

PLANT PATHOGEN DETECTION AND IDENTIFICATION METHODS: A REVIEW

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ABSTRACT

Many species of bacteria, viruses and fungi cause diseases in plants. These diseases causing pathogens cause major production and economic losses in agriculture and forestry. Accurate and robust detection and quantification of these pathogens is important in minimizing the disease induced damage to crops during growth, harvest and postharvest processing, as well as to maximize productivity and ensure agricultural sustainability. Currently, more and more diagnostic laboratories and inspection agencies are using molecular methods for detection and identification of diseases caused by plant pathogens. Better understanding of plant-pathogen interactions, pathogenicity factors, rapid and accurate detection of pathogens to species or strain level are a crucial prerequisite for disease surveillance and development of novel disease control strategies. Traditional, Serological and nucleic acid-based methods for detection and identification of plant pathogens are briefly described. The present review recognizes that quick and accurate detection of plant diseases can facilitate the control of the diseases through proper management strategies such as vector control through pesticide applications, fungicide applications, and disease-specific chemical applications; and can improve productivity.

Keywords: Serological, detection, quantification, pathogens, pathogenicity

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INTRODUCTION

Plant diseases cause major production and economic losses in agriculture and forestry (Sindhuja et al., 2010). Currently, over one billion people are suffering from different situations of malnutrition due to lack of food supply and approximately twice that population do not have access to sufficient nutrients or vitamins to meet their daily nutrition needs (Conway, 2012). The situation can be attributed to the continuous decline in agricultural land area that causes a decrease in productivity. Although decrease in agricultural productivity can be attributed to a variety of reasons, damage caused by pests and pathogens plays a significant role in crop losses throughout the world. The losses in crop yield due to pathogen infections range between 20% and 40% (Savary et al., 2012). Overall, the economic losses due to infections are estimated at 40 billion dollars annually in the United States alone (Pimentel et al., 2005, Roberts et al., 2006, Li et al., 2006). Global losses caused by crop diseases have been estimated to range from 9% to 14.2% of potential yield (Orke et al., 1994), the developing countries suffering more losses compared to developed countries (Agrios, 2005).

In phytopathology, early identification of the causative agent of disease is paramount in order to recognize the pathogen, and implement regulations involving control and quarantine (Atkins and Clark, 2004). In order to minimize the disease induced damage in crops during growth, harvest and postharvest processing, as well as to maximize productivity and ensure agricultural sustainability, advanced disease

detection and prevention in crops are highly important. This review discuss briefly the Traditional, Serological and Nucleic Acid methods for detection and identification of plant diseases

1.0 Traditional Method of plant disease diagnosis

Traditionally, diagnosis of plant diseases has been based on recognizing characteristic symptoms presented by diseased plants and looking for the presence of pathogens on their surface (McIntyr and Sands,1977). This, together with other observations and evaluation of the environmental conditions, generally allows the causative agent to be classified as a virus-like organism, a bacterium, a fungus or some environmental factor. Successful diagnosis of many fungal and bacterial plant diseases depends on a knowledge of plant pathology and experience in detecting and identifying the pathogen on the surface. In considering pathogen detection, problems can arise in particular disease-host combinations:

1. Many pathogens, particularly bacteria and fungi, spend part of their life cycles as pathogens and the remainder as saprophytes.
2. Pathogens may not be present on the surface; and it is then necessary to look for the pathogen inside the diseased plant, e.g. seed-borne pathogens.
3. Symptoms can be obscure, e.g. latent infections in potato ring rot (De Boer and McNaughton. 1986).
4. The occurrence and prevalence of plant pathogens usually vary from season to season, depending on the abundance of pathogens, their vectors, environmental conditions and the susceptibility of crops and varieties grown.

These among many other challenges limit the use of traditional methods in phytopathological studies.

2.0 Serological methods

Serology is the use of specific antibodies to detect their respective antigens in test samples. Serology as a method was first employed for bacteria detection, as early as in 1918. It is based on the immunological principle that foreign molecules (immunizing agent or antigens) injected into bloodstream of mammal stimulate its immune system to produce specific antibodies which recognize and bind to the antigens (Schaad 1987, Fox 1993). The antibodies recognize many chemical sites on target antigens and are known as polyclonal antibodies. Introduction of monoclonal antibodies has markedly improved specificity of serological tests as these antibodies recognize only one chemical site on target antigens

2.1 Antigens and antibodies

Proteins are the most important antigens for distinguishing pathogens such as viruses. The nucleic acid of a virus particle is enclosed in a protein coat which may have several epitopes. An **epitope** is a restricted part of a molecule which acts as an antigenic determinant. It has a three-dimensional structure complementary to that of the antigen binding site on the antibody. For protein antigens, epitopes comprise 5-7 amino acids.

2.2 Immunogenicity (the capacity of an antigen to induce an immune response) depends on the animal used, the method of immunization and the physicochemistry of the antigen molecule. The features of proteins which determine their immunogenicity and antigenic specificity are number of epitopes (there should be at least two per molecule), structure (they should have a stable 3-dimensional conformation that will expose the same epitopes on the exterior of the molecule) and nature of the epitopes as

determined by sequence of amino acids and conformation. Hidden epitopes (cryptotopes) may be exposed if the protein is denatured. Some epitopes may arise from the interaction of amino acids on neighbouring proteins (neotopes). It is possible for two proteins to have identical epitopes, but no other similarities and for them to cross-react in serological tests.

2.3 *Immuno-electron microscopy*

Direct observation of antigenic virus particles which have been either selectively bound to the membrane of an electron microscope grid by pretreating the membrane with antibody (immunosorbent electron microscopy or IEM) or by observing antibodies bound to the particles after they have been attached to the membrane (decoration) allows the serotype of particles to be determined. Thus rod-shaped particles may be assigned to the genus *Potyvirus* on the basis of their particle morphology (shape and size), whereas decoration may allow the virus to be identified to species level.

2.4 *Enzyme linked immunosorbent assay*

Amplification through the binding of an enzyme to the antibody has led to the development of a large range of sensitive methods for pathogen diagnosis. The most commonly used method is double-antibody sandwich (DAS) enzyme linked immunosorbent assay (ELISA) in which the antibody is adsorbed to the internal surface of a well in a polystyrene microtitre plate. A test sample is added and if antigens (virus particles, for example,) are present they will bind to the antibody. The wells are washed free of unbound contaminants

before an antibody combined with an enzyme such as alkaline phosphatase is added. The conjugant binds to the antigenic agent. Excess conjugant is washed from the wells and a chromogenic substrate is added.

2.5 *Immunofluorescence microscopy*

Immunofluorescence microscopy is a highly recommended immunodiagnostic method for bacteria detection (Van Vuurde 1987). Indirect (Malin *et al.* 1983) and direct (Franken and Van Vuurde 1990), immunofluorescence cell staining involves microscope detection under ultraviolet light of an antigen after staining with homologous antibody conjugated with a fluorescent dye (e.g. fluorescein isothiocyanate).

3.0 *Nucleic Acid Based Techniques*

Nucleic acids are responsible for information content transfer in all organisms. Among the tools available for pathogen detection, nucleic acid based techniques are widely recognized as one of the most useful and efficient methods for detection (Majumder *et al.*, 2013). Nucleic acid-based methods (using probes and/or PCR) have increasingly been used in recent years to develop diagnostic assays for plant pathogens (Schots *et al.*, 1994; Ward, 1994; Martin *et al.*, 2000). Molecular assays offer a promising alternative to routine methods by reducing the time to identification, increasing sensitivity, and enhancing laboratory safety. However, a lack of test standardization and limited validation data for many fungal nucleic acid tests has hindered their general acceptance and broad implementation into clinical laboratories (Wengenack, and Binnicker, 2009).

Nucleic acid based detection techniques, particularly those that rely on the PCR, typically are rapid, potentially very sensitive and highly specific (Majumder *et al.*, 2013; Ward *et al.*, 2004). Nucleic acid

hybridization assays involve the selection, cloning and chemical labeling of sequences specific to the target organism. These are then used as probes to detect RNA or DNA of the pathogen in extracts or tissue squashes of plant material. The assay may involve immobilization and detection of nucleic acid on a membrane or, in some instances, utilize a microplate format similar to that used in immunoassays (Umek *et al.*, 2001).

3.1 PCR-Based Assays

The polymerase chain reaction (PCR), is a technique introduced in the mid-1980's by Kary Mullis (1990). PCR is an in vitro method of nucleic acid synthesis by which a particular segment of DNA can be amplified which detect organism specific DNA/RNA sequence (Majumder *et al.*, 2013). The development of PCR technology relies on three fundamental steps: (1) the selection of a specific target region of DNA/RNA to identify the fungus, (2) extraction of total community DNA/RNA from the environmental sample and (3) a method to identify the presence of the target DNA/RNA region in the sample (Atkins and Clark, 2004). The procedure takes place in three essential steps: the initial melting of the double strands of the DNA follows the annealing (hybridization) of two synthetic oligonucleotides (primers) with sequences complimentary to the ends of the target fragment and the cycle is completed by the final primer extension (polymerization) by the DNA polymerase (Paplomatas, 2006). Although PCR is a highly sensitive technology, the presence of inhibitors in the plant tissues and soil, greatly reduces its sensitivity. The inhibitors are believed to interfere with the polymerase activity for amplification of the target DNA. Another problem with the conduct of PCR arises from the possible DNA contamination leading to false negative results (Narayanasamy, 2011). The internal

transcribed spacer (ITS) region has become a validated DNA barcode marker for the identification of many fungal species (Seifert, 2008). PCR is undoubtedly the most important technique in diagnostics and has found wide application as a powerful molecular tool mostly due to the development of thermo tolerant DNA polymerases and automated thermocyclers (Paplomatas, 2006). PCR is preferred over classical or other molecular techniques in the diagnosis of plant pathogens for a number of advantages that makes it very popular (Henson and French, 1993). PCR methods are easy to set up and have the advantage of requiring only minute amounts of starting material or template DNA. Although simple in concept, PCR methods have unrivaled, often overlooked complexity. The source of this complexity includes multi-ionic interactions, kinetic constants, enzymatic activities among others. These factors can repeatedly affect the reactants in a typically small PCR reaction volume over an extended time period. Despite these potential problems, many methods have been developed and are widely used.

