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EKSU JOURNAL OF SCIENCE AND TECHNOLOGY
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e. Materials and methods should be complete enough to allow experiments to be reproduced, and results written in past tense should be presented with clarity and precision.

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g. Discussion should interprete findings in view of results obtained in present and past studies on the topic.

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CORRESPONDENCE:
Please direct all correspondence(s) to:
Assistant Director (Training and Publications)
Office of Research and Development
Ekiti State University
PMB 5363, Ado-Ekiti
Phone: +234 – 8038544040, +234 8088137313
E-mail: ejst@eksu.edu.ng

Administrative Officer
Office of Research and Development
Ekiti State University
PMB 5363, Ado-Ekiti
Tel: +2348038850252

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+2348037337617
agbede.olusola@1mu.edu.ng

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Quetta, Pakistan
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Faculty of Social Sciences,
University of Ilorin,
PMB 1515, Ilorin,
Kwara State, Nigeria.
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funshofem@unilorin.edu.ng

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STUDY ON URBAN TREES IN EKITI STATE UNIVERSITY, ADO EKITI, NIGERIA: PERCEPTION OF CAMPUS OCCUPANTS

Joshua Kayode*, Iyanuoluwa Kikelomo Ajayi and Benson Oluwafemi Ademiluyi
Department of Plant Science and Biotechnology,
Ekiti State University, Ado-Ekiti, Nigeria
Corresponding e-mail: joshua.kayode@eksu.edu.ng

Abstract

The perception of campus occupants of the Ekiti State University, Ado-Ekiti, Nigeria on trees in the campus was examined using semi-structural questionnaire matrix that was administered on 20 randomly selected individuals in each of the four groups of campus residents. Respondents' perception on the trees on campus, their population, types and locations were determined and recorded. Their preferences for tree functions were defined. Results revealed that the campus occupants were of diverse socio-economic classifications. 60% of them asserted that the present numbers of trees in EKSU campus were inadequate. Respondents' tree type preference was skewed towards the planting of trees for shade (40%), fruits (30%), wind-control (25%) and ornamental (5%). In term of tree location, preference for planting shade trees was expressed for car parks (50%) and lecture rooms (45%), fruit trees planted by roadsides (65%) and lecture rooms (30%). Preferences for wind-controlled trees was expressed for lecture rooms and car parks (35% respectively) and ornamental trees expressed for banking offices (35%) and roadsides (30%).. The examination of species preferences for the various tree-types revealed that H. crepitan and S. grandis were preferred by 30% and 25% of the respondents respectively for shade, M. indica (30%) and A. occidentale (25%) for fruits, D. regia (35%) and S. grandis (25%) for wind-control and P. longifolia (40%) and A. occidentale (30%) for ornamental. Strategies that would improve tree density and diversity on the campus were proposed.

Key words: Urban trees, campus occupants, tree density, tree diversity.

Introduction

The trees and vegetation in the cities, towns, and communities where people live and work are described as urban forests. Several studies have enumerated the importance of these forests in the recent times. These include but not limited to Onishi, *et al*. (2010) who opined that urban forests decreased urban temperatures. Nowak, *et al*. (2013) asserted that urban trees improved air quality. The trees constituted important objects of the environment. Kayode (2008), Ihimikaiye and Tanee (2014) observed that the trees sustains human existence as they provide human with raw materials, foods, shelter, clothing, medicine, oral care, fuel wood, wood craft, as well as fodder and forage for livestock.

Konijnendijk et. al (2004) asserted that urban forestry could be another effective means of biodiversity conservation and ecosystems potentials in terms of physiological, sociological, economic, and aesthetic benefits. Hence it could be used to reduce the challenges posed by

urbanization such as food insecurity, energy shortage, deteriorating air quality, high temperatures, health hazards, and increased noise levels (Fuwape and Onyekwelu 2011). Urban forestry enhances healthy environment which translates to healthy citizens, beautification of the environment and scenery, cooler air temperature, reductions in ultraviolet radiation, and social and ecological benefits (Dwyer *et. al.* 2000 and Westphal 2003).

Thus, urban forestry encompassed planning, design, establishment, and management of trees and forest stands in and around cities, towns, and communities (Elmendorf *et al.* 2005). In Nigeria, attempts to encourage tree planting have been met with little or no success. Kayode (2004) enumerated the various factors that affect tree cultivation in Ekiti State, Nigeria to include tenure issues and the long gestation periods required of trees to mature to yield the expected dividends hence tree cultivation has been neglected by individuals and left for governments and institutions who in turn have failed in this task.

Institutions such as the Universities are mostly concerned with the dissemination of knowledge. Perhaps the recent concerns on the environment, particularly the issue of climate change, is now an enormous tasks for institutions of knowledge such as the Universities as they are expected to proffer sustainable strategies that will enhance human survival. Recent observation now revealed that Universities do not make consultation with their occupants in planting and / or retention of trees on their campuses. Hence governments and institutions have concentrated on planting few exotic species to the detriments of the indigenous tree species.

Consequent on the above, the study being reported here was aimed at the determination of the perception of campus occupants of the Ekiti State University, Ado-Ekiti, Nigeria on trees in the campus of this institution.

Materials And Methods

The detailed of the location of Ekiti State University, Ado Ekiti, Nigeria was described by (Ajayi *et. al.* 2020) and enumerated the detailed classifications of the campus into four strata - Road side (A), Car parks (B), Office area (C), Student halls/ religion area (D) - and each stratum was further sub-divided into sub-strata. Also, four tree functions were defined as types. These are shade trees, fruits trees, ornamental trees and wind control trees. Similarly four different campus occupants - students, officials of banks operating on campus, traders on campus and staff - were identified and classified as groups.

Semi-structural questionnaire matrix was administered on 20 randomly selected individuals in each of the classified groups. The perceptions of these respondents on the trees on campus, their population, types and locations were determined and recorded. Also respondents' preferences for tree functions as shade, fruits, ornamental and wind control were determined and recorded. The information obtained was used to determine the perceptions of these campus occupants on the existing trees and the ideotypes of trees required on campus of the University.

Results

The results revealed that the campus occupants were diverse in nature as they cut across different socio-economic classifica-tions. Females constituted 55% of the respondents, mostly above 20 years old (80%), literates and mostly of two dominant religious groups practiced in the study area (Table 1). 60% of the respondents asserted that the present numbers of trees in EKSU campus were inadequate (Table 2). Prefe-rence for tree planting was skewed towards planting for shade (40%) and fruits (30%). Planting trees for wind control was expressed by 25% of the respondents. Least preference (5%) was expressed towards planting trees as ornamentals (Table 2).

Table 1. Socio-economic classification of respondents in EKSU campus

Feature	Description	Proportion (%) of Respondents
Gender	Male	45
	Female	55
Age	< 20 Yrs	20
	> 20 Yrs	80
Literacy Status	Literacy	65
	Illiterate	35
Religious Status	Christianity	55
	Muslim	45

Table 2. Perception of Respondents on Adequacy of Trees and preference for tree types in EKSU Campus

Features	Description	Proportion (%) of Respondents
Adequacy of Trees		
	Adequate	40
	Inadequate	60
Preference for Tree-type		
	Shade trees	40
	Fruit trees	30
	Ornamental trees	5
	Wind control trees	25

Preference for tree location was equally examined among the respondents. Table 3 revealed that 50% and 45% of the respondents would like shade trees to be planted around car parks and lecture rooms respectively. Only 20% and 15% of the respondents would like shade trees to be planted by the roadsides and students' halls of residence/religious area respectively. 65% of the respondents prefer fruit trees to be planted by roadsides, 30% by lecture rooms while only 10% and 5% would want fruit trees planted by car parks and banking offices respectively.

Preferences for wind controlled trees (wind-breakers) were expressed for lecture rooms and car parks by 35%, each of the respondents. 25% and 20% of the respondents would want trees planted in the roadsides and banking offices respectively. Preferences for ornamental

trees were expressed by respondents for banking offices (35%), roadsides (30%), car parks (25%) and lecture rooms (20%).

The examination of species preferences for the various tree-types (Table 4) revealed that *H. crepitan* and *S. grandis* were preferred by 30% and 25% of the respondents respectively for shade, *M. indica* (30%) and *A. occidentale* (25%) for fruits, *D. regia* (35%) and *T. grandis* (25%) for wind-control and *P. longifolia* (40%) and *A. occidentale* (30%) for ornamental.

Table 3. Tree location preference by respondents in EKSU, Nigeria

Location	Proportion (%) of Respondent s/ Tree Types			
	Shade	Fruits	Ornamental	Wind control
Lecture Rooms	45	30	20	35
Banking Offices	15	5	35	20
Roadside	20	65	30	25
Car Park	50	10	25	35

Table 4. Rank order of respondents' species preference for the tree types in EKSU campus

Rank	Proportion (%) of Respondent s/ Tree Types *			
	Shade	Fruits	Ornamental	Wind control
	H. crepitan (30%)	*M. indica* (30%)	*P. longifolia* (40%)	*D. regia* (35%)
	S. grandis (25%)	*A. occidentale* (25%)	*A. occidentale* (30%)	*S. grandis* (25%)
	D. regia (15%)	*C. papaya* (20%)	*T. mantaly* (25%)	*H. crepitans* (20%)
	G. arborea and *T. mantaly* (10% each)	*C. sinensis* (15%)	C. variegatum (20%)	*T. grandis* (15%)
	T. catapa. and *P. guajava* (50% each)	*C. nucifera*	*A. cunningami* (15%)	*B. monandra* and *G. arborea* (10% each)
	-	-	*C. nucifera* (10%)	-

The examination of the ideotypes expected for tree types revealed that respondents preferred trees with strong stems with branches at average heights, wide spreading canopies that produce lots of oxygen. Species with average heights and delicious fruits were preferred for fruits species. Tall trees with strong stems, strong roots, strong branches, dense crown and evergreen were preferred for wind control. Preference for ornamental tree is skewed towards the species with good display of aesthetic features such as flowers, leaves, scent, overall foliage texture, fruit, stem and bark, and aesthetic form. Field observation revealed that all the features stated above

were lacking in the existing tree types in the campus.

Discussion

The campus respondents were of diverse socio-economic classifications. This diversity resulted in diverse perceptions on the diversity and density of trees in this campus. All the respondents were conscious of the type and importance of trees in the campus. Study by Kayode *et al.* (2016) asserted that socio-economic classification was not a prerequisite to tree mindedness in the study area. The respondents obtained in the survey were more of female than male. Mifsud (2012) asserted that *w*omen are *not* more concerned about *environmental issues* than men. Indeed, Kayode (2006) opined that the females were more knowledgeable on environmental issues. These tend to lend credence to the enthusiastic responses of females serving as respondents in this study.

A total of 27 tree species, belonging to 17 families were sampled in this campus (Ajayi *et. al.* 2020). These were mostly planted and exotic. Thus the survey revealed that the exotic tree composition in this campus far out-numbered the indigenous species. Respondents' preference was skewed towards planting of trees for shade and fruits around car parks and lecture rooms. Study by Annon. (2020a) revealed that trees planted in car parks reduce the heating up of cars and also reduces the evaporation of hydrocarbons from gasoline. Respondents opined that trees create microenvironment that is suitable for learning. Alloay (2015) asserted that trees improve working memory capacity of man by 50%.The trees improve the microclimate of an area by acting as carbon-sink and by improving the proportion of oxygen in the environment.

Respondents in this study would like trees to be planted by the roadsides and halls of residence/religious area. Fruit trees were preferred for roadsides and lecture rooms. It was believed that fruit trees provide a nutritious food source and food security. Thus, supporting the previous observation of Larinde and Ogunniyan (2011), who observed that students and staff of a University campus in Nigeria demonstrated special likeness for fruit trees in their campus.

Preferences for ornamental and shade trees were expressed by respondents for banking offices. Observation revealed that all the seven banks operating in the campus did not make provision for seats within and outside the banking halls for customers transacting business in their premises. Each of the banks attracts a huge number of customers who are mostly students. Secondary information revealed that this University has a student population of over 20,000 students. Thus respondents opined that planting trees in their premises will provide necessary respite.

Similarly, preferences for ornamental trees were expressed for roadsides and other strata. It is believed that this will improve aesthetic view of the campus. Annon. (2020b) opined that trees planted along and around buildings provide a distraction for the eye, softening the background and screening unsightly views. They contribute eye-catching colors to their surroundings, from the different shades of green found in the leaves, the colors found in flowering trees and sometimes even the bark of the tree.

The examination of species specificity for the various tree type revealed that most of the respondents were grossly deficient in tree taxonomy hence preferences for tree types were limited to few species. In this study, preference for shade was limited to *Hura crepitan* and *T. grandis,* fruits were limited to *M. indica* and *A. occidentale,* wind control to *D. regia* and *T. grandis* and ornamental limited to *P. longifolia*. Though these species were adequately suitable for the roles expected of them in the identified strata, yet it is expected that respondents ought to identify diverse species for each tree types in each stratum.

Preference for *M. indica* could be attributed to its fruits that contain high level of vitamin C, fibre and pectin. Previous reports revealed that the species possessed numerous nutritional and medicinal values. For example TNN (2017) described the species as a perfect fruit that helps in controlling high cholesterol level. The act of eating the fruits of this species cleanses the skin from deep inside the body hence ensuring flawless skin. Its leaves regulate diabetes. Also, the species contained tartaric, malic and citric acids that helps in maintaining the alkali reserve of the body.

M. indica also contains a lot of vitamins and essential nutrients, it is equally loaded with fibrous content thus it boosts the digestive function and burns unwanted calories from the body. Thus, helps in losing extra weight. Recent initiative also revealed that its fruits, known as the 'love fruit' has aphrodisiac qualities which also increase virility in men, hence its consumption enhance love and passion. The fruit is also loaded with vitamin A, making it a perfect fruit to improve eye sight. It prevents night blindness and dry eyes. The enzymes in its fruits help in breaking down protein content in the body thus preventing many stomach related diseases. Its vitamins and the different kinds of carotenoids present in them strengthen the immune system.

Furthermore, the fruits contain antioxidants such as quercetin, fisetin, isoquercitrin, astragalin, gallic acid and methyl gallate. All these protect the body against breast cancer, colon cancer, prostate cancer and leukaemia. The high iron content in their fruits is a natural remedy for anaemic people and ready source of iron and calcium, especially to women. The consumption of the fruits also improves memory,

Consequent on the above, investment in *M. indica* will not only improve the aesthetic of the campus but will also make the fruits of this species available to the campus occupants, impacts on their health and nutrition and lowers the University's budget on health maintenance.

The study established the damaging effects of wind on numerous buildings on campus. Previous study by the University of British Columbia has found that a single urban tree can help moderate wind speeds and decrease heating costs (Schindler, et. al. 2012). Though respondents in this study suggested the use of evergreen trees for wind control, the study by Schindler, *et. al.* (2010) asserted that both deciduous and evergreen trees reduce pressure loading on buildings throughout the year. Trees and airflow have diverse interactions (Schindler, et. al. 2012). They include the reduction in near-surface wind speed and production of turbulence by trees. Near-surface wind conditions affect physiological processes in trees, tree growth, and survival (Ennos 1997;

Eugster 2008). Also if the University can invest in tree planting in the different strata of the campus used in this study, there will be a gross reduction in the amount spent on health and environmental management. The ornamental trees are distinguished by one or more unique characteristics, such as flowers, foliage, bark or the tree's form itself are features to consider (Wikipedia 2020). In Nigeria, the use of trees for ornamental was not popular among individuals. Apart from the roadsides in this campus, a gross dearth of ornamental trees abounds in the campus. Improvement in this lapse should be made.

In conclusion, the composition of trees in the study area could be improved upon if priority is placed on peoples' preference. In a university campus, trees were not to be planted without considering the roles that such trees would play in the ecology and economy of the immediate environments. While preference is given to tree cultivation, the retention of tree wildlings especially of the indigenous species must not be neglected. Also in a growing University campus such as the study area, attention should be paid to tree conservation rather than cutting them down during the process of construction, expansion and infrastructure development. Annon (2017) earlier opined that tree preservation in developments increases the project's attractiveness, monetary value, and marketability by providing aesthetic and functional values. The tree component in a University environment should be seen as very important hence adequate planning must be made for them.

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EVALUATION OF GROUNDWATER POTENTIAL USING VERTICAL ELECTRICAL SOUNDING IN AGBABIAKA AREA OF ILORIN, NORTH-CENTRAL NIGERIA

[1]Fawale, O*., [2]Nwankwo, L. I., and [3]Lawal, T.O.
[1]Department of Science Technology, Federal Polytechnic Ado-Ekiti, Ekiti State. Nigeria.
[2]Department of Physics, Federal University Kashere, Nigeria.
[3]Department of Physics, University of Ilorin, Ilorin, Nigeria.
Corresponding e-mail: fawaleoluwakorede@yahoo.com

Abstract

An electrical resistivity survey has been carried out for groundwater exploration at Agbabiaka area, Ilorin North–Central, Nigeria with a view to determine the groundwater potential and the need to secure inhabitants and other nearby communities of the area from acute water shortages. A total of eight (8) Vertical Electrical Sounding (VES) stations with 5m station interval were completed using a campus Ohmega portable resistivity meter. The Schlumberger electrode configuration with maximum current electrode spacing of 100m was utilized. The acquired field data were arranged, processed and interpreted by partial curved matching method and computer iteration technique using Inverse lite and AGCross interpretation software. The interpretation of the VES data reveals four geo-electric layers which include the top lateritic layer with resistivity ranging from 121 to 550 Ωm and thickness of 0.6 to 1.1m; the weathered basement with resistivity ranging from 20 to 94 Ωm and thickness of 1.3 to 7.7m, the fractured basement with resistivity ranging from 82 to 550 Ωm and thickness 4.3 to 17.4m. The fresh basement has resistivities greater than 11473Ωm. The aquifer delineated extend towards the southern part of the area. These aquifer units exhibit good groundwater potential. The result obtained shows that, most VES stations directly opposite the school road have formations with relatively high resistivities while stations 5 and 6 close to a well consist of rocks that are deep with no distinct aquifer exhibit low resistivities, thick overburden and weathered layer which is considered to be diagnostic of good groundwater potential and therefore recommended for groundwater tube drilling.

Keywords: Geo-resistivity, Agbabiaka, Groundwater, Schlumberger, Ohmeger, Basement

Introduction

Agbabiaka area is a fast growing economic area in Ilorin due to its accessibility and strategic position as a link town between numerous industries, government establishments and tertiary institutions. Hence, the demand for potable and consistent water supply by the inhabitants in the area for both domestic and industrial usage in the area is high. In view of this, a vision for an independent source of water in the area is inevitable. In order to pursue a community scale groundwater development, it is essential to have a reliable assessment of the groundwater potential (Singh, 1984). In line with this goal, a study of groundwater condition in the area has been carried out. Groundwater is

the water that lies beneath the ground surface, filling the pore space between grains in bodies of sediment and elastic sedimentary rocks and filling cracks in all types of rocks (Plummer *et al.,* 1999). The choice of a particular geophysical method to be adopted for groundwater exploration is governed by the nature of the terrain and cost considerations (Emenike, 2001). (Olorunfemi and Fasuyi, 1999; Amadi and Olasehinde, 2010) also described the occurrences of groundwater in recoverable quantity as well as its circulations are controlled by geological factors.

