the member will not exceed the total amount that is in the non-rotational savings account. The non- rotational savings account serves as member's collateral

Table 6: mean annual loan disbursements and repayment from the contingency and emergency fund

Community	Mean amount available for loan N	Mean amount disbursed as loan N	% between mean amount available and meant	Meaning principle amount repaid N	% repayment

			amount disbursed		
Oko – Anala	110423.20	74403.15	67.38	71680.00	96.34
Okwe	40201.00	25419.09	63.23	23319.47	91.79
Ogbele	78362.02	45920.14	58.60	44404.77	96.70
IdumujeUnor	90344.20	63575.21	70.37	56028.00	88.13
Ugbodu	51922.20	32866.75	63.30	30520.07	92.86
OnichaOlona	44154.20	30,000.00	67.94	29076.00	96.92
Ewulu	54900.00	31199.67	56.83	22320.24	71.54
Ishagu	74211.50	50463.82	68.00	41592.28	82.43
Ossissa	52251.62	26496.80	50.71	23608.65	89.10
Total	**596769.94**	**380344.63**		**342549.48**	

Table 6 also showed loan repayment by members. Observations showed that loan repaymentrate was high. These observations were also made by Ezihe, Akpa and Ayoola (2016) and Afolabi and Kamla (2010). Members rarely borrow more than their contributions to the fund. This may be due to the fact that some members usually belong to other savings and credit organizations as observed by (Nweze, 2008). The fund from these other organizations could be used to settle the non-farm problems. Another reason may be because the non-rotational savings fund was kept mainly by members for farm production purposes.

Constraints that Limit the Operations of the Informal Financial Self-Help Groups.

Problem of the Formal Financial Institutions

All the respondents used for the study identified the formal financial institutions as a problem. The problems mentioned include fewness or absence of the banks in rural areas, problem of collecting their deposit from the bank and fear that some of the banks especially the micro - finance banks owned by influential individuals may fold which may lead to loss of their deposits. Findings also revealed that in 1997, three (3) of the groups banking with a community bank lost all their deposits when the bank suddenly went bankrupt and folded. All efforts made to retrieve their deposits failed. The major factor being that majority of the members were illiterate and also the groups do not have any legal backing and government did not come to their aid either. Due to the problem of getting their deposits from the rural banks that were close to them many of the groups (13) studied now prefer to deal with commercial banks in the city.

Inadequate Record Keeping

There was good record keeping in eight (8) of the groups where the treasurer were retired teachers and financial workers. However majority of the groups (10) were only concerned with basic record keeping like deposits and withdrawals and marking of attendance register. Working the details of the amount to be paid by each member and interest rates were difficult areas that need attention. Sometimes members' children who were educated or were in tertiary institution were usually co-opted to help in record keeping.

Conclusion

The study have shown that indigenous informal financial non-rational self-help groups can play great roles in financial intermediation of the rural economy if properly harnessed and given the right environment, Government should therefore avoid direct intervention and control in informal rural financing since this has been frought with abuse, leakages and the fund rarely getting to the farmers. The roles of government should be more of regulatory, supervisory and enlightenment. There should be guidelines for these informal financial non-rotating self-help groups. The guidelines should not destroy the traditional systems of savings and credit now available but should improve on it. Government should spend most of her resources on infrastructural development like providing feeder roads, electricity, and pipe born water, health facilities and education among others to the rural communities. These will help improve the standard of living of the rural farmers. It will also improve the productive capacity of the rural dwellers

and increase the growth of the rural economy.

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MYCOFLORA AND COWPEA BEETLE INFESTATION ON SELECTED COWPEA CULTIVARS AND THE EFFICACY OF SOME PLANT POWDERS AGAINST FUNGAL PATHOGENS

Agbaji, Francis[1,2], Aduramigba-Modupe, Adefoyeke O[1*] and Alabi, Olajumoke Y[1].