3.2 Random amplified polymorphic DNA (RAPD)

In RAPD analysis, genomic or template DNA is primed at a low annealing temperature (30–38°C) with a single short oligonucleotide (ca. 10 bases) in the PCR. Multiple PCR products of different electrophoretic mobility are typically generated (Williams *et al.*, 1990). RAPD analysis detects two types of genetic variations: (i) in the length of DNA between the two primer binding sites, and (ii) in sequence variation at the priming regions. Nucleotide substitutions in the region of PCR primer binding, particularly at the 3' ends, can prevent binding of the primer to the DNA template. As a result, this band will be missing in a PCR reaction. Similarities in

banding profiles among strains can be calculated and used to infer strain relationships. When multiple primers are screened, RAPD analysis can be very sensitive to detect variation among isolates that cannot be observed using other methods. Furthermore, RAPD data are easy to interpret because they are based on amplification or non-amplification of specific DNA sequences (amplicons), producing a

binary data set that is easy to enter into a spreadsheet for analysis (McDonald, 1997). Although technically fast and simple, there are some disadvantages to RAPD. The major drawback is irreproducibility. Despite their drawbacks, RAPDs are powerful tools that are especially useful for fungi that are obligate parasites or that have a population structure composed of clonal lineages. (Xu, *et al.*, 2006, Binyam, 2015).

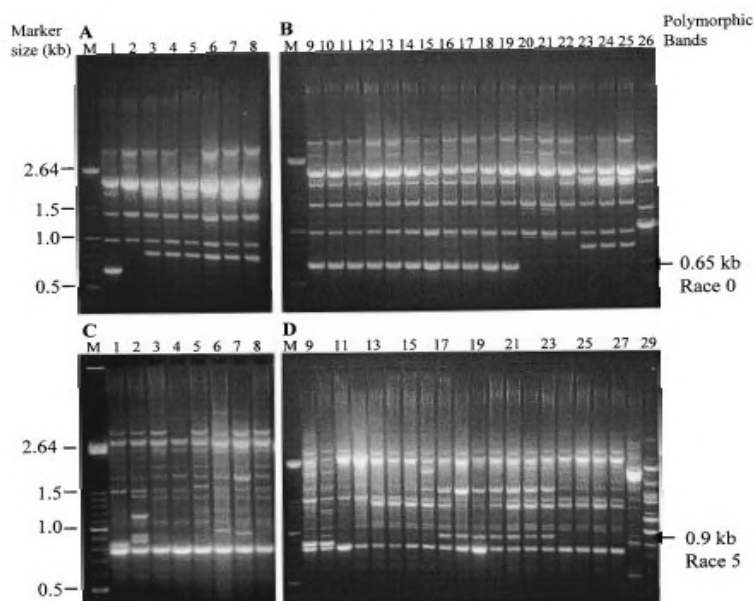


Figure1: RAPDs generated gel by primer OPF-16 (A, B) and OPF-10 (C, D) using a DNA bulk of *F. oxysporum f. sp. ciceris* isolates of a race (A, C) and DNA from individual isolates representative of the race (B, D). (Jimenez-Gasco *et al.*, 2001).

Restriction polymorphisms have been used to discriminate species and strains of fungi as well as other biological taxa. One approach is to digest genomic DNA with a restriction enzyme and directly examine the resulting bands in agarose or polyacrylamide gels after electrophoresis. Depending upon the size of the genome and the frequency of restriction recognition sites in the genome, it may be possible to directly compare digests of whole genomic DNAs from different species/strains. The efficiency of RFLP detection varied with the number of restriction fragments to which the probes hybridized (Tzeng *et al.*, 1992)

3.4 Amplified fragment length polymorphism (AFLP)

The development of amplified fragment length polymorphism (AFLP) method has had a significant impact in its relatively short history. AFLP is a powerful method for fingerprinting strains and for generating a large number of dominant markers for the analysis of genetic crosses (Vos *et al.*, 1995). AFLP usually involves two PCR steps. The first step is the pre-amplification step that uses unlabelled primers with single selective nucleotide in the primer. After the first step, the reaction mixtures are diluted

for second PCR amplifications. In the second amplification, additional selective nucleotides are often added to enhance specificity (Binyam, 2015, O'Brian *et al.*, 2003).

3.5 Single-strand conformation polymorphism (SSCP)

SSCP is a promising technique that allows efficient detection of nucleotide substitutions in short fragments (<100 bp) of DNA. SSCP analysis typically involves the amplification by PCR of a unique segment of genomic DNA, melting the PCR products, and running the single strands on a non-denaturing polyacrylamide gel (Hauser *et al.*, 1997). The detection system can be accomplished by either radioactive labeling of DNA during the PCR amplification step or by silver staining of DNA after gel electrophoresis. Polymorphic differences in strand mobility result from the effects of primary sequence changes on the folded structure of a single DNA strand. The success of any particular SSCP experiment depends heavily on the following two factors: (i) the particular DNA fragments being investigated, including the primary DNA sequence organization and the size of the DNA fragments, and (ii) the optimization of experimental conditions to maximize differential migration among fragments. Investigators have used a variety of methods to improve the resolving power of SSCP, including adding glycerol to polyacrylamide gels, reducing temperatures, and increasing the length of the gels or the duration of gel electrophoresis. Nonetheless, differentiation among polymorphic molecules on a polyacrylamide matrix is not entirely predictable, and the method can result in false negatives, ambiguous results and experimental artifacts. (Binyam 2015).

3.6 Real-time PCR

The process of quantifying target DNA has recently been simplified considerably with the advent of real-time PCR. This method avoids the usual need for post-reaction processing, as the amplified products are detected by a built-in fluorimeter as they accumulate. This is done by using non-specific DNA binding dyes (e.g. Sybr Green) or fluorescent probes that are specific to the target DNA (Wittwer *et al.*, 1997). The principle underlying real-time PCR is that the larger the amount of target DNA present in the sample being tested, the quicker the reaction progresses and enters the exponential phase of amplification. The amount of PCR amplicon produced at each cycle is measured, using the fluorescent dyes or probes, and for each sample tested the cycle threshold (Ct) is calculated. This is the cycle number at which a statistically significant increase in fluorescence is detected.

3.7 Immunodiagnostic Assay

This method though not nucleic acid based is commonly used today. The principal aim of an immunodiagnostic assay is to detect or quantify the binding of the diagnostic antibody with the target antigen. There are a number of different ways of detecting antibody/antigen binding, but often these involve coupling the antibody to an enzyme that can be used to generate a colour change when a substrate is added. Antibodies are molecules, produced by mammalian immune systems that are used to help identify invading organisms or substances. If antibodies can be generated that recognize specific antigens associated with a given plant pathogen they can be used as the basis of a diagnostic tool. The use of antibody technology is well established in medical diagnostics and interest in its use in plant pathology has been increasing over the last decade (Ward *et al.*, 2004).

CONCLUSION

Numerous detection methodologies are now available, but regardless of the approach, important questions need to be answered prior to their inclusion into experiments. These include sensitivity, accuracy, robustness, frequency of testing, and cost. Despite many novel technologies being available, challenges remain to identify as yet un-cultural fungi, to detect cryptic species, and to characterize the assemblage and diversity of fungal communities in different environments without bias. There is always a need to characterize fungi quickly and accurately. No one knows how many fungal species exist, but sequencing of environmental DNA may improve the accuracy of current estimates (Hawksworth, 2001).

REFERENCES

- Atkins, S. D. and Clark, I. M. (2004). Fungal molecular diagnostics: a mini review. *J. Appl. Genet.* 45(1):3-15.
- Bantiari, E. E., Goddwin, P.H. (1985). Detection of potato viruses S, X, Y, by enzyme-linked immunosorbent assay on nitrocellulose membranes (dot-ELISA). *Plant Disease* 69:202-205.
- Binyam T. (2015). A Review on Disease Detection, Pathogen Identification and Population Genetics in Fungi. *Journal of Biology, Agriculture and Healthcare*, 5: 6-20
- Boonham, N., Walsh, K., Mumford, R.A., Barker, I. (2000). Use of multiplex real-time PCR for the detection of potato viruses. *Bulletin*, 30:427-430.
- BOVE, J. M. (1984). Wall-less prokaryotes of plants. *Annual Review of Phytopathology* 22:361-396.
- Clark, M.F., Adams, A.N. (1977). Characteristics of the microplate method of enzyme-linked immunosorbent assay for the detection of plant viruses. *Journal of General Virology*, 34:475-483.
- Deboer. S. H., Mcnaughton, M. E. (1987). Monoclonal antibodies to the lipopolysaccharide of *Erwinia carotovora atroseptica* serogroup. *Phytopathology* 74, 1431-1434.
- Field, D., Eggert, L., Metzgar, D., Rose, R., Wills, C. (1996). Use of polymorphic short and clustered coding- region microsatellites to distinguish strains of *Candida albicans*. *Immunol. Med. Microbiol*, 15: 73-79
- Fox, R. T.V. (1993). Principles of Diagnostic Techniques in Plant Pathology. CAB International. University Press, Cambridge. Frison, 897pp
- Hauser, P.M., Francioli, P., Bille, J., Telenti, A., Blanc, D.S. (1997). Typing of *Pneumocystis carinii* f. sp. *hominis* by single-strand conformation polymorphism of four genomic regions. *J. Clin. Microbiol.* 35: 3086-3091.
- Heid., C.A., Stevens, J., Livak, K.J., Williams, P.M. (1996). Real time quantitative PCR. *Genome Res*, 6: 986-994.
- Henson, J.M., French, R. (1993). The polymerase chain reaction and plant disease diagnosis. *Annual Review of Phytopathology*, 31: 81-109.