Several literatures have shown that groundwater could be explored using electrical resistivity survey (Olorunfemi and Fasuyi, 1993; Olasehinde, 1999; Alile *et al.*, 2008; Abiola *et al.,* 2009). It is also more diversified, cheap, popular and has the widest adoption for groundwater exploration than any other geophysical methods due to the simplicity and relatively high diagnostic value of the technique (Osemeikhian and Asokhia, 1994; Olorunfemi *et al.*, 1999; Hago, 2000; Afolayan *et al.*, 2004; Lashkaripour and Nakhaei, 2005; Ariyo, 2007). Previous work has been carried out around the northern part of the study area, University of Ilorin main campus, while utilizing electrical resistivity technique. Highly fracture controlled pattern of the Oyun river acting as a tributary to the area was elucidated using radial electrical resistivity sounding and Wenner array profiling method (Taiwo, 1999; Olasehinde *et al.,* 1986; Oadunjoye 2011). Nwankwo et al. (2004) determined the structural disposition of the area using using electrical resistivity pseudosection while (Olawepo *et al.* 2013; Olasunkanmi *et al.*, 2011; Nwankwo, 2011; Olasehinde, 1999) employed the use of geo-electrical sounding technique to evaluate the groundwater potential and surbsurface lithologies, at the University of Ilorin with great success. In line with this, the study of groundwater condition using the electrical resistivity method in Agbabiaka area has been carried out to ascertain areas where viable boreholes could be sited for a long-term steady water supply. This present study is aimed at providing useful information that would reduce problem associated with potable water shortage in the study area.

Geology and Hydrogeology of the Study area

Agbabiaka-Ilorin in the North-Central part of Nigeria is bounded by latitudes 8° 08' 40" – 8° 27' 50"N and longitude 4° 37' 0" — 4° 37' 50" E (Figure 1). The area is a semi-arid region of Nigeria, with vegetation composing mainly of guinea savannah, with shrubs and undergrowth (Nwankwo, 2011). This area is located mainly within wooded savannah and is characterized by average temperature range of between 30 and 36°C. The area is marked by two climatic seasons: the dry and wet seasons with an intervening cold and dry harmattan from December to January and an annual rainfall range of between 1,000 and 1,500 mm with the mean annual rainfall of about 1333.7mm (Hussein *et al.*, 2012). The average annual minimum and maximum temperature of the area is 21.6℃ and 33.3℃ (Olatunji *et al.*, 2017). The area is

drained by rivers and streams such as Oyun River and River Ile-Apa as a tributary of River Niger which flows from S-E to N-W direction (Nwankwo *et al.,* 2004). Generally the study area has a low level topography, having elevation of 352m above sea level. Most areas around the site, are undulated with ridges. The ground is also characterized by rough rugged troughs and crests due to erosions which had affected the topography of the area (Nwankwo *et al.,* 2004).

The area is generally underlain by the Precambrian to Cambrian Basement Complex rocks which belongs to lower Paleozoic age and represented basically by migmatite-gneisses, granitic gneisses and metasediments such as quartzites (Alao, 1983). The rocks within the Basement Complex of South-Western Nigeria have been classified into five major groups: Migmatite - Gneiss complex which comprises gneisses, quartzite, calc silicate rocks, biotite hornblende schist and amphibolites; slightly migmatised to unmagmatised Para-schist and metaigneous rocks; charnockitic rocks; older granites and unmetamorphosed dolerite dyke, which comprises late-stage minor pegmatite, quartz veins and doleritic dykes (Rahaman, 1973; Akinluyi *et al*., 2018). Olasehinde et al. (1998) had earlier suggested that Ilorin is situated on the undifferential Precambriam Basement Complex rocks of granite and metamorphic origin. These rock types typify a deep fractured aquifer partly overlain by a shallow porous aquifer situated in the lateric soil cover (Olasehinde *et al*., 1998; Annor and Olasehinde, 1996). These rock unit are interconnected with the south western regional highlands running NW-SE parallel to Niger river drain (Offodile, 2006). The underlying subsurface lithology comprises of weathered, slightly weathered and fresh crystalline rocks.

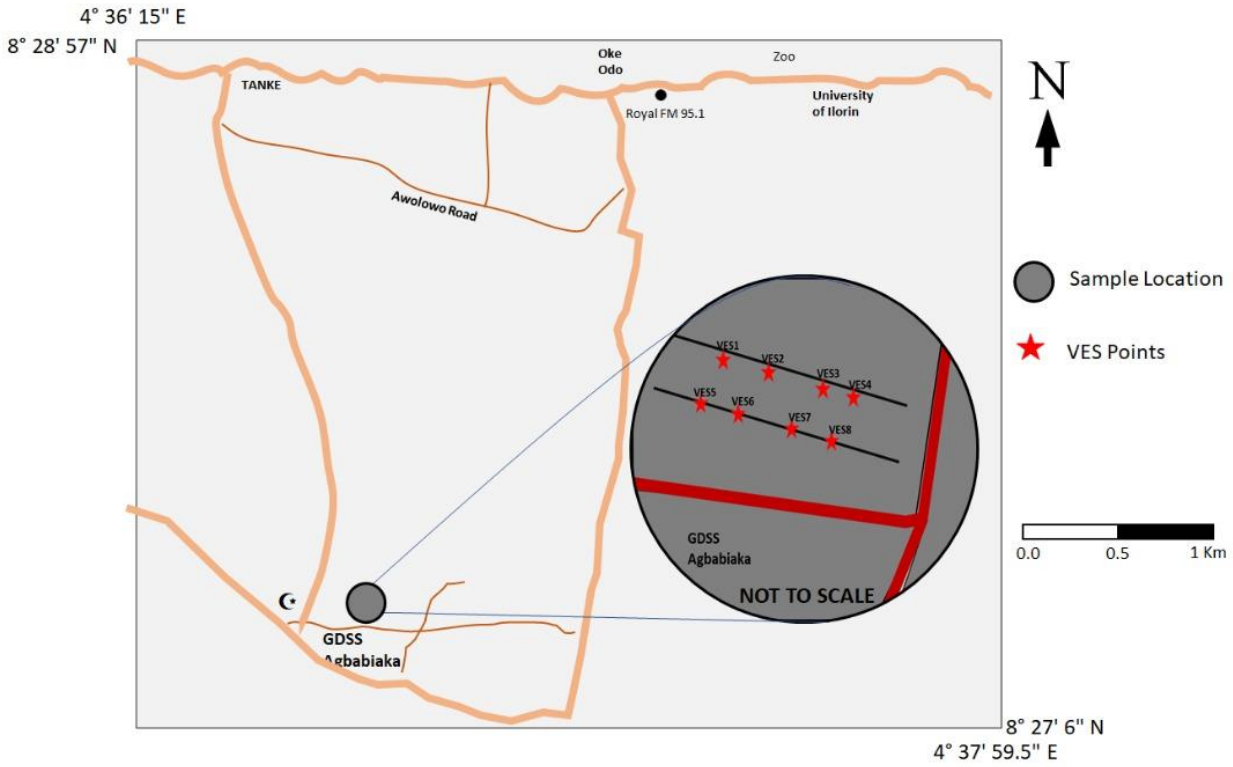

Fig. 1.0: Geological Map of Study Area Showing VES Stations

Materials and Methods

Geo-electrical resistivity field data acquisition was carried out using VES technique. This was done to determine the subsurface resistivity distribution, aquifer characteristics and depth of the sub-surface layers. The primary aim of this, is to locate areas with thick weathered zone and fractured containing groundwater. This technique has been used and adopted for many decades in hydrogeological, mining and geotechnical investigations (Stewart *et al.*, 1983; Acworth and Griffiths, 1985; Loke, 1999; Loke, 2001; Chambers *et al.,* 2006; Tankov, 2008). The method has also been used for engineering and environmental surveys (Lovelock, 1970; Barker, 1990; Buselli *et al.,* 1990; Griffiths and Barker, 1993; Dahlin *et al.*, 1994; Dahlin, 1996; Hago, 2000). In this study, Schlumberger electrode configuration were made at different locations within the study area with the aid of campus Ohmega portable resistivity meter. As much as access to the field space allowed, the maximum 100m current electrode spacing was utilized. In this arrangement, the four electrodes are positioned symmetrically along a straight line, the current electrodes are placed on the outside and the potential electrodes on the inside. To change the depth range of the measurements, the current electrode spacing was increased while the potential electrode separations are kept constant for a while and expanded to ensure a measurable potential emanating from the current sent (Fawale, *et al.*, 2011; Reinhard, 1974; Okoli *et al.,* 2007; Alile *et al.,* 2008) to obtain information from a greater depth. The wider the current electrode separation

the deeper the penetration or depth of investigation (Osemeikhian and Asokhia, 1994; McCann *et al.*, 1997).

A total of eight (8) VES point were completed and analyzed to obtain the layer resistivity values and the corresponding thickness. The resistivity data obtained from the field were plotted on a log-log graph against the corresponding half current electrode spacing while preliminary interpretation involving partial curve matching method. The layered earth model obtained were subsequently further interpreted using computer iteration techniques.

In the Schlumberger electrode configuration the geometric factor is given by:

$$G = \pi\left\{\frac{\left(\frac{AB}{2}\right)^2-\left(\frac{MN}{2}\right)^2}{2\left(\frac{MN}{2}\right)}\right\} \quad (1)$$

$$G = \frac{\pi}{2}\left\{\frac{\left(\frac{AB}{2}\right)^2-\left(\frac{MN}{2}\right)^2}{\left(\frac{MN}{2}\right)}\right\} \quad (2)$$

Where AB is the distance between two current electrodes, MN is the distance between two potential electrodes.

Results and Discussions

The field data interpreted using the conventional partial curve matching and computer iteration technique reveals that the resistivity distribution of the subsurface have curves predominantly made up of four layers mainly HA ($\rho_1 > \rho_2 < \rho_3 < \rho_4$) type. The resistivity of some common water-bearing rocks is 1-100 (Ωm), 80-800 (Ωm), and 10-100 (Ωm) for clay, alluvium, and freshwater respectively (Nwankwo, 2011; Singh *et al.*, 2006). Vertical Electrical Sounding (VES) curves for station 1 to 8 and the corresponding geo-electric layers for each station have been shown in (Fig. 2.0 – 9.0).

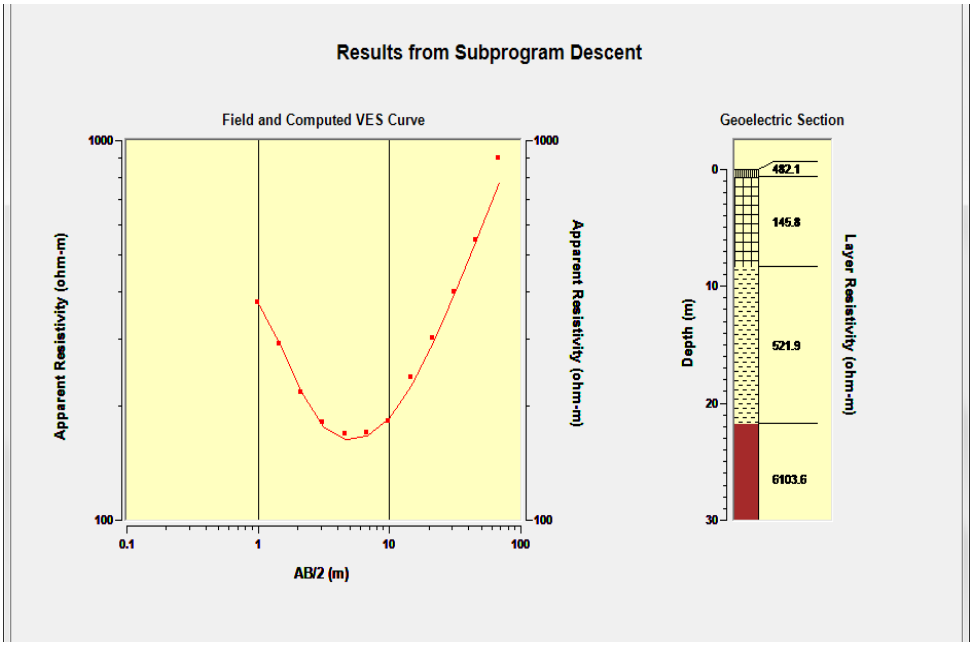

Figure 2.0: VES curve and geoelectric-section for station 1.

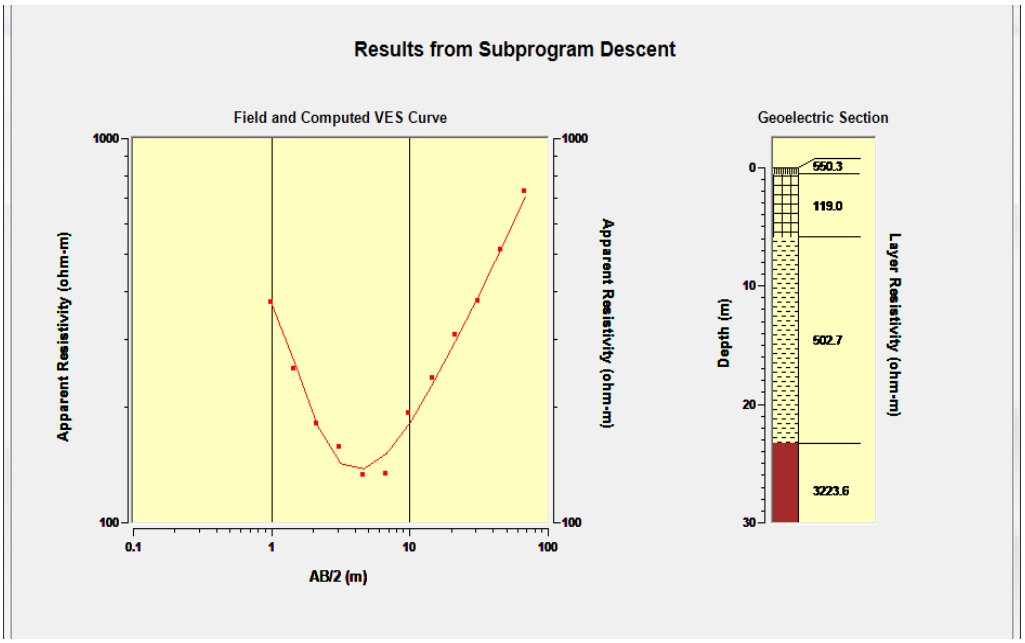

Figure 3.0: VES curve and geoelectric-section for station 2.