[1]Department of Crop Protection and Environmental Biology, University of Ibadan, Nigeria.
[2]Department of Crop Production, Kogi State University, Anyigba, Nigeria.
*Corresponding author: fyaduramigba@yahoo.com, Mobile 08035777810

Abstract

This study was carried out to assess cowpea beetle infestation and identify mycoflora on some selected cowpea grains, and to evaluate the efficacy of three plant powders in the control of fungal pathogens. Seven cowpea varieties; Agonyi, Oloyin, Mala, Milk, Sobo, Drum and Sokoto were obtained from Bodija a local market in Ibadan, Nigeria. Cowpea varieties were stored for six weeks,and cowpea beetle population was monitored weekly. Incidence of fungi were assessed on weekly basis. Fungi were isolated from each of the varieties and identified. Three plant powders; *Moringa oleifera* seeds, *Capsicum annuum* fruit and *Cymbopogon citratus* leaf, each at 0.0 g (control, untreated), 0.5 g, 1.0 g, 1.5 g and 2.0 g were added and thoroughly mixed with 30 g of Oloyin, Sobo, Milk, Agonyi and Drum selected from the earlier seven varieties.. After six weeks of storage, 10 grains of cowpea were selected randomly from the 30 g cowpea grains and surface-sterilized with 10% sodium hypochlorite (NaOCl) and. The grains were incubated for 7 days at a temperature of 28±2°C. Experimental units were arranged in a completely randomized design in three replicates; percentage fungal incidence was determined. Furthermore, treated seeds were planted in 5 kg pots containing sterilised soil and arranged in a randomized complete block design replicated four times. At three weeks after sowing, the effect of these plant powders on the viability of the cowpea varieties was determined. Number of cowpea beetle increased with increase in period of storage from one to six weeks. Beetle population was highest on Sokoto and least on Agonyi across all the weeks. Fungi isolated from cowpea grains were *Aspergillus flavus, Aspergillus niger, Fusarium* sp. *and Mucor* sp. *Aspergillus flavus and A. niger* were the most predominant isolates followed by *Fusarium* sp. *and Mucor* sp. *Aspergillus niger* had the highest incidence in Drum (46%). In the viability test, Oloyin, Agonyi and Drum were the most viable, while Milk and Mala had the lowest viability. Oloyin treated with 1.0 g and 2.0 g of moringa seed powder had the least infection at 4.32 and 3.31, respectively. Among the treatments, pepper fruit powder had the least infection and thus gave the best control against fungal infections.

Keywords: *Aspergillus* spp., *Callosobruchus maculatus,* Cowpea**,** Moringa seed powder, *Capsicum annuum* fruit powder, seed viability

Introduction

Cowpea (*Vigna unquiculata* (L.) Walp.) is an annual herbaceous legume. Cowpea formerly belonged to the family, Leguminosae (Padulosil and Ng, 1997). The crop is a very important food source used widely as grain legume in Asia, Africa, Southern Europe, and Central and Southern America (Chathuni *et al*., 2018). Nigeria is both the world's largest producer and consumer of cowpea (Agbogidi and Egho, 2012; Sheahan, 2012). The world's production is put at 2.2 million tonnes and Nigeria produces about 850,000 tonnes (FAO, 2015). Cowpea seeds are a rich source of amino acid lysine and tryptophan and it is high in calcium and iron (Achuba, 2006; Xiong *et al*., 2016). Apart from its dietary importance (Muoneke *et al.,* 2012), cowpea grain has contributed greatly to increasing incomes of resource-poor farmers (Langyintuo *et al.,* 2005; Baribusta *et al*., 2010, Oluokun, 2005).

However, in spite of its importance and uses, pests and diseases have been great threats to the production of cowpea from the field to the store. The cowpea beetle, *Callosobruchus maculatus* (F.) belonging to the order Coleoptera and family Chrysomelidae, is the main insect pest that causes yield loss in stored cowpea seeds. Also, some storage fungi commonly associated with cowpea are *Aspergillus* sp*., Penicillium* sp. (Gabriel and Puleng, 2013; Ki Deok and Mohamed, 2016;). There is therefore a continuous need to protect the crop against the activities of these pests and diseases (Asiwe, 2005; Hamid *et al*., 2016). During storage, farmers often take little or no consideration of the environmental conditions where they store grains and standard storage procedures are often not followed. These environments often favour the activities of pests and storage fungi which are responsible for the deterioration, especially in weight and quality of grains (Deepak and Prasanta, 2017).