- Hawksworth D. L. (2001). The magnitude of fungal diversity: the 1.5 million species estimate revisited. *Mycological Research* 105:1422–1432.
- Jimenez-Gasco, M.M., Perez-Artes, E., Jimenez-Diaz, R.M. (2001). Identification of pathogenic races 0, 1B/C, 5, and 6 of *Fusarium oxysporum* f. sp. *ciceris* with random amplified polymorphic DNA (RAPD). *European Journal of Plant Pathology*, 107: 237–248.
- Knoll, S., Mulfinger, S., Niessen, L., Vogel, R.F. (2002). Rapid preparation of *Fusarium* DNA from cereals for diagnostic PCR using sonification and an extraction kit. *Plant Pathol.* 51: 728–34.
- McDonald, B.A., Unpublished data. In: McDonald, B.A. (1997). The Population Genetics of Fungi: Tools and Techniques. *Phytopathol* 87:448-453.
- Majumder, D., Rajesh, T., Suting, E. G., Debbarma, A. (2013). Detection of seed borne pathogens in wheat: recent trends. *Australian Journal of Crop Science* 7(4): 500-507.
- Martin, R. R, James, D., Levesque, C.A. (2000). Impacts of molecular diagnostic technologies on plant disease management. *Annual Review of Phytopathology*, 38:207-239
- Martin, R.R., Bristow, P. R. (1988). A carlavirus associated with blueberry scorch disease. *Phytopathology* 78:1636--1640,
- McIntyr, j. I. and Sands, D.C. (1977). How disease is diagnosed. In *Plant Disease: An Advanced Treatise. Volume 1. How Disease is Managed* (J.G. Horsfall and E.B. Cowling. Eds), Academic Press, New York. pp.35-53.
- Meyling, N.V. (2008). *PCR-based characterisation of entomopathogenic fungi for ecological studies*. VegQure, Denmark. 543pp
- Narayanasamy, P. (2011). Microbial Plant Pathogens-Detection and Disease Diagnosis. *Fungal Pathogens*, Vol. 1. Springer Science, New York. 543pp
- O'Brian, G. R., Fakhoury, A. M. and Payne, G.A. (2003). Identification of genes differentially expressed during aflatoxin biosynthesis in *Aspergillus flavus* and *Aspergillus parasiticus*, *Fun. Gen. Biol.* 39: 118–27.
- Oerke, E. C. (2006). Crop losses to pests. *J. Agric. Sci.* 144: 31–43
- Olicio, R., Almeida, C.A., Seuanez, H.N. (1999). A rapid method for detecting and distinguishing clinically important yeasts by heteroduplex mobility assays (HMAs). *Mol. Cell Probes*, 13, 251–255
- Paplomatas, E.J. (2006). Molecular Diagnostics of Fungal Pathogens. Papers Presented in a Symposium* on “Molecular Diagnostic of Plant Pest Species” at the Ninth Arab Congress of Plant Protection held in Damascus, Syria, November 19-23. *Arab J. Pl. Prot.* 24: 147-158.
- Pimentel, D.; Zuniga, R.; Morrison, D. (2005) Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecol. Econ.* 52:273–288.
- Savary, S.; Ficke, A.; Aubertot, J., Hollier, C. (2012). Crop losses due to diseases and their implications for global food production losses and food security. *Food Security.* 4: 519–537.

- Schaad, N. W.; Frederick, R. D. (2002). Real-time PCR and its application for rapid plant disease diagnostics. *Can. J. Plant Pathol.* 24: 250–258
- Schaad, N.W., Berthier-Schaad, Y., Sechler, A., Knorr, D. (1999). Detection of *Clavibacter michiganensis subsp. sepedonicus* in potato tubers by BIO-PCR and an automated real-time fluorescence detection system. *Plant Disease*, 83:1095-1100.
- Schots, A., Dewey, F.M, Oliver, R. (1994). *Modern Assays for Plant Pathogenic Fungi: Identification, Detection and Quantification*. CAB International, Wallingford. 865pp
- Seifert, K.A. (2008). Integrating DNA barcoding into the mycological sciences. *Persoonia*, 21:162–166.
- Sindhuja, S., Ashish, M., Reza, E., Cristina. D. (2010). A review of advanced techniques for detecting plant diseases. *Computers and Electronics in Agriculture* 72: 1–13
- Tzeng, T.H., Lyngholm, L.K., Fordtv, C.F., Bronson, C.R. (1992). A Restriction Fragment Length Polymorphism Map and Electrophoretic Karyotype of the Fungal Maize Pathogen *Cochliobolus heterostrophus*. *Genetics*, 130: 81-96.
- Umek, R.M., Lin, S.W., Vielmetter, J., Terbrueggen, R.H., Irvine, B., Yu, C.J., Kayyem, J.F., Yowanto, H., Blackburn, G.F., Farkas, D.H., Chen, Y.P. (2001). Electronic detection of nucleic acids a versatile platform for molecular diagnostics, *J. Mol. Diag*, 3: 74–84
- Voller, A., Bidwell, D.E. (1985). Enzyme immunoassays. In *Alternative Immunoassays*, (W P Collins Ed.) John Wiley and Sons, Chichester, UK: pp. 77-86.
- Vos, P., Hogers, R., Bleeker, M., Reijans, M., van de Lee, T., Hornes, M., Frijters, A., Pot, J., Peleman, J., Kulper, M., Zabeau, M. (1995). AFLP: a new technique for DNA fingerprinting. *Nucl. Acids Res.* 23: 4407–4414.
- Ward, E. (1994). Use of the Polymerase Chain Reaction for identifying plant pathogens. In: *Ecology of Plant Pathogens*. (J P Blakeman and B Williamson Wallingford, Eds), CAB International, UK: pp. 143-160.
- Ward, E., Foster, S.J., Fraaije, B.A., Mccartney, H.A. (2004). Plant pathogen diagnostics: immunological and nucleic acid-based approaches. *Ann. appl. Biol*, 145:1-16.
- Wengenack, N.L., Binnicker, M.J. (2009). *Fungal Molecular Diagnostics*. Elsevier Inc. *Clin Chest Med*, 30:391–408.
- Williams, J.G. K., Kubelik, A.R., Livak, K.J., Rafalski, J.A., Tingey, S.V. (1990). DNA polymorphisms amplified by arbitrary primers are useful as genetic markers. *Nucl. Acids Res.* 18: 6531–6535.
- Wittwer, C.T., Herrmann, M.G., Moss, A.A., Rasmussen, A.P. (1997). Continuous fluorescence monitoring of rapid cycle DNA amplification. *BioTechniques*, 22:130-138.
- Xu, J. (2002). Mitochondrial DNA polymorphisms in the human pathogenic fungus *Cryptococcus neoformans*. *Curr. Genet.* 41:43–47

Xu, J., Kerrigan, R. W., Callac, P., Horgen, P.A., Anderson, J.B. (1997). The genetic structure of natural populations of *Agaricus bisporus*, the commercial mushroom. *J. Heredity* 88:482–494.

Xu, J., Kerrigan, R.W., Sonnenberg, A.S., Callac, P., Horgen, P.A., Anderson, J.B. (1998). Mitochondrial DNA variation in natural populations of the mushroom *Agaricus bisporus*. *Mol. Ecol.* 7:19–33.

Xu, J.R., Peng, Y.L., Dickman, M.B., Sharon, A. (2006). The Dawn of Fungal Pathogen Genomics. *Annu. Rev. Phytopathol.* 44:337–66

ESTIMATION OF PARAMETERS IN GENERALISED MODIFIED WEIGHTED WEIBULL DISTRIBUTION

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ABSTRACT

Different distributions have been developed by researchers in the recent times using the generalized beta distribution introduced by Mc-Donald (1984) and Jones (2004); to mix two or more distributions in order to generate more robust, flexible and versatile model. Therefore, this paper presents generalised modified weighted weibull distribution called the beta-modified weighted weibull (BMWV) distribution. We obtain the statistical properties such as generalized survival rate and hazard rate function; and derive expressions for the r th moment and moment generating function. Also, maximum likelihood estimation is used to obtain the parameter estimates and

the flexibility of the BMWV distribution is illustrated by applying it to a river flood data set.

Keywords: beta-modified weighted weibull, flexible, moment, generating function

1.0 INTRODUCTION

The use of generalized beta distribution was introduced by Mc-Donald (1984) and Jones (2004) and immediately after this approach, several works by authors have been done base on this approach. Azzalini (1985) introduced a method of obtaining weighted distributions from independently identically distributed (*i.i.d.*) random variables Y_1 and Y_2 based on the expression

$$f_Y(y) = \frac{1}{P(\alpha X_1 > X_2)} f_Y(y) F_Y(\alpha y), \alpha > 0 \quad (1.1)$$

where $f(y)$ and $F(y)$ were the *pdf* and *cdf* of Y respectively and α was an unknown parameter.

Ramadan (2013) slightly modified Azzalini's approach to obtain a new class of Weighted Weibull (WW) distribution defined both the density and distribution function as

$$f_{Y|\{\lambda, \beta, \alpha\}}(y) = \frac{\lambda \beta (1 + \alpha^\beta) y^{\beta-1} \exp(-(\lambda y^\beta)) \exp(-\lambda (\alpha y)^\beta)}{\alpha^\beta}, \text{ for } y > 0 \quad (1.2)$$

and

$$F_{WW\{\lambda, \beta, \alpha\}}(y) = \frac{1}{\alpha^\beta} [(1 + \alpha^\beta)(1 - \exp(-(\lambda y^\beta))) + \exp(-(\lambda y^\beta))(1 + \alpha^\beta) - 1] \quad (1.3)$$

where, λ is scale parameter, β is shape parameter and α is weight parameter.

Again, Aleem et al. (2013) completely modified Ramadan's work by introducing

two shape parameters which they called a class of modified Weighted Weibull (MWW) distribution and the pdf is given as

$$f_{MWW\{\beta, \gamma, \theta, \alpha\}}(y) = \beta \gamma (c \theta^\gamma + 1) y^{\gamma-1} \exp(-\beta (c \theta^\gamma + 1) y^\gamma) \quad (1.4)$$

And the corresponding cdf

$$F_{BMW|(\beta,\gamma,\theta,c)}(Y) = 1 - \exp(-\beta(c\theta^\gamma + 1)Y^\gamma) \quad (1.5)$$

where, β is scale parameter, γ shape parameter, θ and c are shape parameters.

2.0 MATERIAL AND METHOD

2.1 The Beta-modified Weighted Weibull (BMW) Distribution

2.1.1 The Density Function of BMW Distribution

In this article, we also introduce shape parameter(s) to the Aleem's work in order to generate more skewed distribution called BMW distribution. This is done by employed the logit of beta function of Jones, which several works have been done base on this approach. For instance: Nadarajah and Kotz (2004) introduced beta Gumbel distribution, Famoye et al. (2005)

investigated on the beta weibull distribution, Nadarajah and Kotz (2006) studied the beta exponential, Lee et al. (2007) also worked on beta weibull distribution, it properties and applications. Badmus et al. (2014) introduced Lehmann type II weighted weibull distribution, Badmus and Bamiduro (2014) worked on some properties of exponentiated weighted weibull distribution and Badmus and Bamiduro (2014) discussed life length of components estimates with Beta-weighted weibull distribution.