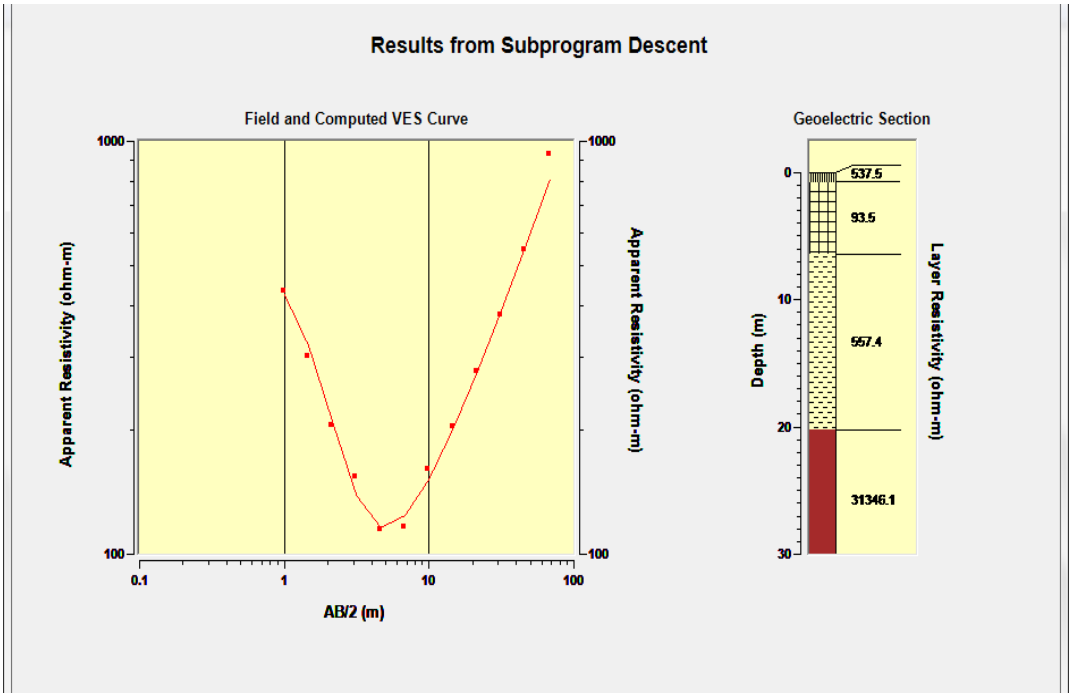

Figure 4.0: VES curve and geoelectric-section for station 3

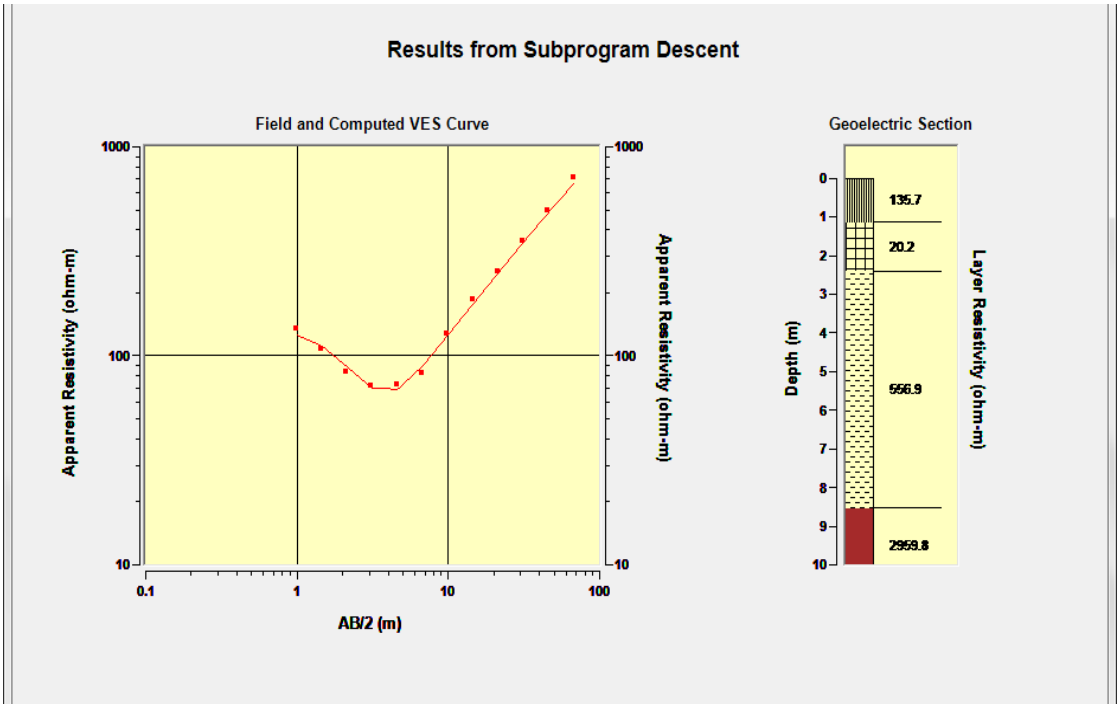

Figure 5.0: VES curve and geoelectric-section for station 4

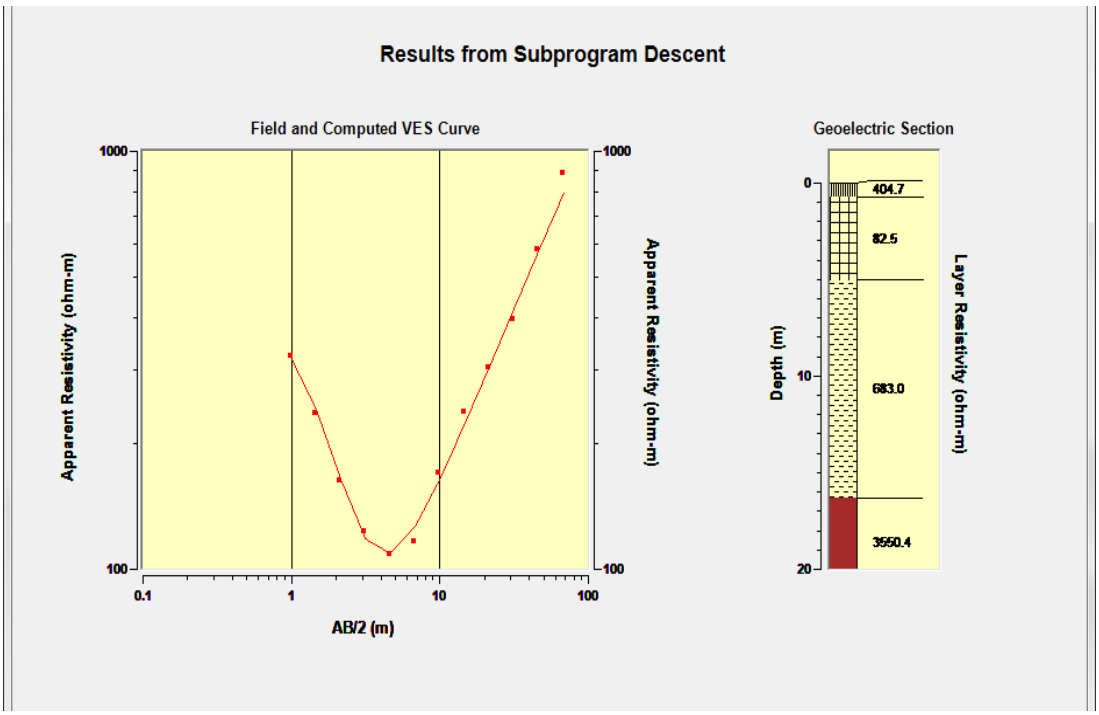

Figure 6.0: VES curve and geoelectric-section for station 5

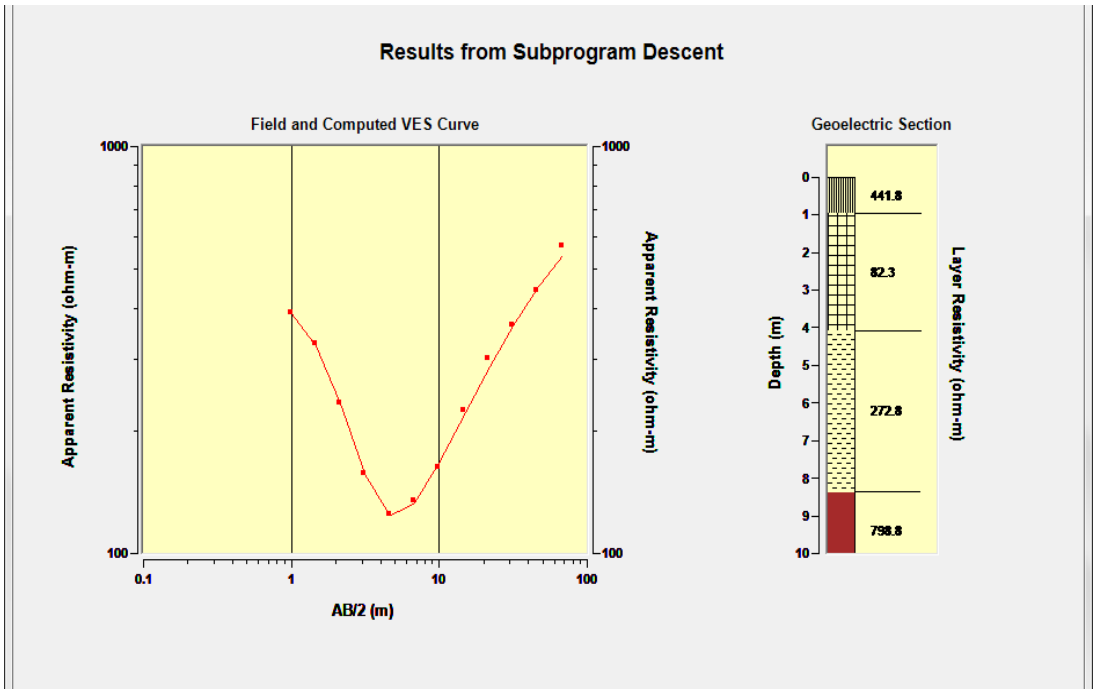

Figure 7.0: VES curve and geoelectric-section for station 6

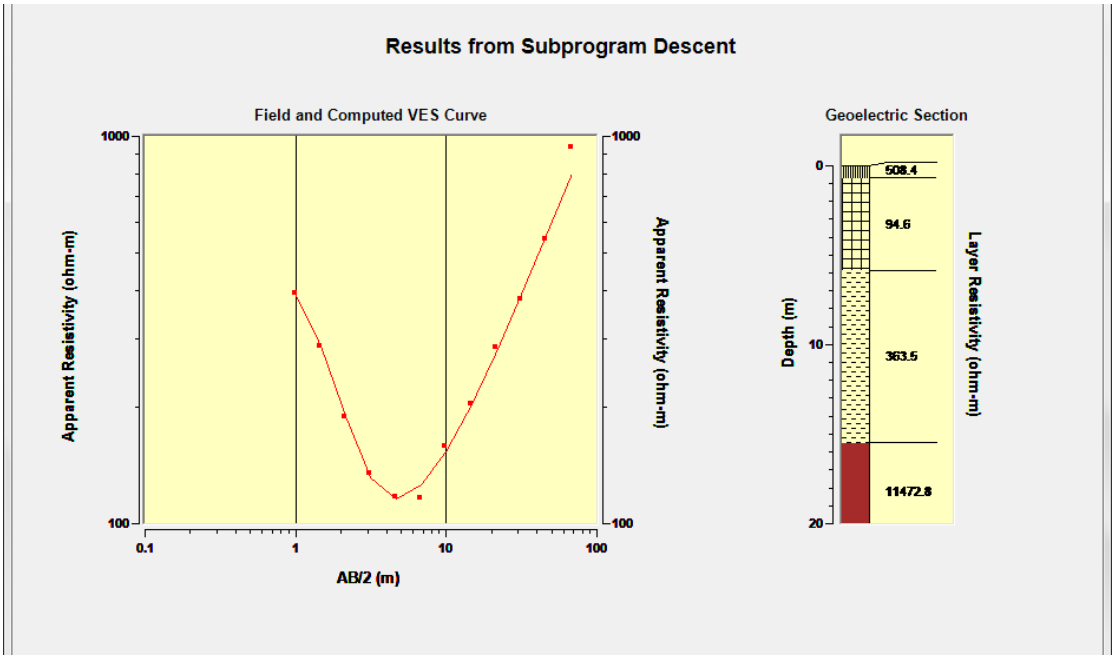

Figure 8.0: VES curve and geoelectric-section for station 7

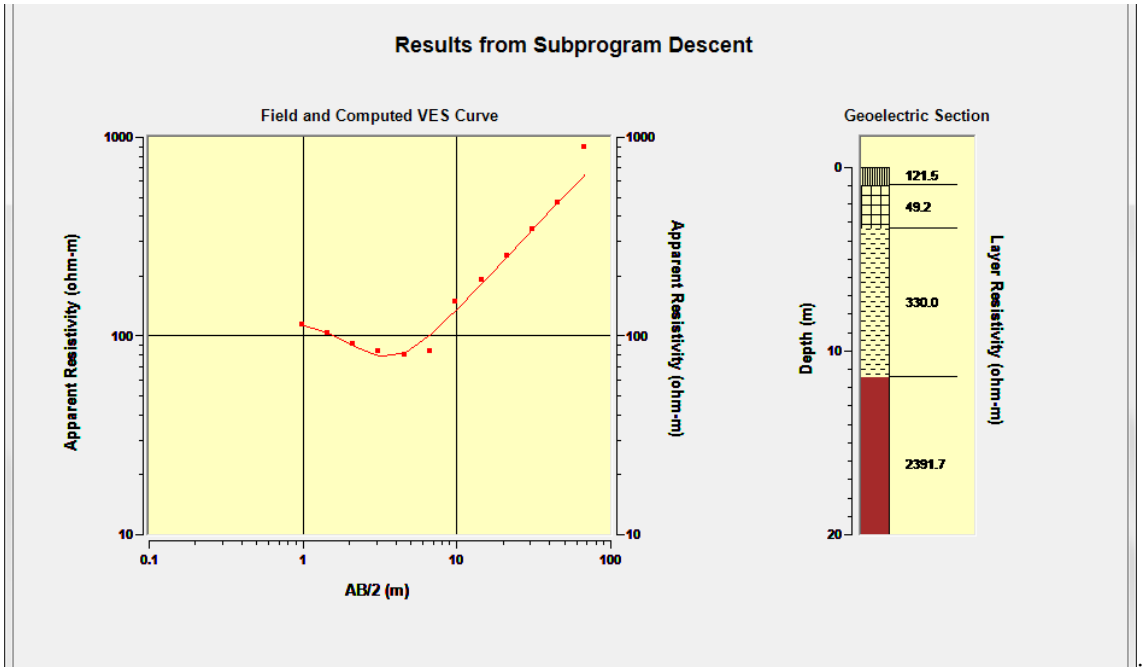

Figure 9.0: VES curve and geoelectric-sectionfor station 8

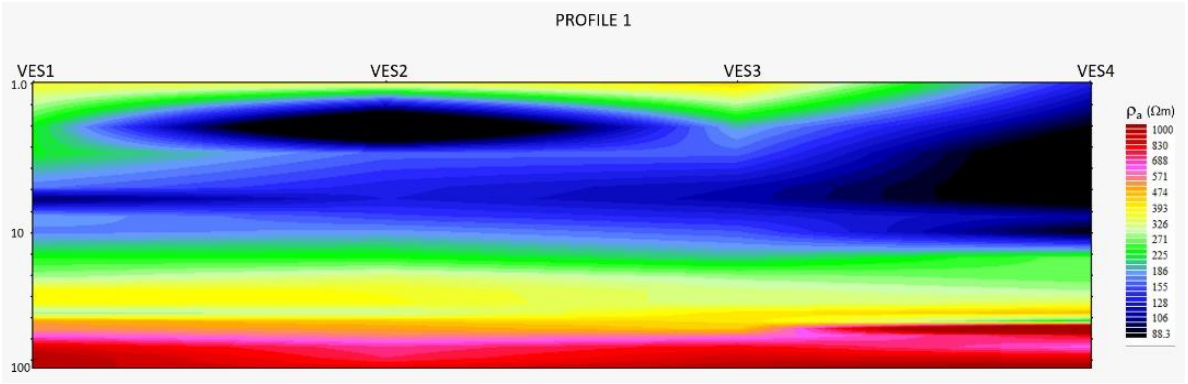

Figure10.0: 2D resistivity distribution map for profile 1

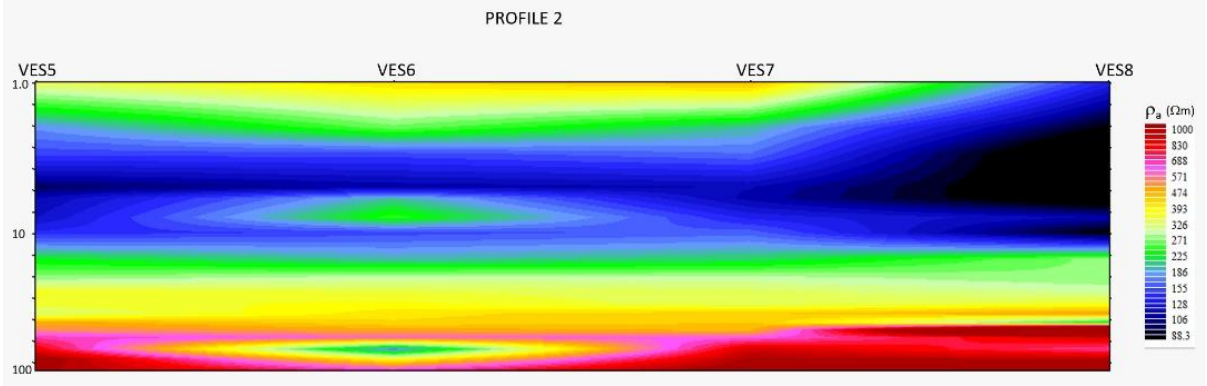

Figure 11.0: 2D resistivity distribution map for profile 2

The processed data were subjected to detailed interpretation aimed at unraveling the subsurface groundwater potential and aquifer protective capacity of overburden

units in the study area. The sounding curves and the geo-electric section analysis of the field data shows that area is embedded with four geoelectric layer earth model. The first layer has a resistivity value ranging from 121 to 550 Ωm and thickness of 0.6 to 1.1m which shows that the texture of the rock constituent in this layer is hard and dry due to high exposure to intense radiation from the sun and interpreted as the top lateritic soil. The second layer has an apparent resistivity value ranging from 20 to 94.6Ωm with thickness of 0.6 to 1.1m, which is interpreted as the weathered layer or relatively weak zone. This layer is partially convenient for ground water accumulation and hence the aquifer cannot yield water in sufficient quantity and economical use (Lateef, 2012). The third layer resistivity ranges from 82.3 to 550.7Ωm with thickness from 4.3 to 17.4m and interpreted as the fractured basement zone. This layer if sufficiently saturated, is permeable and considered to be favouable for sitting any productive and viable borehole. The fourth layer is the fresh basement whose resistivity is greater than 11472.8Ωm. In this layer the resistivity is high and not usually favourable for groundwater accumulation. Although, there is a limited published geophysical studies for the study area, these results are consistent with the available findings of the Ilorin metropolis (Olatunji *et al.*, 2017; Olawepo *et al.* 2013; Olatunji *et al.,* 2020; Nwankwo, 2011; Olasunkanmi *et al.*, 2011; Olasehinde, 1999). They had earlier revealed that the structural characteristics of the area ranges between three to six geo-electric layers.

In order to consider the hydro-electric characteristics of the study area, the result were then developed into 2-D pseudo-section resistivity distribution map of the profile lines (Fig 10.0 - 11.0). The purpose of the map was to convert the field resistivity values into a reasonable geological picture. Based on the model classification in this study, the distribution of resistivities at the surface is observed not to be uniform. Fig. 10.0 shows that the apparent resistivity values are increasingly spreading from the east towards the western and to other parts of the study area. Fig. 10.0 – 11.0 shows that VES station 2, 4 and 8 exhibited low resistivity values ranging from 88.3 to 210 Ωm at the a depth of about 2.0 to 10.0m. This is observed to be likely due to the surface fracture at the area. Larger percentage of the groundwater obtained at this depth is likely due to surface water and precipitates unable to percolates down into the ground filling the cracks in the rocks.

However, there is a diminutive increase in the resistivity value for profile 1 and 2 which ranges from about 220 to 326 Ωm at a depth of about 15 to 30m. High resistivity variations at the depth ranging from 10 to 100m were found with high resistivity value ($>$ 1000 Ωm). This trend is observe to be the major dominance for the majority of the VES station. Fig. 11.0 reveals that there exist some consistencies of low resistivities at these two VES stations 5 and 6 at the depth of 90m. These areas suggest plausible targets for long term and viable groundwater exploration. However, reasonable judgment about the thickness

variations of the aquifer in these areas are to be considered.

Since the extent to which the rocks have been weathered or fractured and the aquifer thickness determines water saturation, which in turn impacts on the electrical resistivity values (Nwankwo *et al.*, 2004). Dogara et al. (1998) also had earlier affirmed that aquifer thickness is of the outmost important, the larger the aquifer thickness, the larger the amount of water the place can hold. VES station 5and 6 is considerable as the best point for the sitting of a borehole, due to the relatively low resistivity values of the weathered and fractured layers.

The result from this study has provided a useful guide towards locating sites for a productive boreholes. In addition, strong and weak zones, typified by their characteristics high and low resistivity values respectively, have been delineated.

Conclusion

A total of Eight (8) VES stations with 5m station intervals involving two profiles have been established and used to evaluate the subsurface hydrogeological conditions of the study area. Based on the interpretation of geo-electrical data, the following conclusions are drawn:

- Interpretation of the VES data indicates the presence of four geo-electric layers which include the top lateritic region with resistivity ranging from 121-550Ωm and thickness of 0.6-1.1m which shows that the texture of the rock constituent is hard and dry due to high exposure to intense radiation from the sun; a relatively weak zones (weathered layer) with apparent resistivity value ranging from 20-94.6Ωm of 0.6-1.1m; fracture basement 82.3-550.7 Ωm and thickness 4.3-17.4m; and the fresh basement whose resistivity is greater than 11472.8 Ωm.
- The groundwater protective capacity of the area is weak due to its vulnerable to pollution if there is leakage of toilet soak away or buried underground storage tanks which posses a source of serious environmental hazard.
- Based on the interpretation of the VES data, station 5 and 6 have been recommended as the most viable location for the development of groundwater resources in the study area.

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ASSESSMENT OF PLANTS USED IN TRADITIONAL MANAGEMENT OF ANIMAL DISEASES IN EKITI NORTH SENATORIAL DISTRICT OF NIGERIA

Olanipekun Mary K*., Tedela Patrick O. and Kayode J.
Department of Plant Science and Biotechnology, Ekiti State University Ado-Ekiti, Nigeria.
Corresponding e-mail: mary.olanipekun@eksu.edu.ng

Abstract

The traditional use of plants as medicine for the management of man and animal health has been from time immemorial to alleviate sicknesses in both local and urban communities. Animal has been a medium of provision of proteins and for the normal growth of organisms, however there are a lot of diseases that are detritions' to the normal health of animals, hence reduced the effectiveness of such an animal. There is therefore a need for ethnobotanical documentation of the medicinal plants as well as associated knowledge and practices. Ethnobotanical surveys were conducted in Ekiti South senatorial district between 2018 and 2019 to document plants used in treating animal diseases in the study area. Semi structured questionnaire and the guided field-walk methods was used to interview the respondents who supplied information on plants used in treating the identified animal diseases. Different ethnobotanical indices were used to evaluate the relevance of the documented plants to the management of animal diseased prevailing in the study area. A total of 63 plant species from 38 families were documented for the management of ruminant and birds animals. The plants were reported using to treat six categories of ailments. The part of the plants mostly used are the leaves (50.7%) followed by the bark (40.8%), the seed (35.2%) and root (18.3%). The plants are prepared and applied either singly or in combination with other plants and are used either in the wet or dried forms. Rationales for the choice of these plants were also identified. The decoctions and infusions are the most frequent methods of preparation. The traditional healers in the study area possess rich ethno-pharmacological knowledge and depend largely on naturally growing plant species. The documented medicinal plants can serve as a basis for further and future phytochemical and pharmacological studies. The study areas are rich in plant biodiversity because of the favorable climatic conditions. However, the indiscriminate exploitation of the farming land is detrimental to the availability of some of the naturally occurred and indigenous plants, thus extinction of the plants cannot be underestimated. Therefore the documentation of the information will significantly contribute to the evaluation of the relevance of the traditional knowledge before it is finally eroded.

Key words: Semi-structured, livestock, diseases, management, indigenous knowledge

Introduction

The rearing of livestock plays important role in supporting the livelihood of poor farmers, consumers, traders and laborers in developing countries (FAO, 2002). Livestock such as cattle, goats, sheep and poultry are mostly reared to provide income, meat, security, employment

amongst others. Therefore, enhancement of livestock production system is designed to produce a great impact and to alleviate poverty among the poor. However (FAO, 2002) reported that animal diseases are crucial constraints in enhancing livestock productivity and production. The high cost of managing animal health, absence or unsuitability of production and resistance to synthetic drugs predispose the animals to diseases. L ivestock farmers are located in the rural areas where the provision of information on veterinary and improved management services are few or not available and when they are available the option is expensive to the rural farmers. Livestock farmers therefore resort to using indigenous methods to curb animal diseases. The knowledge based on the use of herbs differs not only from region to region but also within communities and have developed through trial and error and deliberate experimentation (Olanipekun and Olowokere 2017; Ann and David 2011). Studies carried out in Africa, Asia, Europe, Latin America and North America revealed that plants are routinely used as remedy for animal diseases (Farooq *et al.* 2019; Appidi *et al.* 2008; Passalacqua *et al.* 2006). In Nigeria, farmers especially those in the rural areas are known to treating animal diseases with herbs and other traditional medicines (Olanipekun and Olowokere 2017; Arowosegbe and Olanipekun 2015; Arowosegbe *et al.*, 2015; Kayode *et al.*, 2009 before the advent of orthodox medicine.