The wide adoption of synthetic pesticides has some health and environmental implications (Agunbiade *et al*., 2014). Many of these synthetic pesticides leave toxic residues on grains and foods for a very long time (Egho, 2009). Due to the hazardous effects posed by these synthetic pesticides on the health and the environment, research on the use of botanicals as an alternative to synthetic pesticides have been on the increase (Mashela and Pofu, 2012; Dipsika *et al.,* 2012, Wafaa *et al.,* 2017). Some plants such as neem (*Azadirachta indica* L.) , lemon grass (*Cymbopogon citratus* Stapf), pepper (*Capsicum* spp.), moringa (*Moringa oleifera*) and many others have insecticidal properties that can inhibit the activities of pests and disease-causing pathogens (Kang *et al.,* 2013; Alabi and Adewole, 2017). Plant materials are easily accessed by farmers, locally and relatively inexpensive compared to the synthetic pesticides and easily biodegradable, hence, more ecofriendly and healthy (Premachandra, 2017). In storage, to maximize the insecticidal and inhibitory effects on pests and pathogens, these plant materials are often processed into powder, extracts and oil (Singh *et al.,* 2010; Ohia and Ana, 2017). The use of these natural products has given promising results and these materials are friendly to both human health and the environment unlike the synthetic pesticides (Cannon *et al.,* 2012; Wafaa *et al*., 2017).

Therefore the objectives of this study were to assess the population of cowpea weevil and fungal pathogens associated with selected cowpea grains sourced from Bodija market, Ibadan and to determine the effects of three plant powders on the fungal pathogens and viability of the varieties.

Materials and methods

Source of cowpea grains

Seven varieties of cowpea grains; Oloyin, Sobo, Milk, Mala, Agonyi, Drum, and Sokoto, (2 kg each), were randomly sourced from stalls at Bodija market, Ibadan. The grains were placed in clean, moisture-free polythene bags and taken to the Plant Pathology laboratory, Department of Crop Protection and Environmental Biology, University of Ibadan. Grains were kept at ambient temperature and relative humidity for 48 hours in the laboratory.

Source of botanicals

Seeds of *Moringa oleifera* and dried fruits of *Capsicum annuum* were obtained from Ojoo market, Ibadan. The moringa seeds and pepper fruits were air-dried at room temperature, milled using a motorized high speed-grinder (Model no. HS AG 1:120 N11 ID CNC). Powders were stored in separate labelled plastic containers with

tight lids. Leaf powder of *Cymbopogon citratus* was obtained from Entomology unit, Department of Crop Protection and Environmental Biology, University of Ibadan. All the materials were used as botanicals at different concentrations to treat the cowpea varieties. Air-dried *Moringa oleifera* seeds and *Capsicum annuum* fruits were ground into fine powder

Cowpea beetle infestation on cowpea varieties

Assessment of *Callosobruchus maculatus* infestation on cowpea varieties was carried out at the Entomology Laboratory, Department of Crop Protection and Environmental Biology, University of Ibadan. Thirty grammes of each of the seven cowpea varieties: Oloyin, Sobo, Milk, Mala, Agonyi, Drum, and Sokoto, were stored in plastic jars (20mL) covered with a fine mesh for aeration and replicated five times. The stored grains were observed weekly for emergence of cowpea beetle for a duration of six weeks.