The beta link function is given as:

$$k(y) = \frac{1}{B(a,b)} [K(y)]^{a-1} [1 - K(y)]^{b-1} k(y), a, b > 0 \quad (2.1)$$

where,

$a, b, y > 0$ are shape parameters, $k(y)$ and $K(y)$ are pdf and cdf respectively of base distribution (modified weighted weibull).

Now, we substitute expressions in (1.4) and (1.5) to obtain the density function of BMW as follows:

$$k_{BMW|(\beta,\gamma,\theta,c,a,b)}(y) = B(a,b)^{-1} [F_{BMW}(y)]^{a-1} [1 - F_{BMW}(y)]^{b-1} f_{BMW}(y), \\ \beta, \gamma, \theta, c, a, b \approx BMW(\beta, \gamma, \theta, c, a, b, y > 0) \quad (2.2)$$

$$k_{BMW|(\beta,\gamma,\theta,c,a,b)}(y) = B(a,b)^{-1} [1 - \exp(-\beta(c\theta^\gamma + 1)Y^\gamma)]^{a-1}$$

$$[\exp(-\beta(c\theta^\gamma + 1)Y^\gamma)]^{b-1} \beta \gamma (c\theta^\gamma + 1) y^{\gamma-1} \exp(-\beta(c\theta^\gamma + 1)Y^\gamma) \quad (2.3)$$

where, $f_{BMW}(y)$ and $F_{BMW}(y)$ is the pdf and cdf of base distribution. Expression

(2.2) becomes the pdf of proposed BMW distribution with six parameters.

Again, we let

$$Q(y) = F_{BMW}(y) = 1 - \exp(-\beta(c\theta^\gamma + 1)Y^\gamma)$$

and we get

$$\frac{dQ}{dy} = [f_{BMW}(y)] [F_{BMW}(y)] \quad (2.4)$$

Also expression (2.2) becomes

$$k_{BMW|(\beta,\gamma,\theta,c,a,b)}(y) = B(a,b)^{-1} [Q(y)]^{a-1} [1 - Q(y)]^{b-1} dQ(y) \quad (2.5)$$

2.1.2 Cumulative Distribution Function (CDF)

Using the expression in (2.5), the cdf of BMWW variable Y is given by

$$K_{BMWW}(y) = \int_0^y k_{BMWW}(y) = B(\alpha, b)^{-1} \int_0^y [Q(y)]^{\alpha-1} [1 - Q(y)]^{b-1} dQ(y) \quad (2.6)$$

$$K_{BMWW}(y) = \frac{B(y; \alpha, b)}{B(\alpha, b)} \quad (2.7)$$

2.1.3 The Reliability Function

The reliability function $R_{BMWW}\{\beta, \gamma, \theta, c, \alpha, b\}$ of a random $BMWW(\beta, \gamma, \theta, c, \alpha, b)$ variable Y with cdf $K(y)$ is defined as

$$R_{BMWW}\{\beta, \gamma, \theta, c, \alpha, b\}(y) = 1 - K_{BMWW}(y) \quad (2.8)$$

$$R_{BMWW}\{\beta, \gamma, \theta, c, \alpha, b\}(y) = \frac{B(\alpha, b) - B(y; \alpha, b)}{B(\alpha, b)} \quad (2.9)$$

2.1.4 The Hazard Rate Function

The hazard rate function $H_{BMWW}\{\beta, \gamma, \theta, c, \alpha, b\}$ of a random $BMWW(\beta, \gamma, \theta, c, \alpha, b)$ variable Y with cdf $K(y)$ is given by

$$H_{BMWW}\{\beta, \gamma, \theta, c, \alpha, b\}(y) = \frac{k_{BMWW}\{\beta, \gamma, \theta, c, \alpha, b\}(y)}{1 - K_{BMWW}\{\beta, \gamma, \theta, c, \alpha, b\}(y)} \quad (2.10)$$

Substituting equations (2.5) and (2.9) yields

$$H_{BMWW}\{\beta, \gamma, \theta, c, \alpha, b\}(y) = \frac{[Q(y)]^{\alpha-1} [1 - Q(y)]^{b-1} dQ(y)}{B(\alpha, b) - B(y; \alpha, b)} \quad (2.11)$$

2.1.5 The Reversed Hazard Function

The reserved hazard function $r_{BMWW}\{\beta, \gamma, \theta, c, \alpha, b\}$ of a random $BMWW(\beta, \gamma, \theta, c, \alpha, b)$ variable Y with cdf $K(y)$ is given by

$$r_{BMW\mathcal{W}}\{\beta, \gamma, \theta, c, a, b\}(y) = \frac{k_{BMW\mathcal{W}}\{\beta, \gamma, \theta, c, a, b\}(y)}{K_{BMW\mathcal{W}}\{\beta, \gamma, \theta, c, a, b\}(y)} \quad (2.12)$$

Also, putting equations (2.5) and (2.7) in expression (2.12), we then get

$$r_{BMW\mathcal{W}}\{\beta, \gamma, \theta, c, a, b\}(y) = \frac{[Q(y)]^{a-1}[1-Q(y)]^{b-1}dQ(y)}{B(y; a, b)} \quad (2.13)$$

2.2 Some Reductions of the Generalized Modified Weighted Weibull Distribution

2.2.1 Some new distributions emanate from the BMWW distribution depending on the values of the parameter; these include:

- When $\gamma = 1$ in expression (2.3) the distribution becomes Beta Modified Weighted Exponential (BMWE) distribution. (New)

$$k_{BMWE|\{\beta, 1, \theta, c, a, b\}}(y) = B(a, b)^{-1}[1 - \exp(-\beta(c\theta + 1)y)]^{a-1} \\ [\exp(-\beta(c\theta + 1)y)]^{b-1}\beta(c\theta + 1)\exp(-\beta(c\theta + 1)y) \quad (2.14)$$

- If $\gamma = 2$ in expression (2.3) the distribution reduces to Beta Modified Weighted Rayleigh (BMWR) distribution. (New)

$$k_{BMWE|\{\beta, 2, \theta, c, a, b\}}(y) = B(a, b)^{-1}[1 - \exp(-\beta(c\theta^2 + 1)y^2)]^{a-1} \\ [\exp(-\beta(c\theta^2 + 1)y^2)]^{b-1}\beta 2(c\theta^2 + 1)\exp(-\beta(c\theta^2 + 1)y^2) \quad (2.15)$$

- Setting $a = 1$ in (2.3) we get Lehmann Type II Modified Weighted Weibull (LMWW) distribution (New)

$$k_{LMWW|\{\beta, \gamma, \theta, c, 1, b\}}(y) = b[\exp(-\beta(c\theta^\gamma + 1)y^\gamma)]^{b-1} \\ \beta\gamma(c\theta^\gamma + 1)y^{\gamma-1}\exp(-\beta(c\theta^\gamma + 1)y^\gamma) \quad (2.16)$$

- Putting $b = 1$ in (2.3) we obtain Exponentiated Modified Weighted Weibull (EMWW) distribution (New)

$$k_{EMWW|\{\beta, \gamma, \theta, c, \alpha, 1\}}(y) = \alpha [1 - \exp(-\beta(c\theta^\gamma + 1)y)]^{\alpha-1} \beta \gamma (c\theta^\gamma + 1) y^{\gamma-1} \exp(-\beta(c\theta^\gamma + 1)y^\gamma) \quad (2.17)$$

- Again, if $\alpha = 1$ and $\gamma = 2$ in expression (2.3) the distribution reduces to Lehmann Type II Modified Weighted Rayleigh (LMWR) distribution. (New)

$$k_{LMWR|\{\beta, 2, \theta, c, 1, b\}}(y) = b [\exp(-\beta(c\theta^2 + 1)y^2)]^{b-1} \beta 2 (c\theta^2 + 1) \exp(-\beta(c\theta^2 + 1)y^2) \quad (2.18)$$

- Also, when $b = 1$ and $\gamma = 2$ in expression (2.3) the distribution becomes Exponentiated Modified Weighted Rayleigh (EMWR) distribution. (New)

$$k_{EMWR|\{\beta, 2, \theta, c, \alpha, 1\}}(y) = \alpha [1 - \exp(-\beta(c\theta^2 + 1)y^2)]^{\alpha-1} \beta 2 (c\theta^2 + 1) \exp(-\beta(c\theta^2 + 1)y^2) \quad (2.18)$$

- For $\alpha = 1$ and $\gamma = 1$ in expression (2.3) the distribution becomes Lehmann Type II Modified Weighted Exponential (LMWE) distribution. (New)

$$k_{LMWE|\{\beta, 1, \theta, c, 1, b\}}(y) = b [\exp(-\beta(c\theta + 1)y)]^{b-1} \beta (c\theta + 1) \exp(-\beta(c\theta + 1)y) \quad (2.19)$$

- Hence, $b = 1$ and $\gamma = 1$ in expression (2.3) the distribution reduces to Exponentiated Modified Weighted Exponential (EMWE) distribution. (New)

$$k_{EMWE|\{\beta, 1, \theta, c, \alpha, 1\}}(y) = \alpha [1 - \exp(-\beta(c\theta + 1)y)]^{\alpha-1} \beta (c\theta + 1) \exp(-\beta(c\theta + 1)y) \quad (2.20)$$

Summary of Some New Distributions Emanate from BMWW Distribution

Distribution/Parameter	α	b	β	c	θ	γ
BMWE	--	--	--	--	--	1
BMWR	--	--	--	--	--	2
LMWW	1	--	--	--	--	--
EMWW	--	1	--	--	--	--
LMWR	1	--	--	--	--	2
EMWR	--	1	--	--	--	2
LMWE	1	--	--	--	--	1

EMWE	--	1	--	--	--	1
------	----	---	----	----	----	---

3.0 Moments and Generating Function

3.1 Generating Function

We followed the works of Hosking (1990) which was also used in Badmus et al. (2015; still in press) to derived the moment generating function of our generalized Beta Modified Weighted Weibull (BMWW)

distribution and we obtain the moment generating function (MGF) of beta generated distributions. The MGF $M(t) = E(e^{ty})$ was given as

$$M(t) = \frac{1}{B(a,b)} \sum_{i=0}^{\infty} (-1)^i \binom{b-1}{i} \int_{-\infty}^{\infty} e^{ty} [F_{BMWW}(y)]^{a(i+1)-1} f_{BMWW}(y) dy \quad (3.1)$$