The plants used in the management of these animal diseases are readily available in the wild, reports show that they are more effective than orthodox medicine and less toxic to animal health. There has been little documentations of the traditional knowledge of resource poor livestock farmers in the management of animal diseases, though, there has been transmission of information across generations by oral traditions and folklores and this is in danger of extinction (Matekaire *et al.,* 2004). This study therefore aimed at providing useful information on medicinal plants used by livestock farmers for the management of animal diseases in the Northern Senatorial District of Ekiti-State, Nigeria. This will help veterinarians and other scientist in harnessing the information towards solving livestock problems.

Materials and Methods

Study area:

Ekiti State is situated entirely within the tropics. It is located between latitude 7.667^0 N and longitudes 5.250^0 East. The State has three senatorial districts namely, Ekiti North, Ekiti South and Ekiti Central Senatorial Districts. The survey was carried out in three Local Government Areas (LGA) in Ekiti North Senatorial District. The Local Government Areas are Ido/Osi, Moba and Ilejemeje. The area has a total land mass of 837 square kilometer and population of 908,017 people (2006 National Census). The major occupation of the people dwelling in the district is farming. In each of the sample LGAs, five villages that are far from urban influence were randomly selected and a total of fifteen villages were used in the study.

Field visits were carried out in 2018 and 2019. Information were obtained from rural

dwellers, traditional healers, livestock rearers, veterinary doctors, hawkers of medicinal plant preparations and herbalists with the aid of a semi-structured questionnaire and the guided field-walk methods as described by Olanipekun (2015). Ten respondents each were randomly selected from the fifteen villages to make a total of 150 respondents who have maintained domicile in the community for a period of not less than 20 years. The questionnaire was used to interview these individuals while the guided field-walk involved contacting and interviewing individuals recommended by other community members for their knowledge. The questionnaires were administered to find out the various medicinal plants, the plant parts used, the ailments category for which the plants are used, method of preparation and mode of administration. Similarly, ethnobotanical indices were applied for quantitative analysis. The plants identified were collected, scientifically identified and the voucher specimens were deposited at the Herbarium unit of Plant Science and Biotechnology Department of Ekiti-State University. Data obtained were statistically analyzed. Scientific identification of the plants and their uses in these communities were reaffirmed from the literature sources containing medicinal plants by (Aigbokhan, 2014; Van Wyk *et al.* 1997).

Ethnobotanical indices

Quantitative analysis, various quantitative indices were applied as follows:

Relative frequency citation

The frequency of citation (FC) was used to identify the most used plant species by the local inhabitants of the study area. It was calculated based on the assertion of Vitalini *et al.* (2014), using the following formula:

$$RFC = \frac{FC}{N}$$

where FC is respondents citing the use of specific species and N are the total respondents.

Use value

The relative importance of particular plant species cited by all informants in a given area is quantitatively measured in terms of the use value. It was calculated according to Šavikin *et al.* (2013) using the following formula:

$$UV = \frac{Ui}{N}$$

where *Ui* is the number of citations or used reports by each respondent for a particular plant species and N is the total respondents.

Informant consensus factor

The consensus between respondents and particular plant species used for each diseased category was tested by using informant consensus factor. It was determined following Vitalini *et al.* (2014), using given formula:

$$A: ICF = \frac{Nur-Nt}{Nt-1}$$

where 'Nur' represents the total number of used reports in each group of diseases, and 'Nt' represents the total species cited by all the informants for that group of ailments.

Relative importance

Relative importance (RI) was determined according to Khan *et al.* (2012); Ahmed *et al.* (2014)

using the given formula.

$$RI = (Rel\ PH + Rel\ BS) \times \frac{100}{2}$$

$$Re1PH = \frac{PH\ of\ a\ given\ plant}{Maximum\ PH\ of\ all\ reported\ plant\ species}$$

where PH is the pharmacological attribute of the selected plants and Rel PH is the relative number of pharmacological properties attributed to individual plant species.

$$Re1BS = \frac{BS\ of\ a\ given\ plant}{Maximum\ BS\ of\ all\ reported\ plant\ species}$$

BS is the number of body systems healed up by using single species and Rel BS is the relative number of body systems healed up by using a single species.

Fidelity level

The fidelity level (FL) index was used to determine the most preferred species used to cure a particular disease as to treat the same ailment category with more than one plant species is also used. It was figured out after Friedman *et. al.*, using the given formula:

$$FL = \frac{Np}{N} \times 100$$

Where *Np* is the number of respondents citing the use of species for a particular ailment and N is the total number of respondents citing the plants for any illness.

Intellectual property agreement statement

Prior to the interviews, the informants were duly informed about the objectives of the research with verbal agreement that the information gather during the research shall not be used for commercial purposes but to enlighten and document medicinal plants used for the treatment of ruminant and birds diseases, thus, the interview was granted.

Results and Discussion

A total of 64 plant species from 38 families were identified as botanicals used in the management of the various ailments affecting animals in the study areas (Tables 1). The families of the identified plants are arranged in alphabetical order. The Asteraceae family has the highest number of plants represented by seven species plants, followed by members of Euphorbiaceae and Solanaceae with four plants each. The familes Asclepiadaceae and Caesalpinaceae had three plant species each while other families had one plant species each. The plant species were found to be used medicinally by the local communities. The dominance of Asteraceae might be due to suitable habitat, favorable environmental conditions for the growth of the species and more interactions of local communities that have been from generation to generations in the study area. Therefore the traditional use of the plants have been established and well recognized by the local inhabitants. The diseased condition/symptoms that were reported been treated by extracts from the identified plants ranges from diarrhea, dysentery, retained placenta, ectoparasites/ mange, cough, common cold, gastroenteritis, wounds for ruminants. In birds Newcastle diseases, fowl plague, infected wounds, chronic respiratory diseases, coccidiosis,

among others were found ameliorable with medicinal plants in the study area. The plant parts used depend on the plant under consideration and severity of ailments. Also, the results showed that the leaves of the plants are the most frequently used (79.5%), followed by the seeds (16.3%) and the stem bark (4.11%). The reason why the leaves are the most frequently used might be because it contains more bioactive ingredients such as secondary metabolites, essential oils and phytochemicals, this might contributes to the effectiveness of leaves over other parts of the plants (Kayode et. al., 2018 ; Amjad *et al.*, 2015). It could also be due to the convenience in harvesting for the preparation of herbal medicine (Arowosegbe *et. al.* 2015; Ann and David, 2011; Kayode *et. al.*, 2009 and Giday *et. al.* (2003).

However, the use of roots and stems were observed to be annihilative, destructive and detrimental to the survival of plants as observed by (Kayode *et. al.*, 2018; Olanipekun and Tedela, 2013; Kayode *et. al.*, (2009). Moreover, it is not easy to collect the roots of wood and deep rooted plants (Ahmad and Habib, 2014).The ease of collection and accessibility to leave make the part more useful in ethnobotanical practices.

Herbal preparation and administration

The methods of preparing these medicinal plants vary between decoction, infusion, extract, powdered, and juice 38%, 29%, 23 %, 17 %, 8 % respectively. They are highly reputed and valued by traditional healers in the study area for its curative and palliative effects in the treatments of diseases generally (Umair *et al.*, (2017); Tugume *et al.* (2016) and Hutchings (1996). Decoction is very simple and it is an easy way of preparing herbal medicine with more health benefits. In decoction, the efficacy of herbal remedies increases due to the maximum extraction of health-beneficial secondary metabolites and other bioactive ingredients which accelerated on heating (Qaseem *et. al.* 2019). Also, previous researchers asserted the presence of the varieties of secondary metabolites, pharmacological and organoleptic properties in plants (Amri *et. al* 2015; Taiwo *et. al* 2012) .The majority of the botanicals indicated in the treatment of the ailments are used in combination with other parts of different plants (Table 2). This corroborate with the findings of Ahmad *et. al.* 2017 and Ayannar and Igriacimuthu (2011) that plants have synergy when combined during preparation, thereby making their mixtures more effective. The taste of herbal medicine can be discouraging, however, it can be adjusted by adding honey or sugar to make it more pleasant (Uzun and Kaya, 2016; Nanyingi *et. al.,* 2008). In oral mode of administration, plant materials were mainly ingested as decoction or in powdered form with water, milk or honey. Oral intake of herbal medicine is usually effective for the treatment of internal diseases while for external diseases such as skin infections, joint dislocation, cage fatigue, hemorrhoid and various pains were treated by topical application of the drugs (Bekalo *et al.* 2009). Contrarily, the convectional system of medicine, according to Otoide and

Olanipekun, (2019) and Wong *et. al.* (1992) observed that plants usually lack standardization and quality control in the administration of traditional medicine.

However, the rationales for the choice of some of these plants by the traditional healers and local people without scientific proof have been attributed to some inherent properties, potential, potency and effectiveness of these plants. These plants have been used traditionally over a period of times, they have been tested and proved and been considered being purgative, anti-dysenteric, anodyne, anti-inflammatory, carminative, demulcent, diaphoretic, emollient, styptic or astringent, refrigerant, stomachic, tonic and vasodilator in folk use. Therefore, plants used in treating wounds could be due to the presence of tannin content that imparting astringent activity which helps to recuperate diseases such as diarrhea, dysentery, gastroenteritis, wounds etc. in animals. Plants containing tannins are astringent, able to draw together or constrict body tissues and are effective in stopping the flow of blood or other secretions. Tannins strengthen veins by repairing the connective tissues surrounding veins and decrease capillary fragility Ono (1994). The anti-inflammatory activities and various other healing properties exerted by plants may also be due to the presence of alkaloids, flavonoids and saponins present in these plants (Fawole *et al.* 2009; Kerber 1999; Ono 1994)

Relative frequency of citation (RFC)

Relative frequency of citation (RFC) indicates the traditional importance of each of the plant species with respect to informant who reported the uses of the species as asserted by Farooq *et. al.* (2019); Šavikin et. al., (2013). The RFC value of the reported species ranged between 0.06 for *Parkia biglobosa* and 0.97 for *Ficus exasperata* (Table 3). The highest RFC was calculated for *Ficus thoningii* (0.97), *Momordica charantia* (0.94), *Ficus exasperate* (0.93), *Allium cepa* (0.90), *Flugea virosa* (0.91), *Aframomum melagueta* (0.80) and *Chromolaena odorata* (0.73) respectively. The high value revealed that the inhabitants of the study area have a close association with the plants species and they are frequently using them to treat various diseases. The high RFC of *Ficus thoningii* indicates that this species is commonly utilized by local communities to treat various health disorders affecting their animals. However, this could lead to overexploitation of this species in the study area. The high exploitation of these plants may lead to threat and extinction if not conserved and adequately managed immediately. Therefore the understanding of RFC data contributes significantly to the importance of plant species within an area, the conservation of the species with maximum RFC and for biological, pharmacological and phytochemical screening of such species is imperative.

Use Value

The use value (UV) index was used to measure the ethnomedicinal uses associated with documented medicinal plant species and is ranged from 0.09 for *Zingeber officinale* and 0.01 *Lantana camara* (Table 3). The highest UV was reported for *Zingeber officinale* (0.95), followed by *Momordica charanta* (0.89), *Thitornia diversifolia* (0.89), *Ficus exasperate* (0.87),

Allium cepa (0.87). The high usage of the reported species indicates a strong association and dependence of local communities on surround flora, especially for the treatment of various diseases and as food and livelihoods (Tangjitman *et al.* 2015; Olanipekun et *al.* 2016). Moreover, the plant species which are used excessively are assumed to be biologically more active; therefore these should be subjected to phytochemical and pharmacological screening to increase sustainable utilization and conservation of plant resources (Olanipekun *et. al.* 2016; Guan and He 2015).

Fidelity level (FL)

Fidelity level (FL) identifies the most preferred plant species used by traditional healers to cure various diseases and also indicates the proportion of informants reporting the use of specific plant species. The FL level (%) of the reported species was ranged from *Flugea virosa* (97.33), *Allium cepa* (90), *Ficus thonigii* (97), *Ficus exasperate* (93), *Flugea virosa* (91), *Aframomum meleguata* (80), *Nicotiana tabacum* (76), *Chromolaena odorata* (73), *Jathropha multifida* (69) respectively.

However, the lowest fidelity level of the plant species ranged from *Lantana camara* having the lowest fidelity level (0.4), to *Parkia biglobosa* (6), *Vitelaxia paradosa* (7), *Senna occidentale* (9.3), *Psidium guajava* and *Pergularia daemia* (10) each while *Calotropics procera* (11) respectively. Plant species having high FL values are extensively believed to be most preferred ones and they are mostly used in the area compare to those with less FL values as earlier reported by (Farooq *et al.* 2019; Matekaire *et al.* 2004). These species were used to cure different ailments since ancient times in combination with other plants or ingredients and could be considered as a model plants for pharmacological screening. Despite the fact that modern health facilities are accessible, effective though expensive in the study area, local communities still rely on medicinal plants and they possessed significant traditional knowledge on plant resources utilization.

Informant consensus factor (ICF)

The various diseases reported from the study areas were classified into 6 categories to develop the consensus of informants on medicinal plants following World Health Organisation (WHO), international categorization of ailments (Zahoor *et al.* 2017; Tangjitman *et al.* 2015). It was observed that, informant consensus factor (ICF) values ranged from 0.34 to 0.90 while the highest level of 0.90 and 0.88 were for gastrointestinal disorder and skin infection diseases respectively (Table 4). Prevalence of these diseases is mainly caused by poor hygiene conditions, inadequate care and supply of drinking water and consumption of contaminated food (Aziz *et al.* 2017; Kayani *et al.* 2014). *Aframomum meleguata, Allium cepa, Allium sativum, Aspila africana, Boerhavia difusa, Carrica papaya, Caccia occidentale, Gossypium arboretum, Momordica charantia and Zingeber officinale* were among the most frequently utilized plant species to treat digestive system while *Adansonia digitata, Agerantum*

conizoides, Amaranthus spinosus, Annona senegalensis, Aspilia africana, Azadiracter indica, Chromolaena odorata, Datura stramomium, Ficus exasperate, Sida corymbosa, Vitex doniana and Vitelaxia paradosa were used for the treatment of skin infections. These diseases were observed to be prevalent in the study area; this could be it was rural nature of the areas where extensive and free range methods of animal keeping are dominant.

This may lead to outbreak of pathogenic attacks that may lead to chronic skin diseases and infection Zahoor *et al.* (2017). Many of the plants identified have been reportedly found growing in the study area. This observation tends to explain the reasons why plants medicine had been describe to be readily available, economical, which might be effective with little or no side effects Shaheen *et al.* (2017). The earlier assertion that the preference for plant medicine by the indigenous tribal groups in Nigeria are further enhanced by the extremely poor modern medical infrastructures in the rural areas, urban slums and current economic recession in the country that made the cost of modern medicine soar beyond the reach of most citizens. Interestingly, the availability of phytochemicals such as flavonoids, vitamins, essential oil, alkaloids, saponins and phenols supported the effectiveness of plant based medicines (Olanipekun *et. al.* 2016; Olanipekun *et al.* 2013; Khan *et al.* 2012 and Fawole *et al.* 2009). Additionally, inhabitants of the study areas have traditional knowledge which they have built over a long period of time due to their interaction with these plants species. Plants identified to manage respiratory tract infections varied from *Aframomum meleguata, Allium cepa, Allium sativum, Calotropic procera, Capscicum frutesence, Chromolaena odorata, Citrus aurantifolia, Lagenaria siceraria, Musa parasidiaca* among others. Respiratory tract and throat diseases ranked third highest ICF value and it was found to be 0.6. Various factors such as changes in climatic conditions, poor hygiene conditions, a high proportion of cold, moistures, germs, may cause abnormalities to respiratory tracts of animals (Kayani *et al.* 2014; Fawole *et al.* 2009)

Conclusion

The present study evaluated indigenous knowledge, the importance and the medicinal use of plants as remedies for ruminant and birds diseases in Ekiti North Senatorial District of Nigeria. The use of plants in treating animal ailment is prevalent in the study area because of their cost effectiveness, readily availability and efficacies. The plants are relatively available, effective, diseases resistance and less toxic as determined by the ethnobotanical indices. The most used part of the species is the leaves followed by the seeds and bark respectively. However, there is a need to determine the chemical constituents embedded in the plants to validate their efficacies scientifically for safety use.

Table: 1. List of plants used in treating animal diseases in Ekiti North Senatorial District of Nigeria

S/N	Name of plants	Family name	Part used	Disease treated
1	Adansonia	Bombaceae	Leaves/fruits	Wounds/fowlpox

	digitata (Linn.)			
2	Aframomum meleguata (K. Schum)	Zingeraceae	Seeds	Gastroenteritis
3	Ageratum conyzoides (L)	Asteraceae	Leaves	Wounds
4	Allium cepa (L)	Alliaceae	Leaves/bulbs	Worm/CRD
5	Allium sativum (L)	Alliaceae	Leaves	Cold, Gastroenterites and CRD
6	Alstonia boonei (Pers)	Apocynaceae	Leaves/Stem bark	Fever
7	Amaranthus spinosus (L)	Amarantheceae	Leaves/bulbs	Coccidiosis, Diarrhea, ectoparasites/Mange
8	Anacardium occidentale (L)	Anacardiacea	Leaves/ Stem bark	Diarrhoer
9	Anona senagalensis (L.)	Annonaceae	Leaves	Wounds, Fever
10	Aspilia africana (Pers.)	Asteraceae	Leaves	Wounds/Gastroenterites
11	Azardiracta indica (A.Juss.)	Meliaceae	Leaves/fruits/ stem	Fever, Wounds, Fowpox, Coccidiosis
12	Boerhavia difusa (Engelm & A. Gray)	Nyctaginaceae	Leaves	Worms, gastroenterites
13	Bridelia ferruginea (L)	Euphorbiaceae	Leaves/stem/bark	Diarrhoer, Fever
14	Calotropis procera (R.Br.)	Asclepiadaceae	Leaves	Cough and Cold
15	Capsicum frutescens	Solanaceae	Fruit	Cold/ Fever.
16	Caccia occidentale	Caesalpinaceae	Leaves	Wounds/Gastroenterites
17	Carica papaya	Caricaceae	Seeds/Fruits/Leaves	Fever, Gastroenterites
18	Chromolaena odorata	Asteraceae	Leaves	Wounds, Fever, Coccicdiosis
19	Cissampelos owariensis (P.Beav.)	Menispermaceae	Leaves	Diarrhea/Worms/Wounds
20	Citrus aurantifolia (Christm)	Rutaceae	Leaves/fruits	Cough/CRD
21	Datura stramomium	Solanaceae	Leaves/fruits	Gastroenterites/ Wounds
22	Elaeis guinensis (Jacq)	Arecaceae	Leaves/fruits	Wounds/poison/ Fowlpox
23	Ficus exasperate (L.)	Moraceae	Leaves/latex	Ectoparasites/Mange/Fever
24	Ficus thoningii	Moraceae	Leaves	Retention of placenta