Isolation and identification of fungi from cowpea grains

After six weeks of storage, ten cowpea grains were randomly selected and surface sterilised with 10% sodium hypochlorite (NaOCl) solution for 1 min and rinsed in three changes of sterile distilled water. The surface sterilised seeds were plated aseptically on layers of filter paper and cotton wool moistened with sterile distilled water in Petri dishes in four replicates (ISTA, 1999). The plates were incubated at 28 ± 2 ºC for 4 days for the growth of the seed-borne fungi. The organisms were sub-cultured to obtain pure cultures. Slides were prepared for identification of the organisms. Percentage incidence of fungi was determined by the formula of Claudius-Cole and Somefun, (2011), and Nnaji and Brook (2016) given below:

$$Fungal\ incidence = \frac{Total\ number\ of\ each\ organism\ in\ a\ variety}{Total\ number\ of\ all\ identified\ organisms\ in\ a\ variety}\ X\ 100$$

Effect of plant powders on fungal pathogens in cowpea grains

The powders of each of *Moringa oleifera*, *Capsicum annuum* and *Cymbopogon citratus* were weighed (0.5 g, 1.0 g, 1.5 g and 2.0 g) and stored in separate containers and kept aseptically in sterile conical flasks until when needed. Five varieties of cowpea grains were randomly selected from the seven varieties earlier observed to cowpea beetle infestation and fungi infection based on observable high and low incidents of beetle and fungi attacks. These varieties are Oloyin, Sobo, Milk, Agonyi and Drum each at 30 g were weighed into a sterile 90 mm container with different concentrations of each powder and mixed thoroughly. The containers were stored at room temperature for six weeks. Each level was replicated four times and arranged in a completely randomized design.

After six weeks of storage, 10 grains of cowpea were selected randomly from the 30 g cowpea grains coated with different plant powders. The ten grains were surface sterilized with 10% sodium hypochlorite (NaOCl) for 1 min. and rinsed in three changes of sterile distilled water and then, plated aseptically on the moistened three layers of sterile kitchen towel placed in 90 mm containers and incubated for 4 - 7 days (28±2ºC). Percentage fungal incidence was determined.

Effect of plant powders on germination of cowpea grains *in vitro*

;;Ten seeds from each of the cowpea grains coated with plant powders were plated aseptically on layers of filter paper and cotton wool moistened with sterile distilled water in petri dishes in four replicates. Cowpea varieties were observed for percentage germination at the end of 7 days.

Effect of plant powders on germination of cowpea grains in pots

Five varieties, Oloyin, Sobo, Milk, Agonyi and Drum, 30 g each, were transferred into a sterile 90 mm plastic bowl. The three plant powders; *Moringa oleifera* seed, *Capsicum annuum* fruit and *Cymbopogon citratus* were applied as treatments at five various concentration levels of 0.0 g (control), 0.5 g, 1.0 g, 1.5 g 2.0 g, replicated four times. After six weeks of storage in 90 mm plastic bowl, treated seeds were each planted out in 5 Kg pots arranged in a factorial experiment using randomized complete block design with four replications. Number of seeds germinated was recorded three weeks after planting. Percentage seedling viability was calculated by counting only germinated

seeds 14 days after planting according to ISTA (1999)

Data Analysis
All data were analysed using descriptive statistics and analysis of variance (ANOVA). Significant means were separated using least significance difference at 0.05 level of significance.

Results
Infestation of *Callosobruchus maculatus* on cowpea varieties

Population of emergent beetles from cowpea varieties increased with increase in duration of storage across all varieties (Figure 1). Sokoto variety had the highest number of emergent beetles among all the varieties from week one (47) to week six (255). Agonyi consistently had the least number of emergent beetles of 2.6 at week one and 26.4 in week 6. Population of emergent beetles in other varieties occurred between those of Sokoto and Agonyi in the order; Sobo> Oloyin> Milk> Mala> Drum.

Percentage infection of freshly obtained cowpea grains
Figure 2 represents the percentage infection of the cowpea grains obtained from Bodija market, Ibadan. Sobo (85%), Milk (85%) and Drum (95%) had the highest fungal infection. High percentage infection was observed in Mala (70%) and Sokoto (65%); but infection was not as high as Sobo, Milk and Drum.Oloyin (45%) and Agonyi (45%) varieties had the lowest fungal infection.