Substituting $pdf f_{BMWW}(y)$ and $cdf F_{BMWW}(y)$ as defined in equations (1.4) and (1.5) above into the MGF $M(t)$ in equation (3.1) gave

$$M_{BMWW}(t) = \frac{1}{B(a,b)} \sum_{i=0}^{\infty} (-1)^i \binom{b-1}{i} \int_{-\infty}^{\infty} e^{ty} [1 - \exp(-\beta(c\theta^y + 1)y^y)]^{a(i+1)-1} [\beta\gamma(c\theta^y + 1)y^{y-1} \exp(-\beta(c\theta^y + 1)y^y)] dy \quad (3.2)$$

3.2 Moments

Aleem et al. (2013) gave the r^{th} noncentral moment of the class of Modified Weighted Weibull distribution $MWW(\beta, \gamma, c, \theta)$ as

$$\mu'_{MWWr} = E(Y^r) = \gamma(c\theta^y + 1)\beta^{-\frac{r}{\gamma}} \Gamma\left(\frac{r}{\gamma} + 1\right) (c\theta^y + 1)^{-\frac{r}{\gamma}-1} \quad (3.3)$$

The r^{th} noncentral moment of the Beta Modified Weighted Weibull distribution would be given as

$$\mu'_{BMWW(r)} = \int_0^{\infty} y^r f_{BMWW}(y) dy$$

i.e.

$$\mu'_{BMWW(r)} = \int_0^{\infty} y^r \left\{ \frac{1}{B(a,b)} [Q(y)]^{a-1} [1 - Q(y)]^{b-1} dQ(y) \right\}$$

where

$$Q(y) = 1 - \exp(-\beta(c\theta^y + 1)y^y), u(y) = e^{-\beta y^y}, \psi = (c\theta^y + 1)$$

Then,

$$\mu'_{BMWV(r)} = \left[\frac{\gamma(\psi)\beta^{-\frac{r}{\gamma}}\Gamma\left(\frac{r}{\gamma}+1\right)(\psi)^{-\frac{r}{\gamma}-1}}{B(a,b)} \right] \sum_{i=0}^{\infty} (-1)^i \binom{b-1}{i} \left\{ \int_0^{\infty} [1-u(y)(\psi)]^{\alpha(i+1)-1} dy \right\}$$

$$= W \left[\gamma(\psi)\beta^{-\frac{r}{\gamma}}\Gamma\left(\frac{r}{\gamma}+1\right)(\psi)^{-\frac{(r+\gamma)}{\gamma}} \right] \quad (3.4)$$

see Ramadan (2013)

where $W = \frac{\sum_{i=0}^{\infty} (-1)^i \binom{b-1}{i} \int_0^{\infty} [1-u(y)(\psi)]^{\alpha(i+1)-1} dy}{B(a,b)},$

We obtained the first four non-central moments μ'_r , by putting $r = 1, 2, 3$ and 4 respectively in equation 3.2.2; i.e. μ'_1 is given as

$$\mu'_1 = E_{BMWV}(y) = \left[\frac{\gamma(\psi)\beta^{-\frac{1}{\gamma}}\Gamma\left(\frac{1}{\gamma}+1\right)(\psi)^{-\frac{(1+\gamma)}{\gamma}}}{B(a,b)} \right] \left[\sum_{i=0}^{\infty} (-1)^i \binom{b-1}{i} \right]$$

Also, central moments $\mu_r, r = 1, 2, 3, 4, \dots$ are related to noncentral moments μ'_r as

$$\mu_r = \sum_{k=0}^r \binom{r}{k} \mu'_{r-k} \mu_k', \text{ where } \mu'_1 = \mu \text{ and } \mu'_0 = 1 \quad (3.5)$$

Consequently, the mean and variance, third, and forth moments of the BMWV distribution are given as

$$\mu = \mu'_1$$

$$\mu_2 = \mu'_2 - \mu^2$$

$$\mu_3 = \mu'_3 - 3\mu\mu'_2 + 2\mu^3 \text{ and}$$

$$\mu_4 = \mu'_4 - 4\mu\mu'_3 + 6\mu^2\mu'_2 - 3\mu^4$$

where,

$$\mu'_1 = W \left[\gamma(\psi) \beta^{-\frac{2}{\gamma}} \Gamma\left(\frac{1+\gamma}{\gamma}\right) (\psi)^{-\frac{(1+\gamma)}{\gamma}} \right] \quad (3.6)$$

$$\mu'_2 = W \left[\gamma(\psi) \beta^{-\frac{2}{\gamma}} \Gamma\left(\frac{2+\gamma}{\gamma}\right) (\psi)^{-\frac{(2+\gamma)}{\gamma}} \right] = 2W \left[\gamma(\psi) \beta^{-\frac{2}{\gamma}} \Gamma\left(\frac{2+\gamma}{\gamma}\right) (\psi)^{-\frac{(2+\gamma)}{\gamma}} \right] \quad (3.7)$$

$$\mu'_3 = W \left[\gamma(\psi) \beta^{-\frac{2}{\gamma}} \Gamma\left(\frac{3+\gamma}{\gamma}\right) (\psi)^{-\frac{(3+\gamma)}{\gamma}} \right] = 6W \left[\gamma(\psi) \beta^{-\frac{2}{\gamma}} \Gamma\left(\frac{3+\gamma}{\gamma}\right) (\psi)^{-\frac{(3+\gamma)}{\gamma}} \right] \quad (3.8)$$

$$\mu'_4 = W \left[\gamma(\psi) \beta^{-\frac{2}{\gamma}} \Gamma\left(\frac{4+\gamma}{\gamma}\right) (\psi)^{-\frac{(4+\gamma)}{\gamma}} \right] = 24W \left[\gamma(\psi) \beta^{-\frac{2}{\gamma}} \Gamma\left(\frac{4+\gamma}{\gamma}\right) (\psi)^{-\frac{(4+\gamma)}{\gamma}} \right] \quad (3.9)$$

Moments measures of Skewness, λ_1 and of excess kurtosis, λ_2 , are respectively given as

$$\lambda_1 = \frac{\mu_3}{\sqrt[3]{\mu_2^3}} \quad (3.10)$$

$$\lambda_2 = \frac{\mu_4}{\mu_2^2} - 3 \quad (3.11)$$

4.0 Parameter Estimation

Following the study of Cordeiro et al. (2011) involving the log-likelihood function. We derived the maximum likelihood estimation (MLEs) of the parameter of $BMW(\beta, \gamma, \theta, c, a, b)$ distribution and

from Badmus et al. (2015); setting $\omega = (a, b, q, \varphi)$, where $\varphi = (\beta, \gamma, \theta, c)$ where φ is a vector of parameters. We had the likelihood

$$L_{BMW}(\omega) = n \log q - n \log [B(a, b)] + \sum_{i=1}^n \log [f(y; \omega)] + (a-1) \sum_{i=1}^n \log [F(y; \omega)] \\ (b-1) \sum_{i=1}^n \log [1 - F(y; \omega)] \quad (4.1)$$

$$L_{BMW}(\omega) = Const - n \log [B(a, b)] + \sum_{i=1}^n \log [f(y; \omega)] \\ + (a-1) \sum_{i=1}^n \log [F(y; \omega)] (b-1) \sum_{i=1}^n \log [1 - F(y; \omega)] \quad (4.2)$$

Taking partial derivative of (4.2) with respect to $(a, b, \beta, \gamma, \theta, c)$, we obtain

$$\frac{\partial L_{BMWV}(\omega)}{\partial a} = -n \log(a, b) + (a - 1) \sum_{y=1}^n \log[F(y; \omega)] \quad (4.3)$$

$$\frac{\partial L_{BMWV}(\omega)}{\partial b} = -n \log(a, b) + (b - 1) \sum_{y=1}^n \log[1 - F(y; \omega)] \quad (4.4)$$

$$\begin{aligned} \frac{\partial L_{BMWV}(\omega)}{\partial \beta} &= \sum_{y=1}^n \log \left[\frac{\frac{\partial}{\partial \beta} [f(y; \omega)]}{f[(y; \omega)]} \right] + (a - 1) \sum_{y=1}^n \log \left[\frac{\frac{\partial}{\partial \beta} [F(y; \omega)]}{F(y; \omega)} \right] + (b - \\ &1) \sum_{y=1}^n \log \left[\frac{\frac{\partial}{\partial \beta} [1 - F(y; \omega)]}{1 - F(y; \omega)} \right] \end{aligned} \quad (4.5)$$

$$\begin{aligned} \frac{\partial L_{BMWV}(\omega)}{\partial \gamma} &= \sum_{y=1}^n \log \left[\frac{\frac{\partial}{\partial \gamma} [f(y; \omega)]}{f[(y; \omega)]} \right] + (a - 1) \sum_{y=1}^n \log \left[\frac{\frac{\partial}{\partial \gamma} [F(y; \omega)]}{F(y; \omega)} \right] + (b - \\ &1) \sum_{y=1}^n \log \left[\frac{\frac{\partial}{\partial \gamma} [1 - F(y; \omega)]}{1 - F(y; \omega)} \right] \end{aligned} \quad (4.6)$$

$$\begin{aligned} \frac{\partial L_{BMWV}(\omega)}{\partial \theta} &= \sum_{y=1}^n \log \left[\frac{\frac{\partial}{\partial \theta} [f(y; \omega)]}{f[(y; \omega)]} \right] + (a - 1) \sum_{y=1}^n \log \left[\frac{\frac{\partial}{\partial \theta} [F(y; \omega)]}{F(y; \omega)} \right] + (b - \\ &1) \sum_{y=1}^n \log \left[\frac{\frac{\partial}{\partial \theta} [1 - F(y; \omega)]}{1 - F(y; \omega)} \right] \end{aligned} \quad (4.7)$$

$$\begin{aligned} \frac{\partial L_{BMWV}(\omega)}{\partial c} &= \sum_{y=1}^n \log \left[\frac{\frac{\partial}{\partial c} [f(y; \omega)]}{f[(y; \omega)]} \right] + (a - 1) \sum_{y=1}^n \log \left[\frac{\frac{\partial}{\partial c} [F(y; \omega)]}{F(y; \omega)} \right] + (b - \\ &1) \sum_{y=1}^n \log \left[\frac{\frac{\partial}{\partial c} [1 - F(y; \omega)]}{1 - F(y; \omega)} \right] \end{aligned} \quad (4.8)$$

Equations (4.3) to (4.8) can be solved using iteration method (Newton Raphson) to obtain $\hat{a}, \hat{b}, \hat{\beta}, \hat{\gamma}, \hat{\theta}, \hat{c}$ the MLE of $(a, b, \beta, \gamma, \theta, c)$ respectively.

of Wheaton River flood data and is given below:

5.0 APPLICATION TO REAL DATA

5.1 Exceedance River Flood Data

In this section, we compare the results of fitting the BMWV and Modified Weighted Weibull (MWW) distribution to the data set analyzed by Choulakian and Stephens (2011). The data consists of 72 Exceedances

1.7, 2.2, 14.4, 1.1, 0.4, 20.6, 5.3, 0.7, 13.0, 12.0, 9.3, 1.4, 18.7, 8.5, 25.5, 11.6, 14.1, 22.1, 1.1, 2.5, 14.