	(L.)			
25	Flugea virosa (L.)	Euphorbiaceae	Leaves	Retention of placenta
26	Gliricidia sepium (Jacq)	Fabaceae	Leaves	Gastroenterites
27	Gossypium arboretum(Jacq)	Malvaceae	Leaves/seeds	Gastroenterites
28	Guieria senegalensis (L.)	Combretaceae	Leaves	Retention of placenta
29	Boranginaceae	Boranginaceae	Leaves/stems bark	Retention of placenta
30	Hymenocadia acida (L.)	Hymenocardiaceae	Leaves	Retention of placenta
31	Jatropha gossypifolia	Euphorbiaceae	Leaves/latex	Wounds/Fowlpox
32	Jatropha multifida (L.)	Euphorbiaceae	Leaves	Cough
33	Khaya senegalensis (Desr)	Meliaceae	Leaves	Ectoparasites/Mange/Fever
34	Lagenaria siceraria (Molina)	Cucurbitaceae	Leaves	Worms/Newcastle
35	Lantana camera (L.)	Verbenaceae	Leaves	Fever/Fowlpox
36	Momordica charantia (L.)	Cucurbitaceae	Leaves	Gastroenterites/Fowlpox
37	Moringa oleifera (Lam)	Rubaceae	Leaves	Newcastle/ Worms
38	Musa parasidiaca (L.)	Musaceae	Leaves/stems bark	Cough/ CRD
39	Nicotiana tabacum (L.)	Solanaceae	Leaves	Fever/ Ectoparasite/Mange
40	Ocimum bascilicum (Sims)	Lamiaceae	Leaves	Worm/ Diarrhea
41	Parkia biglobosa	Mimosaceae	Leaves/stems bark	Wounds/Fowlpox/ Weakness
42	Pergularia daemia (Forsk)	Asclepaidaceae	Leaves	Newcastle/ Gastroenterites/CRD
43	Parquetina nigrensis (Afz)	Asclepiadaceae	Leaves	Cocidiosis/ Diarrhea
44	Psidium guajava (L.)	Myraceae	Leaves	Fever
45	Rauwolfia occidentale (Afz)	Apocynaceae	Leaves	Fever
46	Lantana camera (L.)	Verbenaceae	Leaves	Fever
47	Senna alata (L.)	Ceasalpiniaceae	Leaves	Diarrhea
48	Senna occidentals (L.)	Ceasalpiniaceae	Leaves	Wounds

49	Sida corymbosa (L.)	Malvaceae	Leaves	Wounds

50	Solanum nodiflorum	Solanaceae	Leaves/fruits	Diarrhea, Worms
51	Spondia mombin (L.)	Asteraceae	Leaves	Coccidiosis/ Worms
52	Talinum triangulare (Jacq)	Portulaceae	Leaves	Fever
53	Tephrosia vogeli (Hook)	Portulaceae	Leaves	Newcastle/ Cough
54	Terminalia schimperiana	Combretaceae	Leaves	Coccidiosis , wounds
55	Thitornia diversifolia (L.)	Asteraceae	Leaves	Weakness/Fever
56	Tridax procumbens (L.)	Asteraceae	Leaves	Wounds, Anaemia
57	Triumfetta cordifolia (A.	Tiliaceae	Leaves	Leaves
58	Venonia amygdalina	Asteraceae	Leaves	Fever/Diarrhea
59	Vitex doniana (Sweet)	Verbenaceae	Leaves	Cough/Wounds/
60	Vitelaxia paradosa	Sapotaceae	Leaves	Wounds/Fowlpox/Coccidiosis
61	Zea mays (L.)	Poaceae	Seeds	Fever/fowlpos
62	Zingiber officinale	Zingiberaceae	Seeds	Gastroenterites/Bloat
S/N	Name of plants	Family name	Part used	Disease treated

Table 2.: List of plants identified use for the treatment of Animal diseases in the study areas

S/N	Family Name	Scientific Name	Local Name	Habit	Part Used	Preparation	Application	Disease treated
1	Alliaceae	*Allium cepa,* (L)	Alubasa nla	H	LF	EX	Internal Internal	Worm CRD
		Allium sativum (L)	Ayu	H	B	EX	Internal Internal Internal	Cold, Gastroenteritis CRD
2	Apocynaceae	*Alstonia boonei* (Pers)	Igi Ahun	T	LF; SB	EX DE	Internal	Fever
		Rawolfia occidentale (Afz)	Asofeyeje	T	LF	PD	Internal	Fever
3	Arecaceae	*Elaies guinensis* (Jacq)	Igi ope	T	F	PA	Internal Internal External	Worm, Poison, Fowl pox
4	Amaranthaceae	*Amaranthus spinosus* (L)	Tete elegun	H	LF SD	PA PA	Internal Internal Internal	Coccidiosis, Diarrhea, Gastroenteritis, Mange
5	Anacardiacea	*Anacadium occidentale* (L)	Kaju	S	FR AP	JU DE	Internal Internal	Diarrhea; Fever
6	Annonacea	*Annona senegalensis* (L)	Igi Abo	T	LF, SD	EX EX	External Internal	Wounds, Fever
7	Asclediaceae	*Calotropis procera* (R.Br)	Bomubomu	H	LF; SD	EX DE	Internal	Cough Cold
8	Asteraceae	*Agerantum conizoides* (L),	Imi esu	H	LF	VG	External	Wounds
		Aspilia Africana (Pers),	yunrinyun	H	LF	EX	External Internal	Wounds, Gastroenterites
		Chromolaena odorata	Igi Akintola	H	LF	EX DE DE	External Internal Internal	Wounds, Fever, Coccidiosis
		Spondia mombin (L);	Igi Ekikan	T	LF	EX DE CH	Internal Internal Internal	Worms, Coccidiosis, Retained placenta
		Thitonia diversifolia (L);	Ewe ododo	H	LF	EX	Internal Internal	Weakness, Fever
		Tridax procumbens (L)	Ewe Igbalode	H	LF	IN TE	External Internal	Wounds, Anaemia
		Venonia amygdalina	Igi Ewuro	T	LF AP	EX JU	Internal Internal	Fever Diarrhea
9	Bombaceae	*Adansonia digitata* (L)		T	LF	DE	External Internal	Wounds Fowlpox
10	Boranginaceae	*Helitricum indicum* (L)	Ewe Aparigun	H	LF	CH VG	Internal	Retained placenta
11	Caecalpinaceae	*Cassia occidentale* (L);	Igi Kassia	T	LF	EX	Internal Internal	Worms Gastroenterites
		Senna alata (L);		S	LF	DE	Internal	Diarrhea

		Senna occidentale (L)		S	LF	DE	External	Wounds
12	Caricaceae	*Carica papaya* (L)	Igi ibepe	T	LF, SD	EX PA	Internal	Gastroenterites, Fever
13	Combretaceae	*Guieria senegalensis* (L);	Gedu	T	LF	EX	Internal	Gastroenterites, Weakness of body
		Terminalia schimperiana (L)		T	LF	EX	Internal External	Gastroenterites, Weakness of body
14	Cucurbitaceae	*Lantana camera* (L)	Ewon Adele	T	LF	EX	Internal External	Gastroenterites, Weakness of body
		Momordica charantia (L)	Igi ejinrinwewe	H	LF; WP	PQ DE	Internal Internal	Gastroenterites, Diahorea
15	Euphorbiaceae	*Bridelia feruginea* (L)	Igi ira	T	LF, SD	EX DE	Internal Internal	Weakness of body, Diahorea
		Flugea virosa (L)	Isawewe ameranbabo	T	LF	CH	Internal Internal	Female sex delivery, Diahorea
		Jatropha gossypifolia	Igi lapalapa	H	FL; AP	HR EX	Internal Internal	Pile, Diahorea
		Jatropha multifida (L)	Ogege	H	FL; AP	DE IN	Internal	Pile, Diahorea
16	Fabaceae	*Gliricidia sepium* (Jack.)	Agunmaniye	T	LF, AP	DE IN	Internal	Gastroenterites
17	Hymenocadiaceae	*Hymenocadia acida* (L)	Orupa	H	LF	DE	Internal	Retained placenta
18	Lamiaceae	*Ocimum bascilicum* (Sims.)	Igi Efiri	H	LF	EX	Internal Internal	Pile, Diahorea
19	Malvaceae	*Gossypium arboretum* (Jacq)	Igi owu	S	LF, SD	EX EX	Internal	Gastroenterites
		Sida corymbosa (L)	Iseketu	H	LF	EX	External	Wounds
20	Meliaceae	*Azadiracta indica* (A.Juss) *Khaya senegalensis* (Desr.)	Igi dongoyaro	T	LF, AP	DE IN	Internal External External External	Fever, Wounds, Fowlpox, Coccidiosis
21	Menispameaceae	*Cissampelous owariense* (P.Beav.)	Ewe jookoje	H	LF	EX	Internal External	Diahorea, Worms Wounds
22	Mimocaceae	*Parkia biglobosa* (Aubereville)	Igi iru	T	LF, SD	EX PA	Internal External External	Weakness, wounds Fowlpox
23	Moraceae	*Ficus exasperate* (L)	Igi sawn paper	T	LF; AP	DE IN	Internal External External	Ectoparasites, Mange, Fever
		Ficus thoningii (L)	Igi odan	T	LF	DE	External External External	Ectoparasites, Mange, Retained placenta
24	Musaceaea	*Musa*	Ogede	H	LF,	HR	Internal	Cough,

		parasidiaca (L)			FR	CH	External Internal	CRD
25	Myraceae	*Psidium guajava* (L)	Gurofa	T	FR; LF	EX PD	Internal	Fever
26	Nyctaginaceae	*Boerhavia difusa* (L)			LF	EX	Internal Internal	Worms, Gastroenterites
27	Poaceae	*Saccharium officinarium* (L)	Igi ireke		LF	JU	Internal	Gastroenterites
		Zea mays (L)	Agbado		SD	CH	Internal External	Fever, Fowlpox
28	Portulaceae	*Tephrosia vogeli* (Hook)	Orobeja		LF	EX	Internal Internal	Cough, Newcastle disease
29	Rubaceae	*Moringa oleifera* (Lam)			LF, SD	EX DE	Internal Internal	Newcastle disease; Worms
30	Rutaceae	*Citrus aurantifolia* (Christm)	Osan wewe		LF, SD	JU	Internal External	Cough, CRD
31	Sapotaceae	*Vitelaxia paradosa*	Emimi		LF	EX	Internal External Internal	Wounds; Fowlpox; Coccidiosis
32	Solanaceae	*Capsicum frutescens*	Igi ata		SD	IN	Internal External	Cold, Fever
		Datura stramonium (L)	Adodo-mode		LF SD	EX PA	External Internal	Wounds; Gastroenterites
		Nicotiana tabacum (L)	Igi taba		LF; SD	IN	Internal External Internal	Ectoparasite, Mange, Fever
		Solanum nodiflorum (Jacq.)	Ewe Odu		LF	IN	Internal Internal Internal	Diarrheas, Worms, Coccidiosis
33	Steculiaceae	*Walteria indica*	Ewe eje		LF	HR	Internal	Coccidiosis
34	Tiliaceae	*Triumfetta cordifolia* (A. Rich)			LF	EX	Internal External	Fever Body weakness
35	Verbenaceae	*Lantana camera* (L)	Ewon Adele		LF	EX	Internal External	Fever, Fowlpox
		Vitex doniana (Sweet)	Oriri		LF	DE	Internal External	Wounds, Cough, Fowlpox
36	Zingebaraceae	*Aframomum meleguata*, ()	Atare		SD	PA	Internal Internal Internal	Gastroenterites, Cold, CRD

Keys: Habit: H, herbs, S shrubs, T trees, C climber; 2. Part(s) used: LE leaf, FR fruit, RT Root, ST stem, AP aerial Parts, WP whole Plant, FD fronds, SD Seed, FL flower, BA bark, BL bulb, RH rhizome, TW twig, SH shoot, LX latex, LB leaf bud, FP floral parts, 3. Method of preparation: PD powder, DE decoction, EX extract, PA paste, JU juice, PO poultice, IN infusion, HR hot rubbing, CH chewed, VG vegetable, TE tea, ET eaten, CK cooked, HB hot beverage.

Table 3: Quantitative Analysis of the data of the plants identified in the study areas

S/N	Botanical Name	Rel.PH	Rel. BS	RI	FC	RFC	UV	FL (%)
1	*Adansonia digitata* (L)	0.50	0.54	52.0	30	0.20	0.07	20
2	*Aframomum meleguata*	0.83	0.98	90.5	120	0.80	0.78	80
4	*Allium cepa* (L.)	0.86	0.91	85.5	135	0.90	0.87	90
5	*Allium sativum* (L.)	0.67	0.78	72.2	98	0.65	0.60	65
6	*Alstonia boonei* (Pers)	0.64	0.64	64	84	0.56	0.48	56
7	*Amaranthus spinosus* (L)	0.58	0.56	57	64	0.43	0.23	43
8	Anacardium occidentale (L.)	0.58	0.51	55	64	0.43	0.40	43
9	*Anona senagalensis* (L.)	0.58	0.54	56	64	0.43	0.28	43
10	*Aspilia africana* (Pers.)	0.61	0.78	69.5	72	0.48	0.33	48
11	*Azardiracta indica* (A.Juss.)	0.58	0.54	56	84	0.56	0.52	56
12	*Boerhavia difusa*	0.12	0.18	15	9	0.06	0.02	06
13	*Bridelia ferruginea* (L.)	0.58	0.54	56	84	0.56	0.53	56
14	*Calotropis procera* (R.Br.)	0.23	0.35	29.0	16	0.11	0.07	11
15	*Capsicum frutescens* (L.)	0.69	0.79	74	98	0.65	0.61	65
16	*Carrica papaya* (L)	0.69	0.64	66.5	98	0.65	0.61	65
17	*Caccia occidentale* (L.)	0.50	0.47	48.5	30	0.20	0.12	20
18	*Chromolaena odorata* (L.)	0.78	0.89	83.5	110	0.73	0.53	73.30
19	*Cissampelos owariensis* (P.Beav.)	0.70	0.81	75.5	99	0.67	0.19	66.00
20	*Citrus aurantifolia* (Christm)	0.49	0.48	48.5	28	0.19	0.15	18.70
21	*Datura stramomium* (L.)	0.66	0.59	62.5	89	0.59	0.23	59.33
22	*Elaeis guinensis*	0.62	0.78	70	78	0.52	0.47	52.00

	(Jacq)							
23	*Ficus exasperate* (L.)	0.91	0.86	88.5	140	0.93	0.87	93.33
24	*Ficus thoningii* (L.)	0.93	0.82	87.5	146	0.97	0.92	97.33
25	*Flugea virosa* (L.)	0.86	0.92	89	136	0.91	0.67	91.33
26	*Gliricidia sepium* (Jacq)	0.78	0.79	78.5	110	0.73	0.61	73.33
27	*Gossypium arboretum* (Jacq)	0.58	0.58	58	64	0.43	0.23	42.66
28	*Guieria senegalensis*(L.)	0.53	0.54	53.5	34	0.23	0.15	22.70
29	*Helitricum indicum*(L.)	0.58	0.54	56	67	0.45	0.32	44.66
30	*Hymenocadia acida*(L.)	0.61	0.71	66	73	0.49	0.19	48.66
31	*Jatropha gossypifolia* (L.)	0.69	0.88	78.5	91	0.61	0.43	60.66
32	*Jatropha multifida* (L.)	0.71	0.92	81.5	103	0.69	0.52	68.66
33	*Khaya senegalensis* (Desr)	0.55	0.43	49	62	0.41	0.33	41.33
34	*Lagenaria siceraria* (Molina)	0.62	0.67	64.5	74	0.49	0.19	49.33
35	*Lantana camera* (L.)	0.10	0.11	10.5	6	0.04	0.01	4.00
36	*Momordica charantia* (L.)	0.65	0.78	71.5	92	0.94	0.89	61.33
37	*Moringa oleifera* (Lam)	0.67	0.71	69	94	0.63	0.57	62.66
38	*Musa parasidiaca (L)*	0.56	0.54	1.15	39	0.26	0.29	26.00
39	*Nicotiana tabacum* (L.)	0.79	0.92	85.5	114	0.76	0.59	76.00
40	*Ocimum bascilicum* (Sims)	0.55	0.45	50	62	0.41	0.80	41.33
41	*Parkia biglobosa* (Aubereville)	0.12	0.09	10.5	9	0.06	0.43	6.00
42	*Pergularia daemia* (Forsk)	0.17	0.08	12.5	15	0.10	0.27	10.00
43	*Parquetina nigrensis*	0.53	0.54	53.5	60	0.40	0.25	40.00

	(Afz)							
44	*Psidium guajava* (L.)	0.17	0.13	15	15	0.10	0.10	10.00
45	*Rauwolfia occidentale* (Afz)	0.54	0.29	41.5	39	0.26	0.06	26.00
46	*Lantana camera* (L.)	0.62	0.78	70	43	0.29	0.11	28.67

47	*Saccharium officinarium* (L.)	0.62	0.71	66.5	43	0.29	0.29	28.67
48	*Senna alata* (L.)	0.48	0.34	41	28	0.19	0.21	18.67
49	*Senna occidentals* (L.)	0.16	0.13	14.5	14	0.09	0.19	9.33
50	*Sida corymbosa* (L.)	0.64	0.65	64.5	48	0.32	0.29	32
51	*Solanum nodiflorum* (Jacq)	0.18	0.14	16	16	0.11	0.33	11
52	*Spondia mombin* (L.)	0.67	0.78	72.5	94	0.63	0.57	63
53	*Talinum triangulare* (Jacq)	0.60	0.78	69	60	0.40	0.25	40
54	*Tephrosia vogeli* (Hook)	0.48	0.26	37	28	0.19	0.45	19
55	*Terminalia schimperiana* (L.)	0.51	0.34	42.5	32	0.21	0.27	21
56	*Thitornia diversifolia* (L.)	0.68	0.57	62.5	95	0.63	0.89	63
57	*Tridax procumbens* (L.)	0.52	0.54	53	34	0.23	0.23	23
58	*Triumfetta cordifolia* (A. Rich)	0.48	0.36	42	28	0.19	0.27	19
59	*Venonia amygdalina* (Del)	0.60	0.78	69	80	0.55	0.66	55
60	*Vitex doniana* (Sweet)	0.11	0.09	10	10	0.67	0.19	67
61	*Vitelaxia paradosa*	0.11	0.08	9.5	11	0.07	0.21	7
62	*Walteria indica*	0.48	0.55	51.5	28	0.19	0.27	19
63	*Zea mays* (L.)	0.60	0.78	39	80	0.55	0.45	55
64	*Zingiber officinale* (Rosc)	0.61	0.88	74.5	82	0.55	0.95	55

Rel. PH relative number of pharmacological properties attributed to a single plant, Rel. BS relative number of body systems treated by a single species, RI relative importance, FC frequency of citation, RFC relative frequency of citation, UV use value, FL fidelity level

Table 4: Informant Consensus factors of the Respondents in the study area

S/N	Group of Diseases	Name of the associated diseases	Informant Consensus Factors
1	Skin diseases/ Mange	Ectoparasites, Mange, Wounds	0.90
2	Digestive system diseases	Diahoera, Dysentary,	0.80
3	Respiratory diseases	Cough, throat	0.60
4	Circulatory/ Reproductive diseases	Urinary diseases, Retained placenta	0.50
5	Fever	Weakness and Pain	0.45
6	Muscular/Joint diseases	Dislocation of joints, weakness of legs or cage fatigue	0.34

Declaration

Ethics approval and consent to participate

Authors received approval from the leadership, the kings and the traditional practitioners before receiving and documenting information from the respondents on the use of plants for treating animal diseases in the Ekiti North Senatorial district, Ekiti State, Nigeria. Also, certificate of ethnical approved was obtained from office of Research and Development (ORD) Ekiti State University, Ado-Ekiti.

Availability of data and materials

The datasets generated during and/or analysed during the current study are not publicly available due to the compromising of the authors' privacies, however, the data are available from the corresponding author on reasonable request.

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Competing interests

The authors declared no Competing of interest in the designing of the work, the collection, analysis, interpretation of data, writing of the manuscript and in the decision to publish the results.