Incidence of fungal pathogens in seven varieties of cowpea after six weeks in storage
Fungi isolated from cowpea grains were *Aspergillus flavus, Aspergillus niger, Fusarium* sp. *and Mucor* sp. *Aspergillus flavus and A. niger* were the most predominant fungi isolates among the seven cowpea varieties followed by *Fusarium* sp. *and Mucor* sp. Drum had the highest incidence of *Aspergillus niger* (46%). Incidence of *A. flavus* was highest in Drum (68%) and Sokoto (60%).Drum had the highest incidence of *Fusarium* sp. (32%), while Agonyi had the lowest incidence of *Fusarium* sp. (6%), Oloyin had the lowest incidence of *Mucor* sp. (10%) among all the varieties (Table 2).

Percentage germination of cowpea varieties in vitro
Figure 3 represents the percentage germination of cowpea varieties *in vitro*. Oloyin percentage germination was the highest (90%), while Drum had the lowest germination percentage of 50%.

Effect of plant powders on fungal infection in cowpea grains
The effect of three plant powders on storage fungi is presented in Tables 3, 4 and 5. In Table 3, Oloyin and Agonyi treated with Moringa seed powder at 1.0 g and 2.0 g had the least infections at 4.32 and 3.31 3.54 and 4.64. Drum treated with 1.0 g and 2.0 g had the highest infection of 9.67 and 9.63, respectively. Table 4 shows the effect of pepper fruit powder in the control of fungal pathogens. Agonyi treated with 1.0 g and 2.0 g had the least percentage infections of 1.70 and 1.74. Drum treated with 1.0 g and 2.0 g had the highest percentage infection of 6.78 and 5.55 respectively. In Table 5, Oloyin treated with 1.0 g and 2.0 g of lemon grass powder had the least infection percentages of 2.00 and 1.25, respectively. Drum not treated (0 g), and Drum treated with 1.0 g both had the highest infection percentages of 14.9 and 10.5 respectively.

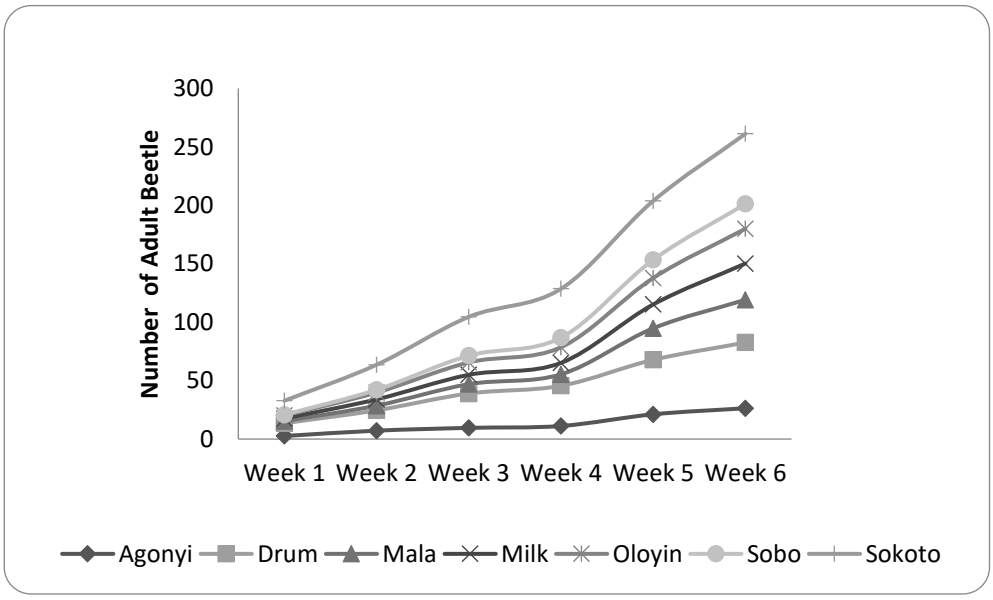

Figure1: Population of *Callosobruchus maculatus* in seven varieties of cowpea over six weeks storage.