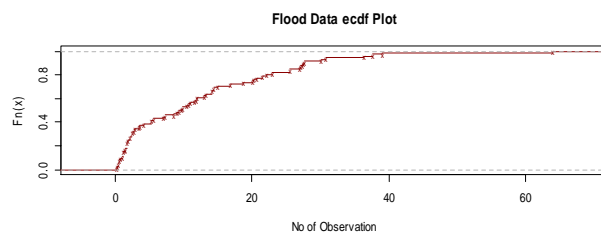
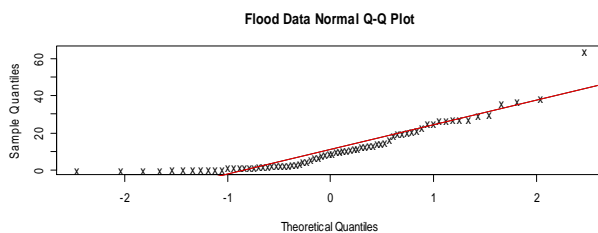
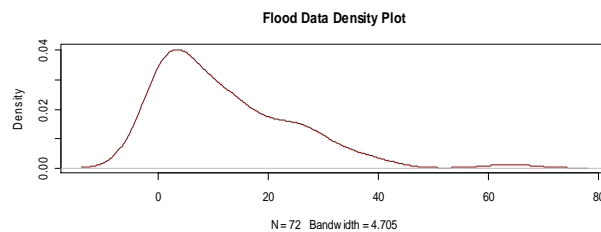
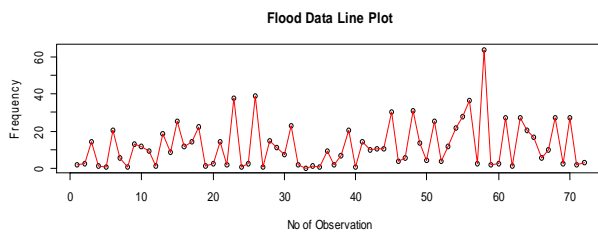
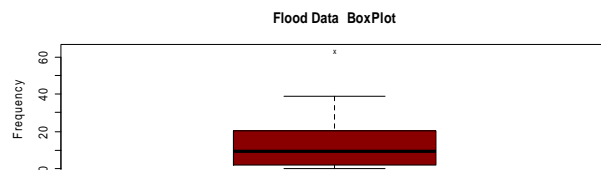
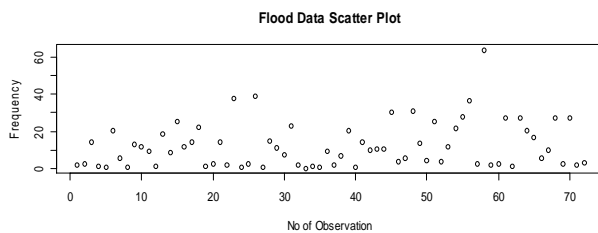
4,1.7,37.6,0.6,2.2,39.0,0.3,15.0,11.0,7.3,22.9
 ,1.7,0.1,1.1,0.6,9.0,1.7,7.0,20.1,0.4,14.1,9.9,
 10.4,10.7,30.0,3.6,5.6,30.8,13.3,4.2,25.5,3.4,

11.9,21.5,27.6,36.4,2.7,64.0,1.5,2.5,27.4,1.0,
 27.1,20.2,16.8,5.3,9.7,27.5,2.5,27.0,1.9,2.8.

Therefore, the data exploratory data analysis is presented as follows:

5.1.1 Summary: Descriptive Statistics

Min	1st Qut.	Median	Mean	3rd Qut.	Max	Skewness	Kurtosis
0.100	2.125	9.500	12.200	20.120	64.00	1.472508	5.889549



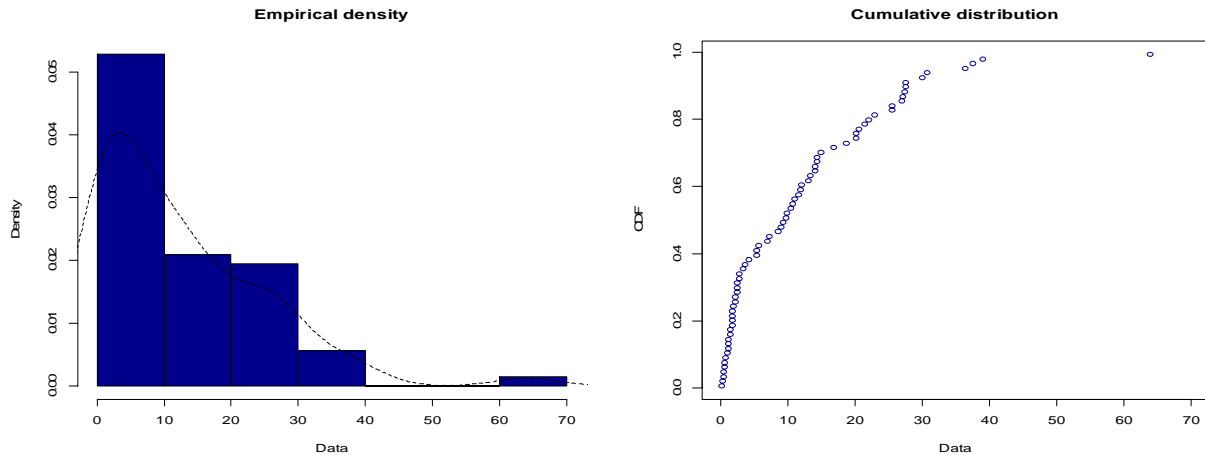


Figure 1: Contains flood data scatter plot, line plot, normal QQ plot, box-plot, Empirical density and cumulative distribution.

5.2 Result: Graphs of BMWW and MWW Distribution

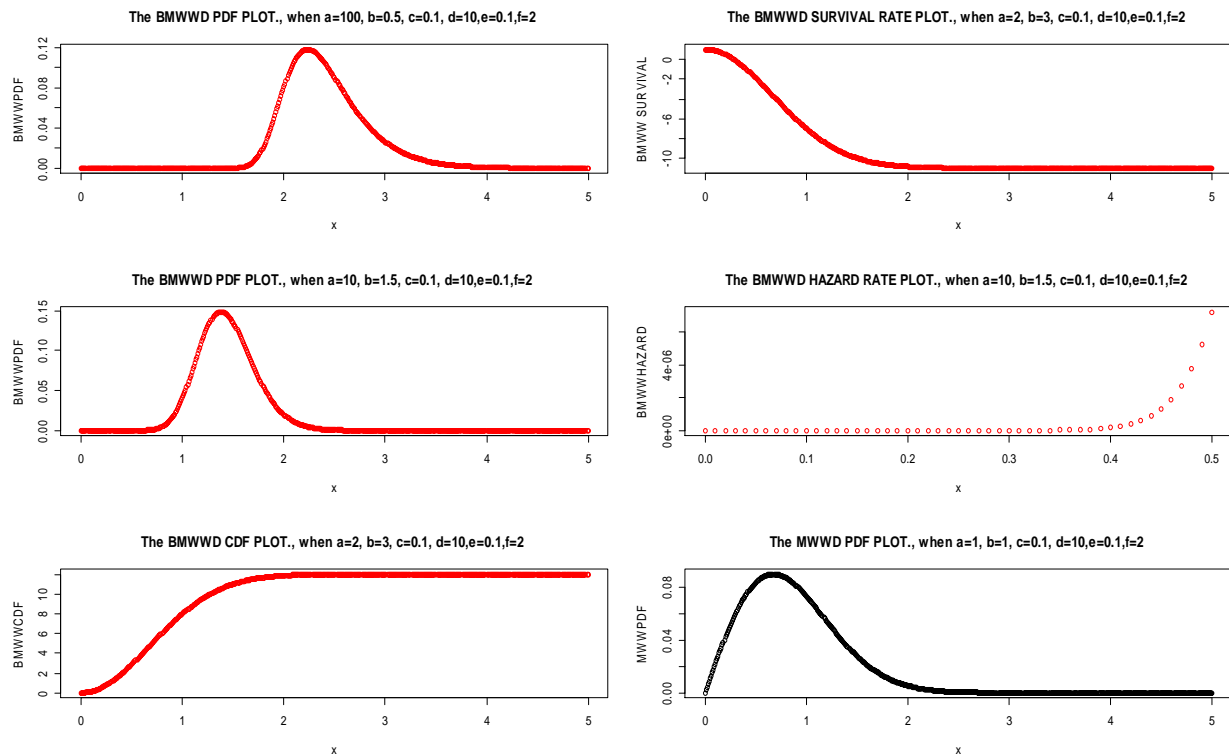


Figure 2: Consists of pdf, cdf, survival rate and hazard rate plot of BMWW (in red ink) and pdf plot of MWW (in black ink).