Authors Contribution

OMK, TPO and KJ participated in designing the protocol of the survey. OMK carried out the research; TPO, OMK and KJ participated in data analysis and writing the manuscript. All authors participated in reviewing the manuscript. All authors read and approved the final manuscript.

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RELATIONSHIP BETWEEN ABO BLOOD GROUPS AND MALARIA INFECTION IN ENDEMIC REGIONS OF NIGERIA

Bawo D. S.* and Isaiah E. Pouna
Department of Biological Sciences, Niger Delta University, Wilberforce Island, Nigeria
corresponding e-mail: dorcasbawo@gmail.com
Phone: +2348037055333

Abstract

Over the years, malaria has been a major global force to reckon with. Though it is treatable, it however remains prevalent annually, promoting the need for an improved understanding of its pathogenesis to reduce it prevalence. Genetic studies have shown that AS and SS genotype individuals rarely infested with malaria because the sickled haemoglobin present in their red blood cells are not accessible for recognition and entry by malaria parasites. However, AA genotype individuals whose hemoglobin is not sickled have shown to also resist malaria, this led to the concepts that the differing ABO blood-groups contributes to the resistance and susceptibility of individuals to malaria. A total of 455 individuals were sampled. 261 blood samples were assessed for both malaria (by microscopy and RDT kits) and ABO blood group tests, while 194 individuals were assessed using questionnaire. Results showed that blood group O was most prevalent blood groups among assessed individuals (O 47.8% > A 28.3% > B 16.4% > AB 7.5%). With respect to malaria test done by microscopy, the rate at which blood group O develops low (+) malaria was highest (36.9%) compared to other blood groups, while blood group A had the highest rate of developing severe (+++) malaria (44%). Rapid diagnostic test results showed that blood group O had the lowest rate of developing positive malaria cases (43.1%), while blood AB had the highest rate of developing positive malaria cases (66.7%). Assessment done with the use of questionnaire revealed that blood group A had a slightly higher number of individuals having severe malaria (41) compared to blood O (40), however blood group O was present in much higher number (83) compared to A (72). All three results pointed to blood group O having a relatively lower rate of developing severe malaria compared to other blood groups.This understanding is essential for purposes such as, individuals of the non-O blood groups exhibiting a more sensitized knowledge on the onset of malaria symptoms so as to treat it early, for transfusion purposes, and also for the development of new drugs and vaccines to reduce the prevalence of malaria globally.

Keywords: Genotype, ABO blood groups, Malaria infection, Susceptibility, Resistance, Erythrocytes.

Introduction

Disease is any harmful or abnormal deviation from the normal structural and functional (physiological) state of an organism (William *et al,* 2018). It is associated with signs and symptoms that indicates an abnormal state, which is why it

is different from an infection (a phenomenon of pathogenic penetrance into a host). A disease results when a pathogen or parasite has penetrated and established itself in a susceptible host, a process that results into physical manifestation of the presence of the pathogen, it also means that, the normal condition of an organism had to be understood in order to recognize the expression of a disease.

Malaria can bear the tag of an infection as well as a disease. It occurs as a result of the excessive destruction of erythrocytes (red blood cells) by parasites of the genus *Plasmodium.* Over the years, malaria has proven to be a major selective force on the human population, especially in populations of many tropical and sub-tropical areas (Alexander *etal*, 2007), as thousands of deaths are continuously being recorded annually as a result of malaria. Knowing fully well that the human malaria vector (female *Anopheles* mosquitoes) and human malaria parasite *Plasmodium spp.* feeds on erythrocytes (RBCs) to obtain nutrients required to undergo their life cycle, in the process causing malaria disease. There appears to be a definite relationship between the human blood and malaria parasite. Such relationship is parasitic, where the host has nothing to gain from the relationship, however, humans can either be susceptible or exhibit some levels of resistance to malaria disease through their blood.

With respect to resistance, genetic studies have shown that 'AS' and 'SS' genotype individuals possess high levels of resistance to malaria disease, this is because the sickled haemoglobin present in their red blood cells are not accessible for recognition and entry by the parasite (Otubanjo, 2013).

However, resistance to malaria has also been frequently reported among 'AA' genotype individuals. Considering this fact, the explanation of the sickled haemoglobin due to the presence of the sickle cell (S) allele as the factor that confers resistance to humans against malariawill not always be correct because 'AA' genotype individuals do not carry sickle cell (S) allele. The ABO blood group became an aspect to look out for to find answers to resistivity and susceptibility of the human blood to malaria disease, since it is directly involved in the interaction with malaria parasites and also because, generally, human blood are classified using the ABO blood grouping system. Findings were made and there actually exists a school of thought which says ABO blood groups have varying susceptible and resistance relationship with human malaria parasite. Susceptible in that some blood groups are more easily affected by malaria infections and resistance in that one or two has mechanisms that are capable of keeping malaria at a bay. If this is true, then it would be correct to say that malaria and its parasites contributes to varying global distributions of ABO blood groups in human populations (Alexander *et al*., 2007), especially in populations where malaria is prevalent. This study provides insights into malarial pathogenesis in relation to ABO

blood groups, putting into consideration factors that could confer resistance to a host against malaria infection and possible measures in a bid to reduce the prevalence of malaria in malaria endemic region such as Africa and particularly, Nigeria.

Materials and methods

The experimental procedures are in correspondence with the standard methods used in diagnosing malaria and determining ABO blood groups (Cheesbrough 2005, 2006; Burton *et al.*, 2013). To attain accuracy as much as possible, four kinds of study/experiment were conducted *viz*;

- Determination of malaria parasitaemia in the blood by microscopy,
- Determination of malaria parasitaemia in the blood through the use of test kits (SD Malaria Ag P.f),
- Determination of ABO blood groups by standard agglutination method,
- The use of questionnaire to assess the relationship of individuals' ABO blood groups and malaria.

In all experiments conducted, simple percentages was used as statistical tool to report and communicate results obtained in this study.

Determination of malaria parasitaemia by microscopy

Sample collection

Blood samples of one hundred and five (105) patients who came to Lusada Medical Diagnostic Centre, Lusada, Ogun State, Nigeria, seeking medical attention, were collected for a period of one month, February 4th – March 2nd, 2019, with the use of needle and syringe or by finger-pricking into the EDTA bottle or directly on glass slide.

Procedure

- Blood samples of patients were collected with the use of needle and syringe or by pricking, this is dependent on the required test (s) to be carried out, as most times a combination of malaria parasite test and widal (typhoid test) is required. This kind of test is done using needle and syringe and into the EDTA bottle. When only malaria parasite test is required, finger-pricking is done and blood is dropped directly on the glass slide.
- Blood sample is placed on sterile glass slide and a thin blood smear is made with the use of a spreader and then allowed to dry.
- The dried thin smear is stained with Leishman stain and washed with distilled water after 2-3 minutes, and then allowed to dry again.
- Immersion oil is placed on the prepared sample and observed under 40X objective lens of the microscope. The severalty of infestation is denoted with +, ++, or +++, depending on the level of parasitaemia seen under the microscope.

Determination of malaria parasitaemia in the blood through the use of rapid diagnostic test kits (SD BIOLINE Malaria Ag P.f) device

Sample collection

Blood samples of 150 registered students of Niger Delta University, Wilberforce Island,

Bayelsa State, were collected with the use of needle and syringe and into the EDTA bottle.

Procedure

- With the use of pasteurpippete, a drop of each collected blood sample was placed in the test portion of the SD BIOLINE Malaria Ag P.f device.
- A drop of buffer is added on the blood sample to make it more mobile.
- Observation of result after 15-30 minutes as instructed by the kits manufacturer.

Result determination

- Negative result: when there is the presence of only one coloured band, the 'C' band standing for control.
- Positive: When there is the presence of both the control 'C' band and the P.f band.
- Invalid: result is invalid when there is no visible control line showing.

Determination of ABO blood groups by standard agglutination method

The ABO and Rh blood grouping system is based on agglutination reaction. When red blood cells carrying one or both the antigens are exposed to the corresponding antibodies they interact with each other to form visible agglutination or clumping.

Sample collection

Each blood samples already used for malaria parasite tests either by microscopy or by rapid diagnostic tests (RDTs) are labelled and immediately used for the determination of blood group, and results are documented in correspondence with the malaria parasite test results done initially.

Procedure

- Blood sample already used for malaria parasite tests are also used for ABO blood group determination, with the use of the pippete or by pricking, these blood samples are dropped or placed on three different portions of the reaction plate.
- Then, a drop of corresponding antisera, anti-A to the first drop of blood, anti-B to the second, anti D which test for the rhesus factor (positive or negative) to the third drop of blood on the reaction plate.
- With the use of the stirring rod, the prepared sample is stirred and rocked to observe for agglutination reactions.

Questionnaire

A total of 200 questionnaires were administered, 100 of which came from 400 level students of the Department of Biological Sciences, Niger Delta University, while the remaining 100 was gotten from persons picked at random across the university campus and community.

Results and Discussions

Table 1: Result of Malarial Parasite Test Done By Microscopy

Test results	Blood groups							
	A+	A-	B+	B-	AB+	AB-	O+	O-
+	5	1	7		3		15	2
++	8		8	2	5	1	13	
+++	11		5		5		14	2
TOTAL	25		22		14		46	
%	23.4%		20.5%		13.1%		43%	

A total of 107 blood samples were used to undergo malaria parasite test by microscopy and their ABO blood groups were determined. Out of the population tested A^+ (23.4%), B^+ (20.5%), AB+ (13.1%) and O+ (43.0%), respectively (Table 1).

Table 2: Rate of developing malaria parasitaemia among blood groups (microscopy)

Parasitaemia levels	A	B	AB	O
+	24%	31.8%	21.4%	36.9%
++	32%	45.5%	42.9%	28.3%
+++	44%	22.7%	35.7%	34.8%

The above table represents the rate at which different blood groups develops malaria during the experiment conducted using microscopy. Blood group A has the highest rate of developing (+++) severe malaria (44%), blood group O has the highest rate of developing low (+) malaria (Table 2).

Table 3: Result of Malaria Parasite Test Done Using Test Kits (SD BIOLINE Malaria Ag. P.f)

Test results	Blood groups							
	A+	A-	B+	B-	AB+	AB-	O+	O-
Positive	22	4	13	2	8	4	22	6
Negative	11	4	8	3	4	2	32	5
Total	41		26		18		65	
%	27.3%		17.3%		12%		43.3%	

A total of 150 blood samples from patients visiting the Niger Delta University Health Center (Sickbay) were used to perform malaria parasite using test kits. Out of the population tested A^+ (27.3%), B^+ (17.35%), AB+ (12.0%) and O+ (43.3%), respectively (Table 3).

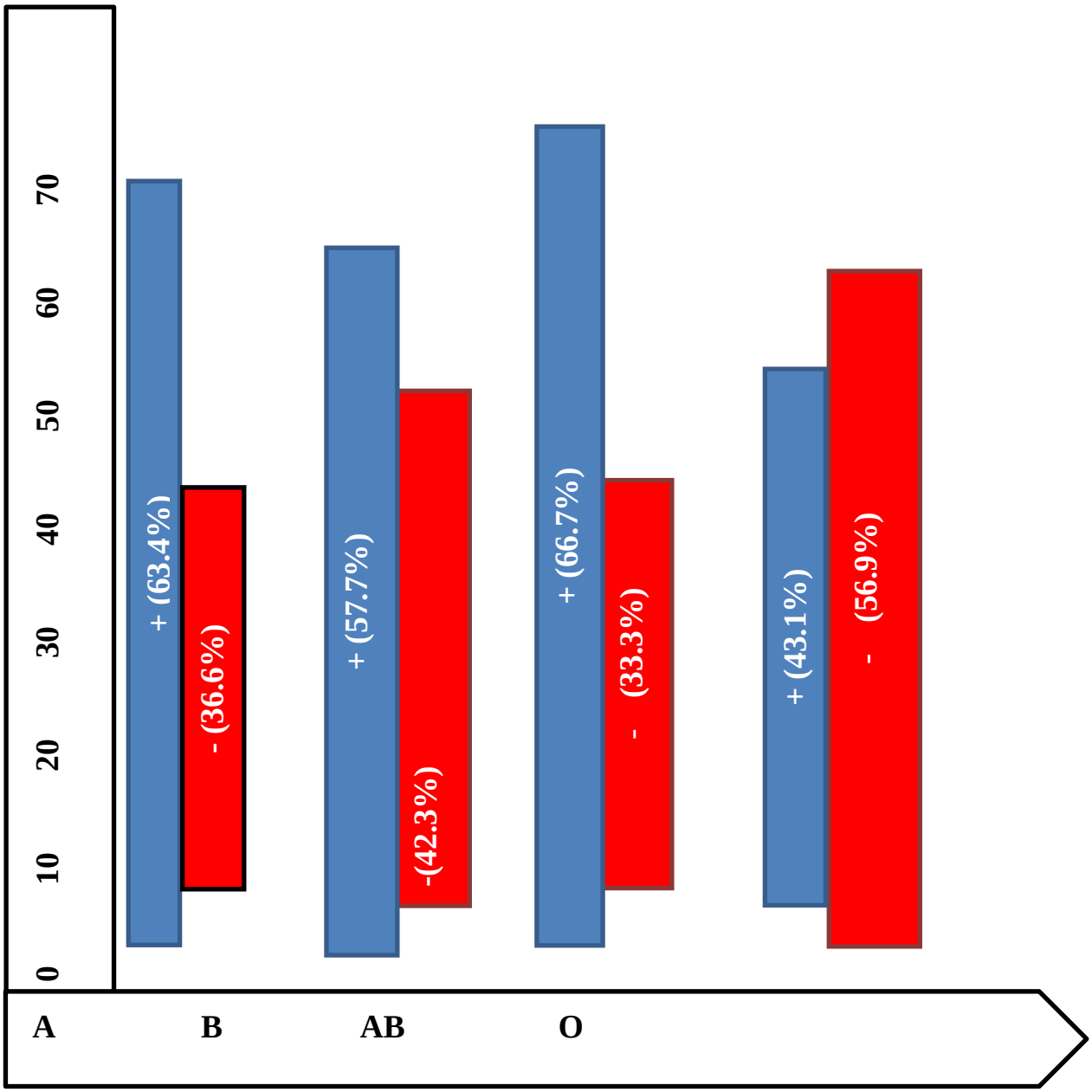


Fig 1: Rate of malaria parasitaemia within blood groups

= Positive cases = Negative cases

Derived from the test kit results, Fig. 1 is a bar chart showing the rate at which malaria positive and negative cases developed within each blood groups. Blood group O can be seen with the lowest rate of developing positive cases (43.1%), while blood group AB exhibits the highest number of positive cases (66.7%).

Table 4: Result Table of Questionnaires

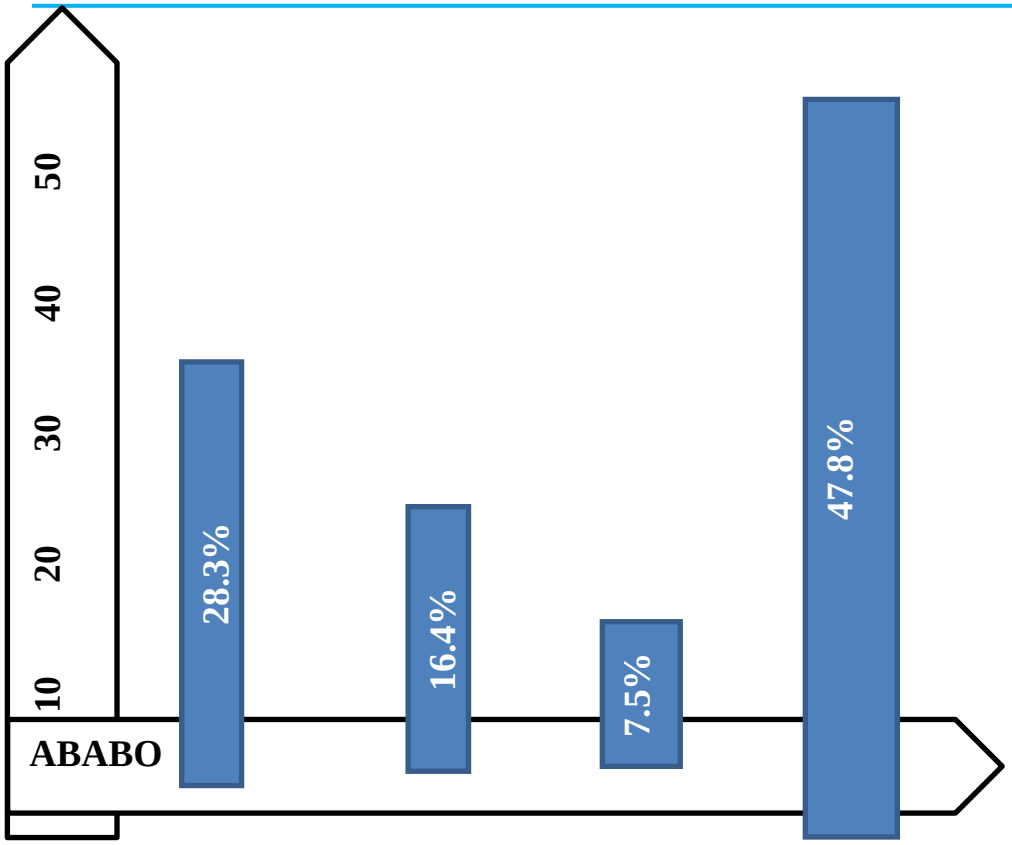
Cases	Blood groups							
	A+	A-	B+	B-	AB+	AB-	O+	O-
Severe malaria	38	3	7	5	5	2	36	4
Symptoms	26	2	9	3	6	2	41	2
Frequent use of malaria drugs	45	2	5	4	6	1	39	4
Annual use of malaria drugs	15	1	2	1	4		33	
Never gets malaria	Nil							
Total	72		24		15		83	
%	37.1%		12.5%		7.7%		42.8%	

A summary of the important points gotten from the questionnaire of over 200 in number with 194 valid results are summarized in Table 4. Out of the population tested A^+ (37.1%), B^+ (12.5%), AB+ (7.7%) and O+ (42.8%), respectively (Table 4).

Table 5: ABO blood groups and their frequency

Blood Groups							
A+	A-	B+	B-	AB+	AB-	O+	O-
86	12	44	13	19	7	151	15
24.8%	3.5%	12.7%	3.7%	5.5%	2%	43.5%	4.3%
28.3%		16.4%		7.5%		47.8%	

Out of the population tested A^+ (28.3%), B^+ (16.4%), AB+ (7.5%) and O+ (47.8%), respectively (Table 5). The percentage frequency of the tested population is as shown in Fig 2.



Discussions

A total of 455 individuals were involved in the study, of which 261 blood samples were used for both malaria tests and ABO blood group test, while 194 individuals were assessed using questionnaire. Blood group results showed that the most common blood group were blood group O with a relative abundance of 47.8%, followed by blood group A (28.3%), then blood group B (16.4%), and lastly is the blood group AB (7.5%). This is in accordance with previous studies such as the one done by Adeyemo and Omolade (2006).

Malaria parasite test by microscopy

The use of microscopy to determine malaria parasitaemia provides a more accurate result compared to the use of rapid diagnostic tests (RDTs) kits or strips. It only detected positive cases and also the level of parasitaemia in the blood stream (+, ++, +++), where the use of rapid diagnostic tests only compares between positive and negative cases. This experiment was performed at a laboratory known as Lusada Medical Diagnostic Center, located at Lusada, Ado-odoota local govt. area, Ogun State, Nigeria, it was done for a period of one month (February 4th – March 2nd 2019) where a total of 107 blood samples were examined for malaria parasite test and ABO blood group determination.