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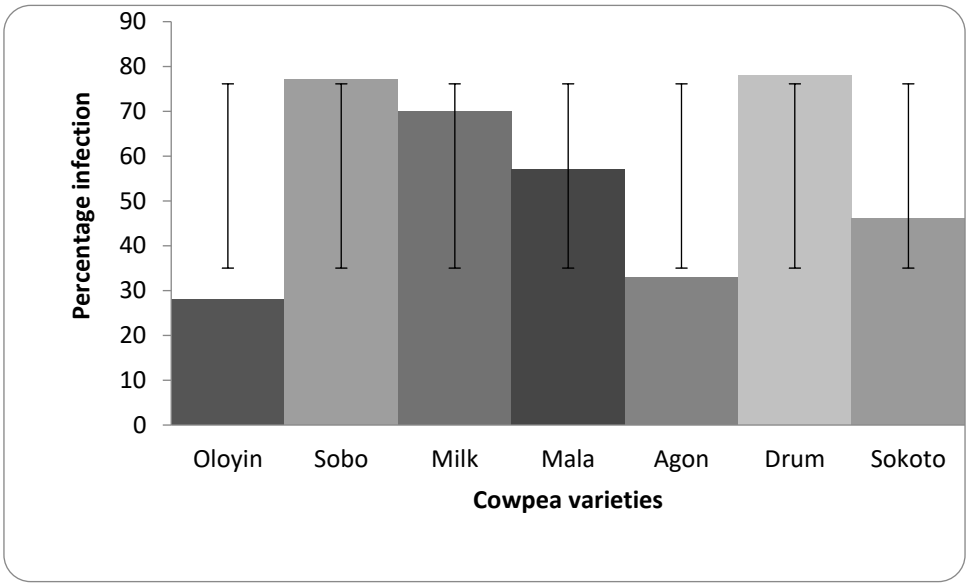

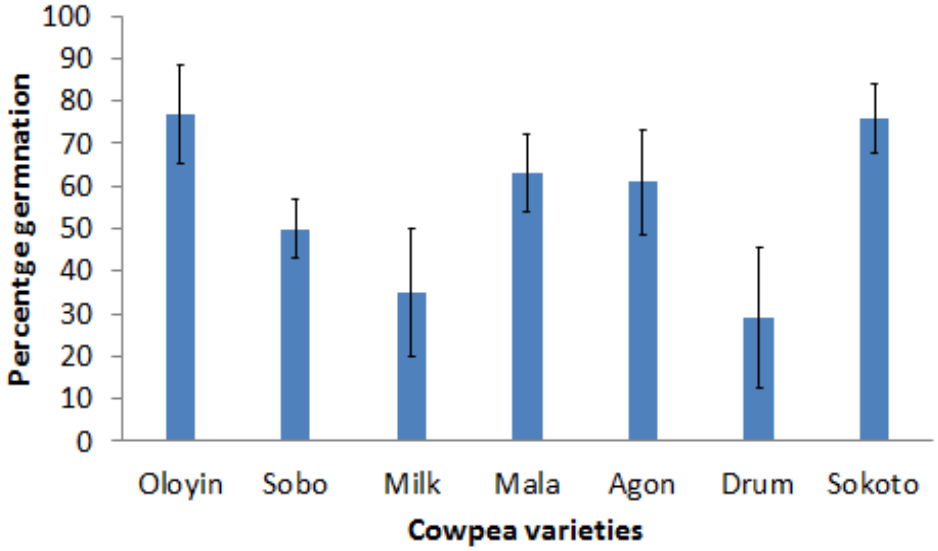

Figure 2: Percentage fungal infection of freshly obtained cowpea varieties

Figure 3: Seed viability test of seven freshly obtained cowpea varieties *in vitro*

Table 2: Incidence of fungal pathogens on seven varieties of cowpea after six weeks in storage in percentages

	Percentage incidence (%)

	Oloyin	Sobo	Milk	Mala	Agonyi	Drum	Sokoto
Aspergillus flavus	40	78	45	58	59	68	60
Aspergillus niger	20	28	19	16	10	46	32
Fusarium sp.	14	20	9	11	6	32	26
Mucor sp.	10	32	20	17	11	34	37