5.3 DISCUSSION

The maximum likelihood estimates, standard error (in parenthesis), AIC, BIC and the maximized log-likelihood \hat{l}_{BMW} for the BMWW distribution were:

$$\hat{\alpha} = 1.0260 (0.04720), \hat{b} = 7.60300 (0.03854), \hat{\beta} = 0.05932 (0.00023), \hat{c} = 3.47700 (0.1323), \hat{\theta} = 0.00028 (0.000007), \hat{\beta} = 0.8770 (0.00038),$$

$$\hat{c} = 5.7590 (0.09870), \hat{\theta} = -0.01674 (0.000028), \hat{\gamma} = 1.03300 (0.1071),$$

$$AIC = 893013.4, BIC = 893022.5 \text{ and } \hat{l}_{MWW} = -446502.7$$

The likelihood ratio statistic for testing the hypothesis $H_0: \alpha = b = 1$ versus $H_1: H_0$ is not true i.e., to compare the MWW and BMWW models, is $w = 2(-\hat{l}_{BMW} - (-\hat{l}_{MWW})) = 763502.2$ (p-value $< 2e-16^{***}$), that gives favorable indications toward the BMWW model and MWW distribution should be rejected.

Moreso, the BMWW distribution involves

The asymptotic covariance matrix of the maximum likelihood estimates for the BMWW distribution, which comes from the inverse of the information matrix, is given by

$$\hat{F}^{-1} = \begin{pmatrix} 2.227408e-03 & 1.055107e-03 & 4.296468e-06 & 9.315093e-04 & -1.065437e-07 & 7.737315e-06 \\ 1.055107e-03 & 1.485633e-03 & -6.835263e-08 & -4.310574e-04 & -2.383338e-07 & -4.771463e-06 \\ 4.296468e-06 & -6.835263e-08 & 5.276867e-08 & 8.694551e-06 & 6.073934e-10 & 6.539148e-08 \\ 9.315093e-04 & -4.310574e-04 & 8.694551e-06 & 1.751135e-02 & 1.070022e-05 & 3.608571e-05 \\ -1.065437e-07 & -2.383338e-07 & 6.073934e-10 & 1.070022e-05 & 4.984180e-11 & 3.561091e-09 \\ 7.737315e-06 & -4.771463e-06 & 6.539148e-08 & 3.608571e-05 & 3.561091e-09 & 9.671602e-07 \end{pmatrix}$$

6.0 CONCLUSION

In this study we introduce the beta Modified Weighted Weibull (BMWW) distribution because of the wide usage of the Weighted Weibull distribution and the fact that the current generalisation provides means of its continuous extension to more complex situations. In fact, the BW distribution (2.3) represents a generalization of several new distributions emanated from the BMWW distribution depending on the values of the parameter (BMWE, BMWR, LMWW, EMWW, LMWR, EMWR, LMWE and EMWE). We properly obtained various

$$\hat{\gamma} = 0.8834(0.00098), AIC =$$

$$129515.2, BIC = 129528.9$$

$$\text{and } \hat{l}_{BMW} = -64751.6$$

while the maximum likelihood estimates standard error (in parenthesis), AIC, BIC and the maximized log-likelihood \hat{l}_{MWW} for the MWW distribution were:

$$\hat{\gamma} = 0.8834(0.00098), AIC =$$

$$129515.2, BIC = 129528.9$$

$$\text{and } \hat{l}_{MWW} = -64751.6$$

two addition parameters which make the distribution more flexible and versatile to fit the data.

properties of the BMWW distributions, including the survival rate and hazard rate function, moment generating function and the rth generalized moment. We also discussed the estimation procedure by the method of maximum likelihood (MLEs). Furthermore, the new BMWW distribution is more flexible than the MWW distribution. We applied real data (exceedance river flood data); and show that the proposed (BMMW) model produced better fit than MWW model. Finally, we compare both BMWW and MWW models using information criteria: the AIC and BIC criteria to give evidence that the BMWW distribution outperforms the MWW model.

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REFERENCES

- Azzalini, A. (1985). A class of distribution which includes the normal ones. Scandinavian Journal of Statistics, 12, 171-178.
- Aleem, M., Sufyan M., Khan, N. S. (2013). A class of Modified Weighted Weibull Distribution and its properties. America Review of Mathematics and Statistics, 1(1) 29 – 37.
- Badmus, N. I., Bamiduro, T. A., Ogunobi, S. G. (2014). Lehmann Type II Weighted Weibull Distribution. International Journal of Physical Sciences. 9(4), 71-78.
- Badmus, N. I., Bamiduro, T. A. (2014). Some Statistical Properties of Exponentiated Weighted Weibull Distribution. Global Journal of Science Frontier Research: F Mathematics and Decision Sciences 14 (2) Version 1.0 Online ISSN: 2249-4626 & Print ISSN: 0975-5896.
- Badmus, N. I., Bamiduro, T. A. (2014). Life Length of Components Estimates with Beta Weighted Weibull Distribution. Journal of Statistics: Advances in Theory and Applications. 11(2), 91-107.
- Choulakian, V., Stephens, M. A. (2011). Goodness-of-fit Tests for the Generalized Pareto distribution, Technometrics 43(4), 478–484.
- Cordeiro, G. M., Alexandra de Castro, M. (2011). Generalized Beta Generated distributions. ICMA Centre. Discussion Papers in Finance *DP* 2011-05.
- Famoye, F., Lee, C., Olumolade, O. (2005). The Beta-Weibull Distribution. Journal Statistical Theory and Applications, 4, 121-136.
- Hosking, J. R. M. (1990). L-moments Analysis and Estimation of distributions using Linear Combinations of Order Statistics. Journal Royal Statistical Society B, 52, 105-124.
- Jones, M. C. (2004). Families of distributions arising from distributions of order statistics test 13, 1-43.
- Lee, C., Famoye, F., Olumolade, O. (2007). Beta-Weibull Distribution: Some Properties and Applications to Censored Data. Journal of Modern Applied Statistical Methods. 6, 173-186.
- Ramadan M. M. (2013). A Class of Weighted Weibull distributions and its Properties. Studies in Mathematical Sciences 6(1), 35-45.
- McDonald, J. B. (1984). Some Generalized Functions for the Size Distribution of Income Econometrica 52:647–663.
- Nadarajah, S., Kotz, S., (2004). The beta Gumbel distribution. Mathematics Probability Engineering. 10, 323-332.
- Nadarajah, S., Kotz, S., (2006). The Beta Exponential distribution. Reliability Engineering and System Safety. 91, 689-697

PHYSIOCHEMICAL TRACE METALS AND MICROBIAL ASSESSMENT OF ABATTOIR EFFLUENT ON SURFACE AND POTABLE WATER IN IJEBU-NORTH, SOUTH WEST, NIGERIA.

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ABSTRACT

Inappropriate waste management and poor sanitation practices have become major concerns in many developing countries, water pollution due to chemical and microbes is one of the serious environmental problems, which has greatly impacted human health. It is estimated that >250 million cases of water borne diseases are reported Worldwide and over 25 million deaths are blamed due to waterborne diseases. This study was conducted for Physiochemical, Trace metals and Microbial analysis of abattoir effluent effects on River Ijapara and Idode and some potable water around in Ijebu-Igbo abattoir. Physiochemical (pH, turbidity, total dissolved solids, total solid, acidity, alkalinity, conductivity, chloride, phosphate, nitrates, dissolved oxygen, total suspended solid, chemical oxygen demand and biochemical oxygen demand), Trace metals (Magnesium, zinc, Copper, Iron, Chromium, Sodium, Cobalt, Manganese, Lead, Cadmium, Potassium, Nickel, Silver and Mercury) and microbial analyses (total plate count, presence of Coliform and faecal coliform confirmation) were conducted. The effluents samples were collected from three points for the stream water sample (upstream, mid stream and downstream) around the abattoir, for potable water samples, they were collected from two wells and one boreholes around the abattoir. The results obtained shows, there were a variation of the analysed physiochemical parameter in the water samples and were found as: pH (5.5 – 9.0), turbidity (FTU), TDS (2100mg/L), TSS (100mg/L) and total solids (2200mg/L). The pH of two samples

was within the permissible limit and four were

standard guideline. TSS of the entire sample was below the permissible limit, TDS was below the permissible limit for the samples and total solid was non-significant. In microbial analyses faecal coliform was positive in two samples and negative in four samples, presence of coliform positive in five samples and negative in one sample and total plate count was above the guideline limit in all samples. These results indicate that physiochemical and microbial parameter of the water were not within the permissible limit and cannot be used for domestic uses as well as irrigation.

KEYWORDS: Physiochemical, Microbial, Effluent, Trace metals, Ijebu-Igbo

INTRODUCTION

An abattoir is a facility where animals are killed for the consumption. The place act as the starting point of the meat processing industry where stock comes from market or farms to enter the food chain. The continuous drives to increase meat production for the protein needs of the ever increasing world population have some pollution problems attached. The meat industry uses large quantity of wastewater that drains into the surrounding environment (Hinton et al., 2000) and (Amisu et al., 2003).

Surface and groundwater pollution is a major problem beclouding most developing nations. The source and nature of contamination however vary from one nation to another. Aside, very few percentage of the population in these

nations has access to good and safe water while most surface water is either contaminated by industrial effluents or sewerage. The pollution can either be of point source or non-point source. Point sources of pollution occur when pollutants are emitted directly into the water body e.g., from industrial sewage or municipal wastewater pipes. A non-point source delivers pollutants indirectly through environmental changes such as pollution from urban run-off (TCEQ, 2002)(Krantz and Kifferstein 2005).

Major known sources of water pollution are municipal, industrial and agricultural. The most polluting of them are sewage and industrial waste discharges into rivers. Industrial effluents mostly contain heavy metals, acids, hydrocarbons and atmospheric deposition (Alam et al., 2007). Agricultural run-off is another major water pollutant as it contains nitrogen compounds and phosphorus from fertilizers, pesticides, salts, poultry wastes and washes down from abattoirs (UNESCO, 2006) (Krantz and Kifferstein, 2005).

Pollution from abattoir effluent can be direct or indirect depending on the different processes that are involved, while effluents from abattoirs can cause deoxygenating of rivers and contamination of ground water because wastewater from abattoir contains blood, manure, hair, fat, feather and bone (Medalye and Hubbart, 2006). In developing countries, pollution of water bodies occur from activities of meat production as a result of failure in adhering to Good Hygiene Practices and treatment of waste water before their discharge into receiving water bodies (Adesemoye et al., 2006). Abattoir spills can introduce enteric pathogens and excess nutrients into waters and also contaminate ground waters (Nafarnda et al., 2006). Equally, improper disposal systems of wastes from slaughter houses could lead to transmission of pathogens to humans and cause zoonotic disease such as Bacillosis, Salmonellosis, Brucellosis and Helminthes. It was also observed that water quality degradation

interferes with vital and legitimate water quality uses at any scale (Cadmus et al., 1999)..