Result showed that blood group O which is the prevalent blood group among the observed blood samples with a total of 46 individuals and relative abundance of 43%, of which 16 individuals had"+++", and "+" cases of 17 individuals, blood group A being the next prevalent blood group had a "+++" cases of 11 individuals and "+" cases of 6 individuals of the 25 individuals that were examined, blood group B had 5 (+++) and 7 (+) of 20 examined individuals, while

AB had 5 (+++) and 3 (+) cases of 14 individuals examined. The rate at which blood group O develops low (+) malaria is the highest (36.9%) compared to other blood groups (Table 2). While the rate at which blood group O develops severe (+++) is second to the lowest (34.8%), behind blood group B (22.7%), however blood group B has a more higher rate of developing (++) malaria (45.5%) compared to O blood group (28.3%). The results from microscopy implies that blood group O has the lowest possibility of developing severe (++, and +++) malaria, while blood group A has the highest rate of developing severe (+++) malaria (44%) compared to other blood groups.

Rapid diagnostic tests for malaria

Rapid diagnostic tests involve the use of test kits or strips to detect positive and negative cases of malaria.150 individuals who sought for medical attention at the Niger Delta University Health Center (sickbay) were examined, of which 95 % are students of the institution, with blood group O being most common. Even though blood group O involved the highest number of individuals, results showed thatblood group O have the lowest rate of developing positive malaria cases (43.1%), while blood AB have the highest rate of developing positive malaria cases (66.7%) showed in figure 1. It can be deduced that blood group A and AB are more frequently infected by malaria parasites compared to other blood groups.

Survey through questionnaires

The use of questionnaire was adopted to have an assessment of the interaction of people with malaria disease with respect to severe malaria, just symptomatic malaria, frequent use of antimalarial drugs, annual use of antimalarial drugs. It was carried out at the university community, Amassoma and involved mostly students of the institution. The questionnaire got a 194 number of required assessments, of which blood group A had a slightly higher number of individuals having severe malaria (41) compared to blood O (40), however blood group O was present in much higher number (83) compared to A (72). Symptomatic malaria was present more in individuals of blood group O (43) than A (28). With respect to the frequent use of antimalarial malaria drugs, blood group A was present in 47 cases, while O was present in 43 cases. Annual usage of antimalarial drugs was found more in individuals of blood group O (33), compared to blood group A (16), which implies that more individuals of blood group O treats malaria only yearly which is factor that points to O blood group individuals being more resistant to malaria disease. The cases of severe malaria was slightly more in blood group A but individuals of blood group O are more in numbers, which would mean that they are less prone to malaria disease.

From the three kinds of experiment performed, a general deduction can be made that individuals of blood group O are less likely to have severe malaria, than individuals of other blood groups. This study is in correspondence with those done

by the Proceedings of the National Academy and Science of the United States of America, who concluded that blood group O protects against severe malaria through the mechanism of reduced rosetting (Alexander, *et al.*, 2007). The work on this subject done in the Federal Capital Territory, Abuja, Nigeria, by Onanuga and Lamikanra, 2016, concludes that there is no association between malaria infection and ABO blood groups but the prevalence of higher malaria parasite density was significantly greater in children with blood group A, they appear to experience more malaria attacks and thus, more frequently susceptible to a higher level of malaria parasitaemia (Onanuga, and Lamikanra, 2016). This work is in contrast to that of Anifowose *et al.*, (2017) done in Nigeria, which stated that blood group O recorded the highest number of positive cases, and gave an explanation that this can be as a result of the fact that majority of the population from which the samples were collected are of blood group O (Anifowose *et al.*, 2017). Therefore, considering the fact that blood group O seem to be the prevalent blood group in many population, analysis of the relationship between ABO blood group and malaria should be done in such a way that ensure that the prevalence of blood group O in populations did not determine resistance and susceptible of blood groups to malaria disease, and thus, this study was done with three different assessments, and percentages with respect to the rate of developing different malaria parasitaemia levels within each blood groupstaken before conclusions were made.

The study of the relationship between ABO blood group and malaria disease has been for several years as numerous works has been done on this subject from several countries, many of which arrived at contradictory conclusions (Uneke, 2007; Cserti and Dzik 2007), thus, the question "does ABO blood group contributes to susceptibility and resistance to malaria?" has never had a clear answer until recently. This study has previously not received attention due to the inconsistent results gotten from previous studies on the effects of ABO blood group on malaria, parasite density, or antimalarial (antibody) levels (Uneke, 2007). However, understanding the pathogenesis of malaria parasites remains an integral aspect considering the fact that the prevalence of malaria as a killer disease doesn't seem to reduce. Though previous studies have suggested that blood group A may predispose to severe malaria among African children (Fischer and Bone, 1998; Lell*et al*, 1999).

Conclusions

Previous understanding of the interaction between malaria parasites and the human blood has helped in reducing malaria globally. Countries like Paraguay and Sri Lanka have been certified malaria free by the World Health Organization (WHO, 2016; WHO, 2018). In Costa Rica, no one has died of malaria since 2009, they are among the twenty one countries identified by WHO as having the potential to eradicate malaria.

These are important improvement in a bid to reduce malaria globally, however, malaria is still prevalent especially in Africa, which accounts for 90% of all malaria cases

globally (WHO, 2018), this prompt for an advancement in the study of the interaction between malaria parasites and the human blood. This study affirms that severe malaria is more common within non-O blood groups and that individuals with O blood group have mechanisms that protects them from severe malaria. This understanding is essential for purposes such as, individuals of the non-O blood groups exhibiting a more sensitized knowledge on the onset of malaria symptoms, for transfusion purposes, and also for the development of new drugs and vaccines. Thus, following the results of this study and other recent studies, it is clear that future studies on this field would provide more insights into malaria in relation with humans, which in turn is needed if the goal of the World Health Organization to completely eradicate malaria is to be achieved.

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AN INTEGRATED STUDY OF THE RESERVOIR ARCHITECTURE OF "YEMI" FIELD, OFFSHORE NIGER DELTA

Ajisafe, Y. C*., Madukwe, H. Y. and Aturamu, A. O.
Department of Geology, Ekiti State University, Ado-Ekiti
*Corresponding email: yemisi.ajisafe@eksu.edu.ng

Abstract
An integrated study of "YEMI" Field offshore Niger Delta Basin, Nigeria was carried out with the aim of having a better understanding of the structural configuration of the reservoir and establishing possible drilling targets for increasing the production capacity of the field. For this study, 3D seismic vintage and composite well logs such as the Gamma Ray, Resistivity, Sonic, Neutron and Density logs of eight (8) wells were employed. The data were examined and interpreted in order to attempt an estimation of the hydrocarbon in place. Results revealed that three (3) of the wells found hydrocarbon while only YEM-04 well found hydrocarbon at all intervals. A total of four (4) reservoir sands were identified based on the correlation across the wells. A total of eleven (11) growth faults (listric) were mapped. They are trending Northwest-southeast and dipping significantly southwest. Four (4) horizons were mapped across the seismic sections. Time and depth maps were generated for the horizons mapped. From the structural interpretation, it was deduced that regional structural highs characterized the field which were bounded by the faults that formed the closures and trapping mechanism. The field has two prospects which are anticlinal structures that support hydrocarbon accumulation. The evaluation of the prospects established the presence of hydrocarbon in the study area which resulted to new drill location bounding the previous existing discoveries. In conclusion, the study has demonstrated the usefulness of the integration of seismic and well log data in the extraction of useful geological insights and identification of well opportunities with attendant increase in the field's production capacity.

Keywords: Reservoir, Structural Configuration, Correlation, Prospects

Introduction

The traps in the Niger Delta basin could be very subtle and complex therefore making them difficult to map accurately using one dataset (Cooke and Muryanto, 1999). Interpretation done using one data type in evaluating a field for development can be unreliable. The more the data, the more reliable the results. The accuracy of the subsurface interpretation is improved with the integration of well and seismic data (Hamed and Kurt, 2008). Therefore, exploration for undiscovered hydrocarbons and development of proven hydrocarbon reserves can be done using integrated study of reservoir architecture. This help to increase the recoverable reserve of the field by identifying possible drill well opportunities (Ajisafe and Ako, 2013). The degree of reliability and precision of the

mapping can be greatly enhanced by integrating seismic data with well logs commonly used independently in hydrocarbon exploration and exploitation studies (Aizebeokhai and Olayinka, 2010). For this study, seismic sections and composite well logs were integrated and interpreted to map the structural configuration and attempt an estimation of the hydrocarbon in place.

Geology of the study area

The study area, "YEMI" Field is situated in the shallow offshore Niger Delta Basin. It is located within the extensional zone on the continental margin of the Gulf of Guinea in equatorial West Africa (Figure 1). The Niger Delta is situated in Southern Nigeria between latitudes 4° N and 6° N and longitude 3° E and 9° E (Nwachukwu and Chukwura, 1986). It covers an area of 75,000 km^2. It is bounded to the west and northwest by the Western African shield, which terminates at the Benin hinge line and to the east, by the Calabar hinge line. The Anambra Basin and Abakaliki Anticlinorium mark its northern limit. To the south, it is bounded by the Gulf of Guinea. The Niger Delta Basin to date is the most prolific and economic sedimentary basin in Nigeria by virtue of the impact size petroleum accumulations discovered and produced from it. During the Tertiary, it built out into the Atlantic Ocean at the mouth of the Niger-Benue river system, an area of catchment that encompasses more than a million square kilometers of the predominantly savannah-covered lowland (Evamy *et al.,* 1978). The regressive wedge of clastic sediments which it comprises is thought to reach a maximum thickness of about 12 km (Doust and Omatsola, 1990).

Accumulation of marine sediments in the basin probably commenced in Albian time, after the opening of the South Atlantic Ocean between the African and South American continents. True delta development however started only in the late Paleocene/Eocene, when sediments began to build out beyond troughs between basement horst blocks at the northern flanks of the present delta area. Since then, the delta plain has prograde southward onto oceanic crust, gradually assuming a convex-to-the-sea morphology (Whiteman, 1982).

Throughout the geological history of the delta, its structure and stratigraphy have been controlled by the interplay between rates of sedimentation, which in turn affect the rate at which sea level changes and the climatic variations in the hinterland. Subsidence has been controlled largely by initial basement morphology and differential sediment loading on unstable shale (Short and Stauble, 1967). The delta sequence is extensively affected by synsedimentary and post-sedimentary normal faults, the most important of which can be traced over considerable distances along the strike. The resultant fault trends lie more or less parallel to the paleogeographic position of the delta front at each stage of its development and are intimately related to the sedimentation pattern (Weber and Daukoru, 1975).

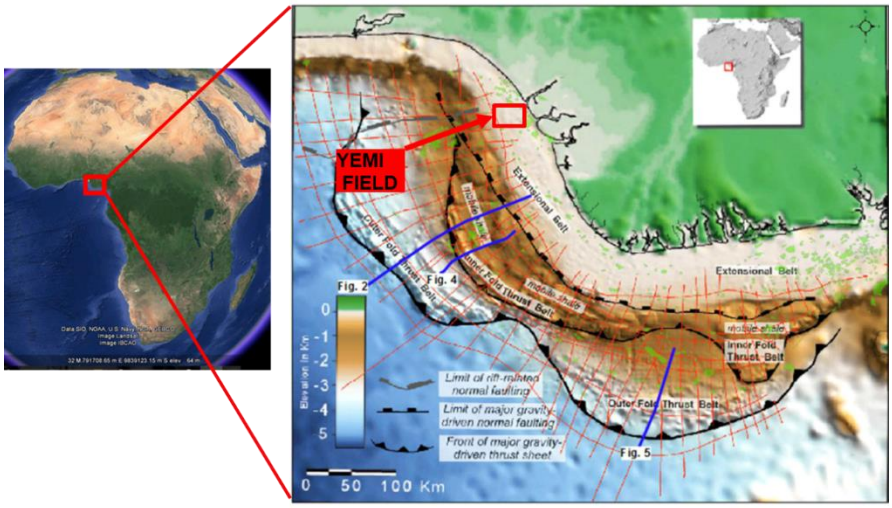

Figure 1: Location of study area (Paul *et al.,* 2014)

Method of study

The data consists of 3D Seismic reflection data- (15 inlines and 27 crosslines), suite of geophysical wireline logs for the eight wells having five vertical wells and three deviated wells (Figure 2) consisting Gamma Ray, Sonic, Caliper, Resistivities and Neutron-density logs; base map of the study area; and checkshot data (Table 1). These data were quality assessed/quality checked and Petrel software was used for interpretation. The gamma ray log (GR log) was used to identify the lithology. Resistivity log was used to differentiate between hydrocarbon and water bearing zones. Seismic to well tie was done using YEM-06, 06ST and 06ST2 as they were the only wells with sonic and density logs. The faults were interpreted on the crosslines which were perpendicular to the dip direction. Horizons were picked, fault polygons were created and time maps were generated for horizons. Checkshot for YEM-01 gave the best velocity relationship with the least error and was used to convert the time map to depth map for all the horizons using a 3rd order polynomial which gave the best fit. Petrophysical analysis was done for computation of the net-to-gross, porosity and water saturation. The log and seismic derived parameters were integrated in other to represent hydrocarbon on the depth map for each reservoir, in other to appropriately determine the Estimated Ultimate Recovery for each reservoir. On each of the depth maps closures that have not been penetrated by any well was categorised as a prospect. The extent of the prospect was terminated at the spill point or last closing contour within YEMI field. Bringing risk into perspective, the lowside, most likely and highside potentials were considered.

Hydrocarbon initially in place (using Petrobjects, 2004 software) was estimated by putting parameters from the petrophysical analysis into the equation below:

HCIIP = $GRV \times NTG \times \emptyset \times S_h \times 7758/43560\ Bo/Bg$ (1)

Where,

HCIIP is Hydrocarbon initially in place, GRV is gross rock volume, $\emptyset$ is porosity, S_h is hydrocarbon saturation, and Bo/Bg is conversion factor for oil or gas.

Reserves were estimated using the formula below:

Reserve = HCIIP X Recovery factor (2)

New drill well locations were proposed by stacking the polygons associated with the prospects identified on the depth map.

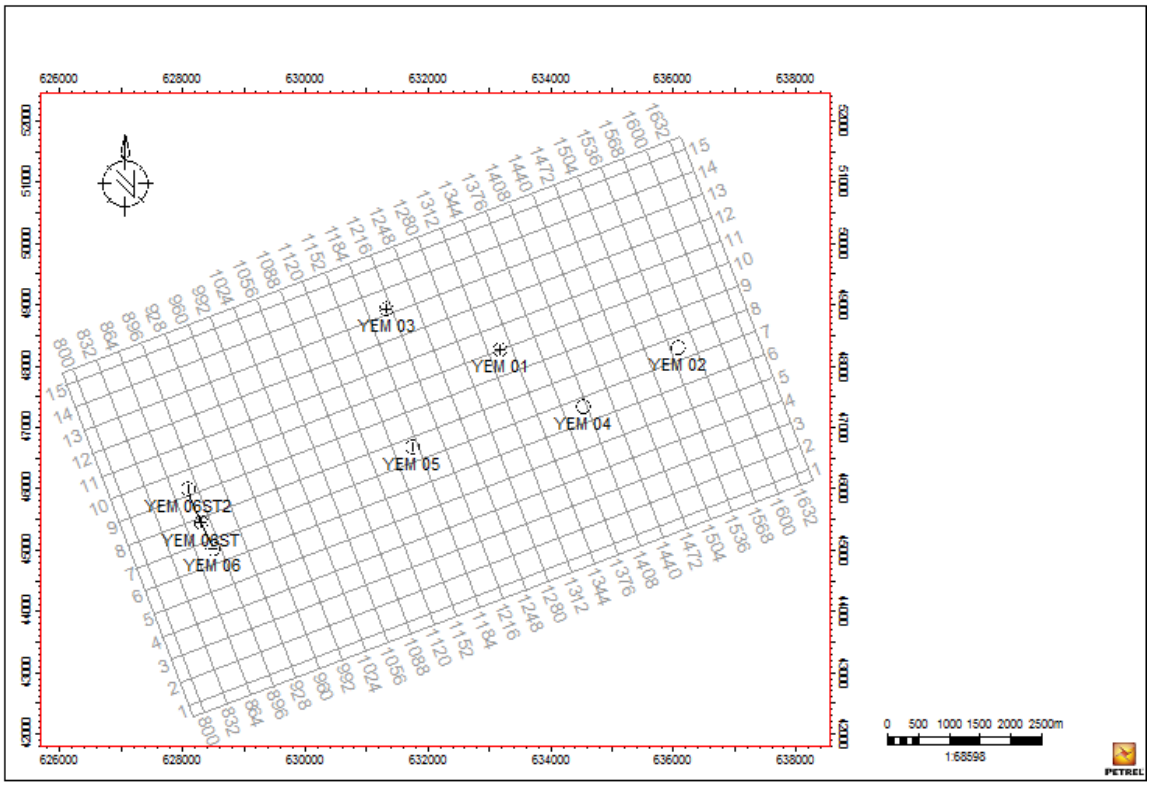

Figure 2: Basemap showing the seismic vintage of YEMI field and well locations.

Table 1: The table showing the available borehole data for the study.

Wells	GR	RES	CALI	NEU	DEN	SONIC	DEV. DATA	CHECKSHOT	TD (ft)
YEM-01	yes	yes	No	yes	no	yes	No	yes	11285
YEM-02	yes	yes	No	yes	no	yes	no	yes	6793
YEM-03	yes	yes	yes	no	no	yes	no	yes	7015
YEM-04	yes	yes	yes	no	no	yes	no	yes	10515
YEM-05	yes	yes	yes	no	no	yes	no	yes	8510
YEM-06	yes	yes	yes	yes	yes	yes	yes	no	9275
YEM-06ST	yes	yes	yes	yes	yes	yes	yes	yes	10796
YEM-06ST2	yes	yes	yes	yes	yes	yes	yes	no	9000

Discussion of results

The top and base of four hydrocarbon bearing reservoirs were identified across the eight wells in the study area namely Sand I, J, K and L. Sand L was the shallowest and Sand I was the deepest reservoir identified (Figure 3). Sands L and K were continuous throughout the wells, Sand J reservoir tended to shale out in YEM-06ST2 while Sand I though tended to shale out in both YEM-06ST and YEM-05, is continuous in the other wells aside YEM-03 and YEM-02 which are shallower relative to the other wells and hence did not penetrate Sand I. For seismic to well, there was very little mis-tie between the seismic and well reading so bulk shifting was employed to ensure a tie between these two. At the end, Peaks were correlated for L and J reservoirs while troughs were correlated for K and I reservoirs. A total of ten (10) faults were mapped amongst which five (5) are major faults and five (5) are minor faults (Figure 4).

The faults generally trend west-east and dips southwards. All the faults picked on the seismic records are counter-regional growth faults which are characteristic of the shelf edge, offshore Niger Delta. Four horizons were mapped across the entire field. Due to the fair to poor quality of the seismic data, it was challenging to get laterally continuous reflections. The corresponding fault polygon was generated for each of the horizons and respective time maps were produced (Figure 5). On each of the time maps, the light (orange) colour represents a structural high as seen mostly in the eastern part of the maps while the deep (purple) colour represent structural low, southwards of the maps. Where the light colour coincide with a closure, we have the crest of the structure and a saddle where the colour is deep. With the velocity model obtained, the time maps were converted to depth maps. Both time and depth maps were observed to have the same structural configuration and structural pattern. The depth map (Figure 6) shows that YEM-04 is up-dip of YEM-05. This justifies why YEM-04 is hydrocarbon bearing (crest of the structure) and YEM-05 is wet (flank of the structure).