Table 3: Effect of *Moringa oleifera* seed powder in the control of fungal pathogens in five cowpea varieties

	Concentration levels	0 g (control)	1.0 g	2.0 g
Cowpea varieties				
Oloyin		5.34a	4.32a	3.31a
Sobo		5.55a	5.24a	5.00a
Milk		5.61a	6.36ab	4.35a
Agonyi		2.62b	3.54a	4.64a
Drum		7.30a	9.67c	9.63b
LSD(0.05)		2.63	2.02	2.58

Values are means of three replicates. Means followed by the same letter in a column are not significantly different ($p \leq 0.05$) using LSD.

Table 4: Effect of *Capsicum annuum* fruit powder in the control of fungal pathogens in five cowpea varieties

	Concentration levels	0 g	1 g	2 g
Cowpea varieties				
Oloyin		4.13a	4.45a	3.35a
Sobo		7.30b	6.60a	2.78a
Milk		6.62b	4.51a	4.32a
Agonyi		4.15a	1.70b	1.74b
Drum		10.00c	6.78a	5.55a
LSD(0.05)		2.15	2.38	1.30

Values are means of three replicates. Means followed by the same letter in a column are not significantly different ($p \leq 0.05$) using LSD.

Table 5: Effects of *Cymbopogon citratus* leaf powder in the control of fungal pathogens in five cowpea varieties

	Concentration levels	0 g	1 g	2 g
Cowpea varieties				
Oloyin		5.56a	2.00a	1.25a
Sobo		7.65a	7.51b	7.00b
Milk		6.67a	4.65a	2.38a
Agonyi		5.42a	4.50a	3.99a
Drum		14.9b	10.5b	9.34b
LSD(0.05)		4.81	3.53	3.24

Values are means of three replicates. Means followed by the same letter in a column are not significantly different ($p \leq 0.05$) using LSD.

Effect of seed treatment with three plant powders on seed germination

Tables 6, 7 and 8 showed the effects of *Cymbopogon citratus* leaf powder, *Moringa oleifera* leaf powder and *Capsicum annuum* fruit powders on the viability of the cowpea varieties. Agonyi (90%) and Drum (85%) treated with C. *citratus* powder were more viable at week 1. At week 2, all varieties were relatively viable. Agonyi (95%), Drum (95%) and Oloyin (95%) were most viable among the varieties at week 3 (Table 6).

Agonyi (90%) and Oloyin (90%) treated with *M*. oleifera seed powder had the highest viability at week 1, while Drum (65%) had the lowest viability. At week 2, Agonyi (95%), Drum (95%) and Milk (95%) had higher viability and had same percentage viability at week 3 (Table 7)

Viability of cowpea varieties treated with *C. annuum* fruit powder is presented in Table 8. Agonyi (95%) and Drum (90%) had the highest viability, while milk (70%) and Sobo (80%) had the least viability at week 1. At week 2, Agonyi (95%) and Drum still had the highest viability percentage, while milk (80%) and Sobo (80%) had the lowest. Agonyi (95%) and Drum (95%) had the highest viability at week 3 (Table 8).

Table 6: Effect of *Cymbopogon citratus* leaf powder on the viability of cowpea varieties at one to three weeks after sowing

Cowpea varieties	Number of weeks		
	1	2	3
Agonyi	90	95	95
Drum	85	90	95
Milk	20	75	80
Oloyin	80	95	95
Sobo	25	70	75

Table 7: **Effect of *Moringa oleifera* seeds powder on the viability of cowpea varieties six weeks after storage**

	Number of weeks	1	2	3
		Percentage viability		
Cowpea Varieties				
Agonyi		90	95	95
Drum		65	95	95
Milk		90	95	95
Oloyin		80	85	85
Sobo		80	85	85

Table 8: **Effect of *Capsicum annuum* fruit powder on the viability of cowpea varieties six weeks after storage**

	Number of weeks	1	2	3
		Percentage germination		
Cowpea Varieties				
Agonyi		95	95	95
Drum		90	95	95
Milk		70	80	85
Oloyin		85	85	85
Sobo		80	80	85