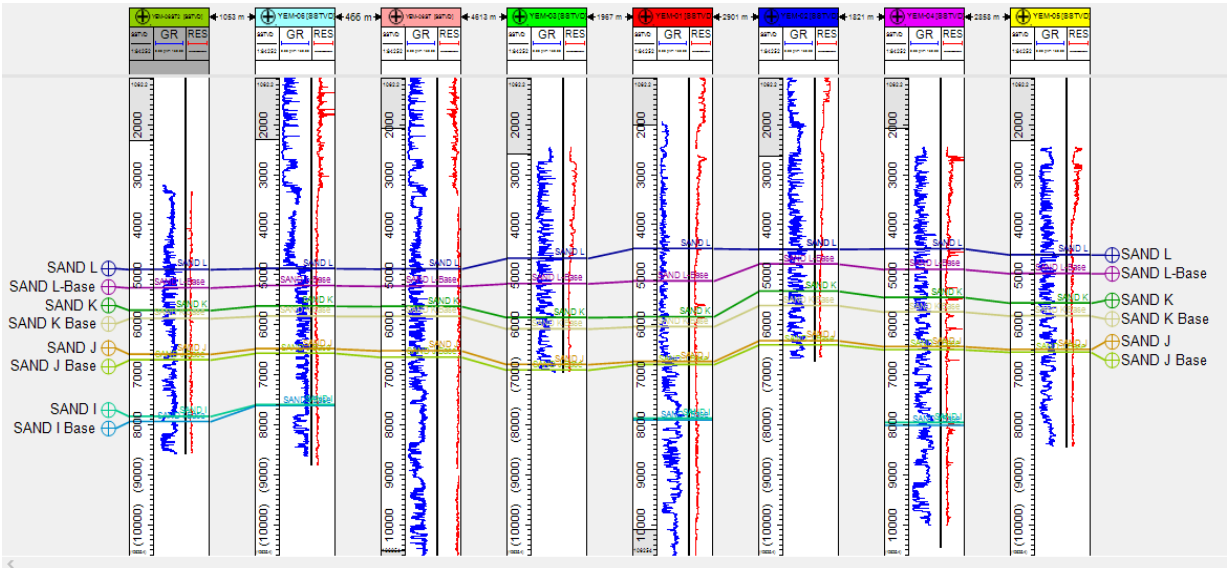

Figure 3: Correlation panel showing the correlation of SAND I, J, K and L

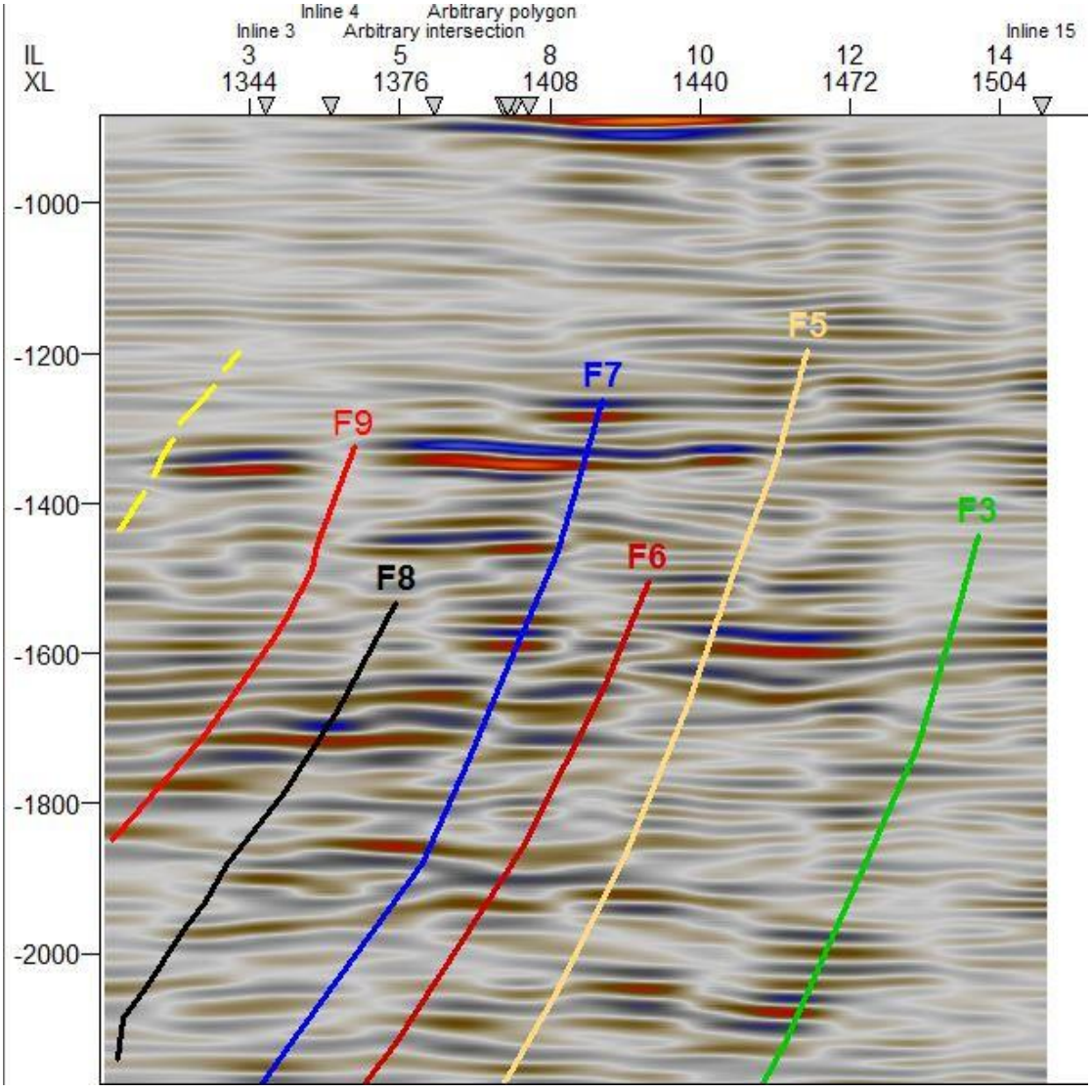

Figure 4: A seismic section showing the mapped faults

YEM-01 and YEM-02 are in a separate compartment from YEM-04 and YEM-05. However, they did not penetrate the crest of the structure, if they were located up-dip of their present location, they could have found hydrocarbon. Two prospects were defined in the study area based on the closures and amplitude analysis (Figure 7). The average petrophysical parameters for the reservoirs studied (Tables 2 to 5) shows that only YEM-04 encountered hydrocarbon in all the six levels i.e. from the shallowest reservoir, L to the deepest one, I. YEM-01 found hydrocarbon only in the L reservoir. From the analysis, L reservoir in YEM-01 had the best average porosity of between 0.19 to 0.31. K reservoir had the best net-to-gross of 0.46 to 0.95 with least value range in the shaly J reservoir of 0.21 to 0.69. Finally, I reservoir had the best water saturation range i.e. least range since the lower the water saturation the higher the hydrocarbon saturation compared to other reservoirs (Table 5). A cumulative Estimated Ultimate Recovery range of 8.15 to 58.08 MMBO was recorded if oil (Table 6) and 17.19 to 200.89 BSCF if gas (Table 7).

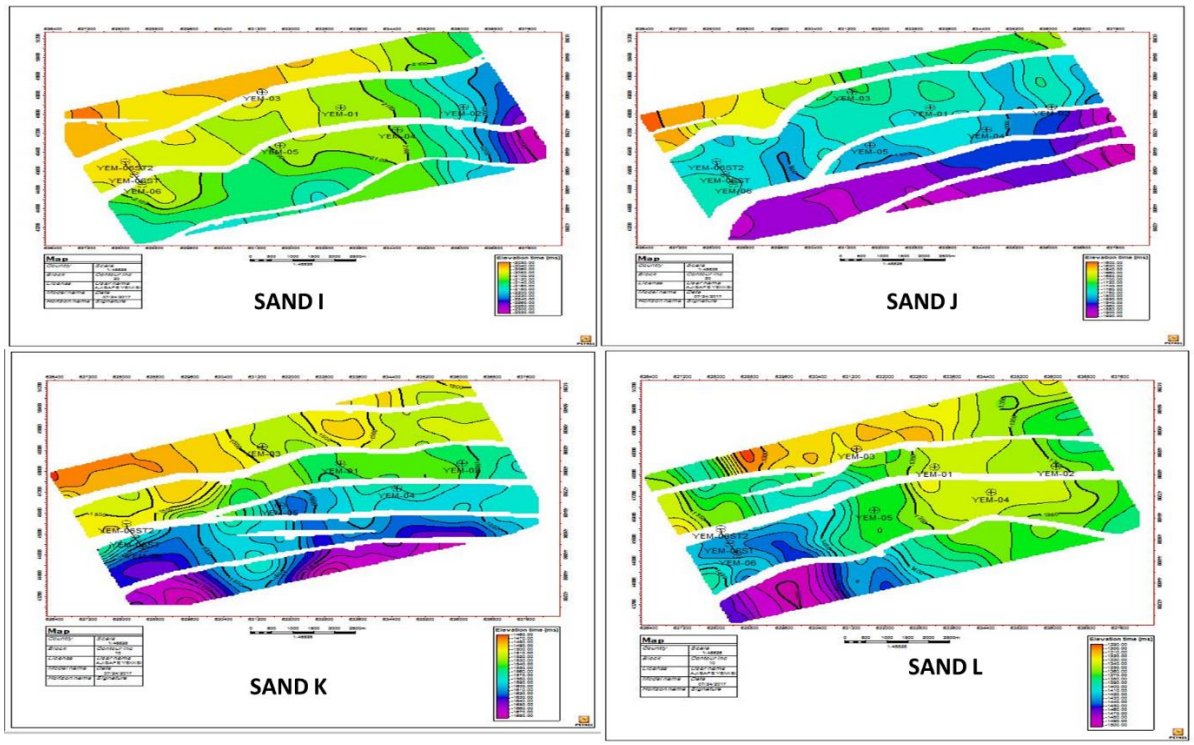

Figure 5: Time Structure Maps for Mapped Reservoirs

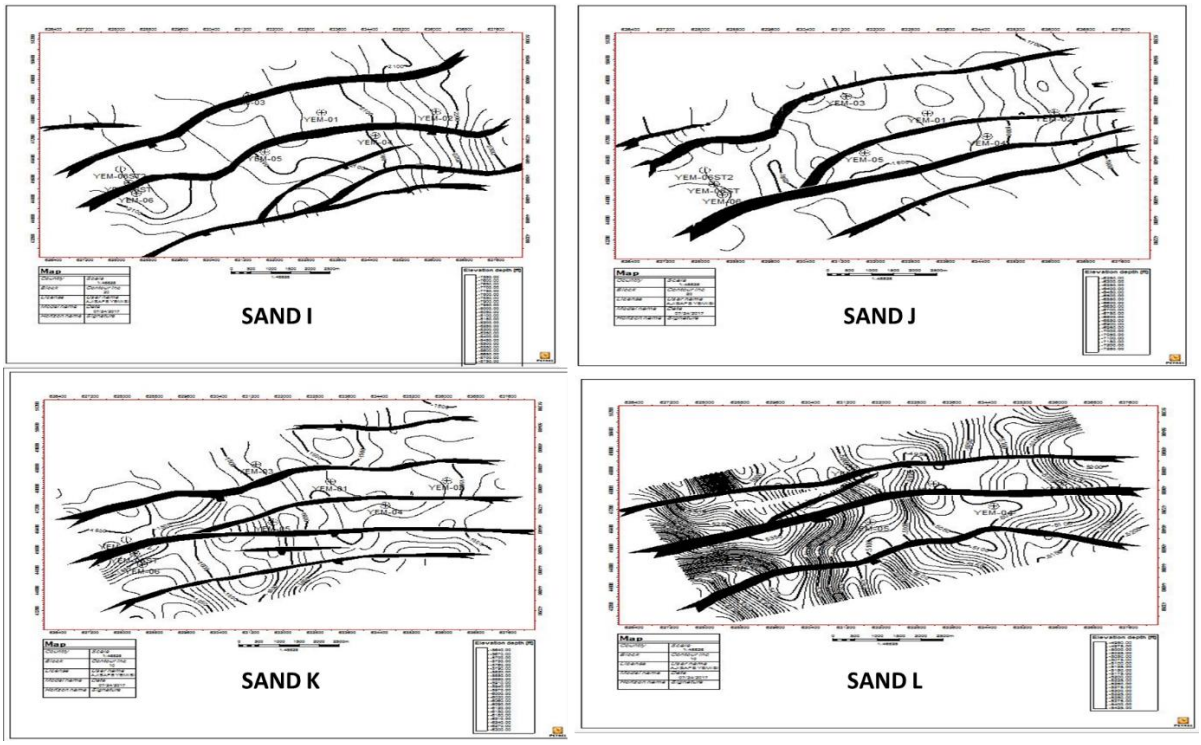

Figure 6: Depth Structure Maps for Mapped Reservoirs

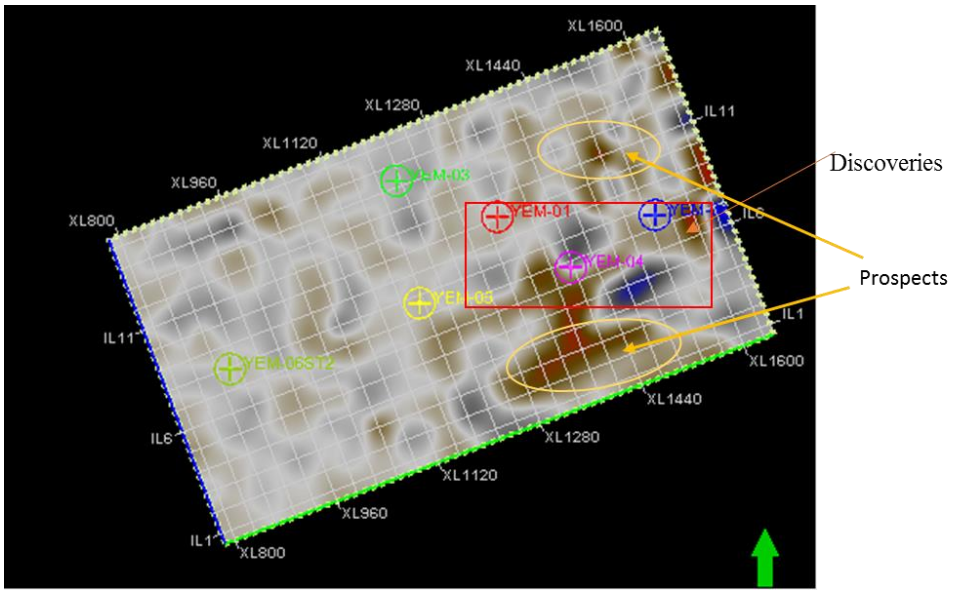

Figure 7: Time Slice at 1800ms showing the discoveries and delineated prospects

Table 2: Pertophysical properties of Reservoir L

GRV: Gross rock volume, NTG: Net-to-gross, S_w: Water saturation, S_h: Hydrocarbon saturation

	Area acres	Thickness ft	GRV ac-ft	Porosity	NTG	S_W	S_h
			LOW SIDE				
OIL CASE	610.53	48.15	29303.41	0.212	0.462	0.779	0.221
GAS CASE	610.53	48.15	29303.41	0.212	0.462	0.779	0.221
	Area acres	Thickness Ft	GRV ac-ft	Porosity	NTG	S_W	S_h
			MOST LIKELY LOW SIDE				
OIL CASE	911.23 3476.95	60.02 36.51	54670.52 86027.25	0.246 0.178	0.601 0.532	0.437 0.315	0.563 0.685
GAS CASE	911.23 3476.95	60.02 36.51	54670.52 86027.25	0.246 0.178	0.601 0.532	0.437 0.315	0.563 0.685
			HIGH SIDE MOST LIKELY				
OIL CASE	1184.51 19715.22	72.23 46.22	85286.04 164472.05	0.258 0.249	0.953 0.724	0.358 0.215	0.642 0.785
GAS CASE	1184.51 19715.22	72.23 46.22	85286.04 164472.05	0.258 0.249	0.953 0.724	0.358 0.215	0.642 0.785
			HIGH SIDE				
OIL CASE	6746.25	32.01	254103.35	0.281	0.805	0.167	0.833
GAS CASE	6746.25	32.01	254103.35	0.281	0.805	0.167	0.833

Table 3: Pertophysical properties of Reservoir K

GRV: Gross rock volume, NTG: Net-to-gross, S_w: Water saturation, S_h: Hydrocarbon saturation

Table 4: Pertophysical properties of Reservoir J

	Area acres	Thickness ft	GRV ac-ft	Porosity	NTG	S_W	S_h
			LOW SIDE				

OIL CASE	513.02	49.02	25138.31	0.245	0.211	0.627	0.373
GAS CASE	513.02	49.02	25138.31	0.245	0.211	0.627	0.373
			MOST LIKELY				
OIL CASE	765.73	57.60	44104.93	0.266	0.512	0.549	0.451
GAS CASE	765.73	57.60	44104.93	0.266	0.512	0.549	0.451
			HIGH SIDE				
OIL CASE	995.41	68.05	67688.84	0.272	0.692	0.488	0.512
GAS CASE	995.41	68.05	67688.84	0.272	0.692	0.488	0.512

GRV: Gross rock volume, NTG: Net-to-gross, S_w: Water saturation, S_h: Hydrocarbon saturation

Table 5: Pertophysical properties of Reservoir I

	Area acres	Thickness ft	GRV ac-ft	Porosity	NTG	S_W	S_h
			LOW SIDE				
OIL CASE	356.01	25.02	8899.13	0.233	0.236	0.024	0.976
GAS CASE	356.01	25.02	8899.13	0.233	0.236	0.024	0.976
			MOST LIKELY				
OIL CASE	531.34	31.13	16470.06	0.253	0.581	0.023	0.977
GAS CASE	531.34	31.13	16470.06	0.253	0.581	0.023	0.977
			HIGH SIDE				
OIL CASE	6907.24	40.04	27627.14	0.271	0.873	0.024	0.976
GAS CASE	6907.24	40.04	27627.14	0.271	0.873	0.024	0.976

GRV: Gross rock volume, NTG: Net-to-gross, S_w: Water saturation, S_h: Hydrocarbon saturation

Table 6: Table showing the Expected Ultimate Recovery (EUR) for Oil Scenario (MMBO)

Reservoir	Low side	Most likely	High side
L	5.70	16.32	34.86
K	0.93	4.87	11.41
J	0.79	3.16	6.37
I	0.78	2.63	5.44
EUR	8.15	26.98	58.08

Table 7: Table showing the Expected Ultimate Recovery (EUR) for Gas Scenario (BSCF)

Reservoir	Low side	Most likely	High side
L	13.05	41.87	103.76
K	1.54	14.40	47.80
J	1.30	8.80	24.69
I	1.30	7.82	24.64
EUR	17.19	72.89	200.89

Conclusion

The drive to sustain energy supply for consumption and generate returns for the company necessitate integrated study of reservoir architecture. The integration of seismic and well log data proved to be a

useful and important technique in the developmental evaluation of "YEMI" field using the Petrel software. The results obtained gave a better understanding of the structural configuration of the field, estimate of the volume in the reservoirs and location of new drill well opportunities. Correlating flooding surfaces across the eight wells in the field helped to identify and define four hydrocarbon bearing sands and thus see the lateral continuity of these sand units. A structural interpretation of the field revealed ten (10) faults, two (2) of which were regional and extensive throughout the survey area while the remaining eight (8) either died out or developed at some points. All the faults dip in the south direction. The well when tied to seismic showed a mistie which was bulkshifted such that the reservoir tops were either troughs or peaks and matched the right reflection on seismic. The resulting time maps were converted to depth maps using the YEM-01 checkshot which gave the least error. From the depth maps, discoveries were confirmed and prospects were identified. Petrophysical analysis of the reservoirs showed that the reservoirs generally have good net-to-gross, porosity and water saturation values which support their having a cumulative Estimated Ultimate Recovery (EUR) of between 8.15 to 58.08 MMBO if oil and 17.19 to 200.89 BSCF if gas.

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