Discussion

Fungal pathogens and insect pests pose a major biotic stress on cowpea at all stages of production leading to great losses from the field to the store. Farmers and researchers are evolving means to curtail the menace caused by these fungal pathogens and insect pests. Among these control strategies is the use of plant materials with fungicidal and insecticidal properties. The population of the cowpea beetle observed showed that, Sokoto had the highest infestation of *Callosobruchus maculatus* population at the end of the sixth week of storage, while Agonyi had the lowest mean infestation. The difference in population of beetles among the varieties suggests that each variety has inherent variation in genetic factors such as differences in physical and biochemical properties that limits or support beetle infestation (Musa and Adeboye, 2017).This agrees with the report of Alabi *et al.* (2003) that cowpea cultivars have different processes by which they withstand insect activities. Several studies have implicated seed physical characteristics (texture, colour, toughness and size) to be responsible for resistance in some cowpea varieties to cowpea beetle (Castro *et al*., 2013; Adebayo and Ogunleke, 2016).

Four species of fungi were isolated from the selected cowpea varieties. The fungi isolated from these varieties were *Aspergillus flavus*, *A. niger, Fusarium oxysporum* and *Mucor* sp. *Aspergillus flavus* and *A. niger* were the predominant fungal species isolated from the cowpea varieties. This study confirms the report of Abd El-Rahim *et al.* (2014) who reported that *Aspergillus flavus* and *A. niger* were the prevalent fungi isolates in cowpea grains. *Aspergillus flavus* and *A. niger* produce aflatoxin in grains which are toxic to man and animals when consumed (Klich, 2007). Milk and Mala varieties were more susceptible to the storage fungi as they showed highest percentages of infection. This suggests that, their high susceptibility to fungal infections could be responsible to their low viability, while Oloyin, Drum and

Agonyi which were far less susceptible to fungal infections showed better viability. This finding is in consonance with Claudius-Cole and Somefun (2011) who found that fungal infection decreased viability in *Vigna subterranean.*
Callosobruchus maculatus is found to predispose cowpea grains in storage to certain fungal infection (Nnaji and Brooks, 2016). Heavily *Callosobruchus maculatus* infested cowpea grains (Sokoto and Mala varieties) after six weeks of storage had more fungal infection rates. This agrees with the finding of Gabriel and Puleng (2013) that, mould infection on cowpea was much higher in heavily beetle-infested seeds than wholesome grains.this could as result of increase in beelte population which led to increase in higher respiration leading to increase in relative humidity.

Milk, Agonyi, and Oloyin cowpea varieties treated with moringa seed powder had higher germination compared to the same varieties treated with lemon grass. This suggested that Moringa seed powder inhibited the growth of some of the storage fungi that would have impaired the viability of the seeds. This agrees with Abo El-Dahab *et al.* (2016) who reported that, moringa extract at 25% concentration enhanced germination and inhibited the growth of seed borne pathogen of sorghum seed. The viability of untreated cowpea has been found in previous research to be adversely affected by seed-borne pathogens (Singh *et al.,* 2002; Islam, 2014). Debnath *et al.* (2012) reported that fungi infection in seeds affect their viability. They observed that seeds that had the highest prevalence of seed-borne pathogens (*Aspergillus flavus*, *Aspergillus niger* and *Fusarium* sp.) and planted without any treatment had the highest germination failure to as high as 29.50%. In this experiment however, the rate of germination failure in cowpea treated seeds was not as high as that reported by Debnath *et al.* (2012). This observation suggests most likely that, treating seeds with the three plant materials before storage can largely reduce germination failure compared to when seeds are not treated.

Untreated Drum and Sokoto had the highest *Callosobruchus maculatus* infestation and were most susceptible to storage fungal infections. It is concluded that, these two varieties should not be stored for a very long period of time without treatment.
Seed treatment especially with *Capsicum* annuum fruit powder and *Moringa oleifera* seed powder could be adopted by farmers because there was no observable incidence of disease infections on treated cowpea.

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