This study is aimed at determining the effect of abattoir effluent on the physiochemical and microbial assessment of water bodies surrounding the abattoir as well as to compare the abattoir effluent with International Standards for surface water and potable water.

MATERIALS AND METHODS

Study Area

The study was conducted around Ijebu-Igbo abattoir situated in Ijebu North Local Government area of Ogun State, Nigeria. Ijebu-North Local Government is situated at 6°, 57° N", 0" longitude 40, 0'E.

Sample collection

Water samples were collected around Ijebu-Igbo abattoir, Ijebu-North Local Government, Ogun State. The water samples were taken from different sources (i.e. upstream, midstream, downstream), wells and boreholes situated around the abattoir. The samples were taken in 5 liters containers which were properly washed with detergent, and later rinsed properly with distilled water, thereafter it was rinsed with the sample which were to be collected. Water samples were collected from six different sources singly into the prepared container. For the stream, the water samples were taken at 10m from one another (i.e. upstream, midstream and downstream). The potable water samples were taken from two wells and one borehole which are 50m, 60m and 100m to the abattoir. The samples were well labeled and taken to the laboratory for further analysis.

Microbial Analysis of Steam and Potable water

Total Plate counts: The total plate count method was used to determine the bacteria colony on a nutrient medium. The colonies that are visible to the naked eyes on a plate are counted. The serial dilutions of the samples were carried out using laboratory procedure (1.10, 1.100, 1.1000). The

medium used was Plate Count Agar (APHA 2012).

Total coliforms: The total Coliform was determined using a medium containing lactose and incubated at a temperature of 44.5°C, they are identified by the production of acid and gas from the fermentation of lactose. Confirmatory test was also carried out. This is to determine the thermo-tolerant coliforms and bacteria of faecal origin.

Physicochemical Analysis of Steam and Potable water

The physicochemical analysis of the water samples were done as prescribed by (Ademoroti, 1996). The parameters determined were:

Temperature: A calibrated Hanna Meter was used to determine the temperature of the water samples. The meter was dipped into each water sample at the point of collection to record their temperature.

pH: The pH meter was calibrated using standard buffer solutions 4.0, 7.0 and 9.2. The electrode of the pH meter was inserted into water sample

Turbidity: The nephelometer is calibrated using standard solutions of formazin and appropriate NTU range selected. The standard solution was removed and was replaced with blank, the instrument was reset to zero, after which the samples were read directly in NTU from the instrument.

Conductivity: A calibrated Hanna Meter was used to determine the conductivity of the water samples. The water sample was brought to 20°C, the conductivity electrode was rinsed thoroughly with the sample and then immersed in it, ensuring no air bubbles adhere to electrodes. The values were read from the dial and the results were obtained by multiplying the observed conductivity by cell constant. The conductivity electrode was calibrated using 0.01M standard potassium chloride solution; this has an electrical conductivity of 127.8 μScm^{-1} at 20°C. The cell constant was obtained by dividing the true conductivity of KCl solution by its measured conductivity.

Total Dissolved Solids (mg/L): 150 cm³ of water sample previously filtered using glass fiber filter was placed into a pre-weighed evaporating dish. The water sample in the evaporating dish was evaporated on a steam bath, and placed in oven at 105°C. After drying, it was placed in the desiccator for cooling and the residue in the dish was weighed and recorded. The total dissolved solid (mg/L) was calculated as thus:

The total dissolved solid

$$(\text{mg/L}) = \frac{\text{Mass of residue after drying in mg}}{\text{Volume of water sample in L}}$$

Total Suspended Solids (mg/L): A pre-weighed filter was placed on holder and it was washed with 3 x 2ml distilled water, 100 cm³ of water sample was filtered, the filter was carefully removed and it was dried for 1 hour at 105°C. It was cool in desiccators and then weighed. The dry cycle was repeated until a constant mass is obtained.

The total suspended solids

$$(\text{TSS}) \text{ mg/L} = \frac{\text{Mass of solid on filtered (mg)}}{\text{Volume of standard filtered (L)}}$$

Total Solids (mg/L): An empty porcelain evaporating dish was dried in an oven at 105°C, it was allowed to cool in a desiccator and the dish was washed after it is cooled. 100 ml of water sample was placed on steam bath and the water was evaporated, the dish was transfer to an oven at 105°C and it was dried. The dish was allowed to cool and it was placed in a desiccators and the dish was weighed when it has cooled.

The total residue

$$(\text{mg/l}) = \frac{\text{mass of solid in mg}}{\text{Volume of samples (liter)}}$$

Total Hardness (mg/L): The total hardness was determined using EDTA titration method. 2cm³ of strong ammonium chloride buffer solution was added to 50 cm³ of water sample and then followed by 3 drops of Eriochrome black T indicator solution was added. The solution was titrated against 0.01 M EDTA solution until the colour change from purple to blue which indicates the final end point of the titration.

The total hardness
 (as CaCO₃, mg/L) = $\frac{1000 \times V_{\text{EDTA}} \times 20}{\text{Volume of samples (liter)}}$

Acidity: The acidity of the sample was determined by titration. 100 cm³ of water sample was measured into 250 cm³ clean conical flask, few drops of phenolphthalein indicator were added and the colour of the solution was noted. The solution was titrated with the 0.02 N sodium hydroxide solution (NaOH) in the burette while swirling slowly until a definite colour pink was observed which indicated the end point of the titration.

Acidity (mgL⁻¹) =

$$\frac{\text{Volume of 0.02 N NaOH used} \times \text{Molarity of NaOH} \times 1000}{\text{Volume of water.}}$$

Alkalinity: 100 cm³ of water sample was measured into a 250 cm³ clean conical flask, 2 -3 drops of phenolphthalein indicator was added to the solution and the colour of the solution was noted. The solution was titrated with 0.1 N HCl acid in the burette while swirling slowly until the initial pink colour discharged. Afterward, 2 drops of methyl orange indicator was also added to the solution in the conical flask, while swirling slowly until a definite orange colour was observed which indicated the end point of the titration.

Alkalinity (mg/L) =

$$\frac{\text{Volume of 0.1 N HCl} \times \text{Molarity of HCl} \times 1000}{\text{Volume of water sample}}$$

Chloride: 100 cm³ of water sample was measured into a conical flask, 1 ml of 5% potassium chromate solution was added and it was titrated with 0.1 M AgNO₃ solution with constant stirring till the first colour change. The blank was determined using distilled water.

Chloride (mg/l) =

$$\frac{V(\text{AgNO}_3 \text{ for sample}) - V(\text{AgNO}_3 \text{ for blank}) \times 1000}{V \text{ of water sample}}$$

Nitrate: A mixture of 20ml of water sample and 1ml of freshly prepared 0.5% sodium salicylate solution was evaporated.

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Dissolved Oxygen (DO): Dissolved oxygen was carried out by electrometric method using oxygen detecting electrode. Dissolved oxygen analyzer (Model JPB 607 portable) was used to determine the dissolved oxygen. The calibration was carried out with the use of the manufacturer calibration procedure and the probe was inserted into the water sample, readings were noted immediately.

Biochemical Oxygen Demand (BOD): The BOD value is expressed in milligrams during 5 days of incubation at 20°C. The dissolved oxygen was analyzed before incubation and after 5 days of incubation. The BOD was computed from the difference between initial DO and final DO.

BOD (mg/L) = D₁ - D₂

D₁ = dissolved oxygen of the sample before incubated

D₂ = dissolved oxygen of the sample after 5 days

Analysis of steam and potable water for trace metals contents

The samples were analysed for trace metals using Atomic Absorption Spectrophotometer (AAS, Perkin Elmer model 2130). The trace metals determinate are Copper, Iron, Sodium, Cobalt, Manganese, Lead, Cadmium, Potassium, Nickel and Silver in accordance with the procedure of standard methods.

The results obtained from this study are compared with the standard guidelines.

RESULTS

Table1: The Results of Physiochemical parameters from Stream beside Ijebu-Igbo abattoir

PARAMETER	US	MS	DS
Colour	23	0	41
Appearance	Clear	Clear	Clear
Ph	7.69	7.92	7.92
Turbidity	0.53	0	0.75
Conductivity	281.9	24.39	467
TSS (mg/L)	2	4	2
TDS (mg/L)	278	197	308
Total solids (mg/L)	280	201	310
Acidity (mg/L)	71	144	135
Alkalinity (mg/L)	270	205	225
Chloride (mg/L)	63	23	76
Nitrate (mg/L)	9.3	2	13.4
Phosphate (mg/L)	0.43	0.77	0.76
Sulphate (mg/L)	1	5	22
DO (mg/L)	5	6.08	5.3
COD (mg/L)	73	123	0
BOD (mg/L)	18.25	30.8	0

Table 2: Trace metal contents from Stream beside Ijebu-Igbo abattoir

PARAMETER	US	MS	DS
Calcium (mg/L)	10.822	4.459	5.225
Copper (mg/L)	0.0213	0.0036	0.0072
Iron (mg/L)	0.9971	0.2866	0.5763
Sodium (mg/L)	10.379	2.819	6.427
Cobalt (mg/L)	0	0	0
Manganese (mg/L)	0.9703	0.085	0.495
Lead (mg/L)	0	0	0.0835
Cadmium (mg/L)	0.0124	0	0.0061
Potassium (mg/L)	4.0570	0.5501	2.2667
Nickel (mg/L)	0	0.0253	0.0327
Silver (mg/L)	0	0	0

Table 3: Microbial analysis of waste water from Stream beside Ijebu-Igbo abattoir

PARAMETER	US	MS	DS
Total Plate Count	30	40	30
Presence of Coliform (MCA)	+ve	+ve	+ve
Faecal Coliform Confirmation (EMB)	-ve	-ve	-ve

Keywords: UP=Upstream;
MS= Midstream; DS=Downstream;
+ve= Positive;
-ve= Negative.

Table 4: Result of Physiochemical analysis of Potable water around Ijebu-Igbo Abattoir

PARAMETER	BOREHOLE	WELL 1	WELL 2
Appearance	Colourless	Cloudy with particles	Slight cloudy with particles
Temperature	27.6	27.6	27.8
pH	6.7	7.0	6.2
Turbidity	0.99	35.4	1.1
Conductivity	0.15	0.61	0.04
TSS (mg/L)	7	17	0
Acidity (mg/L)	28	48	18
Alkalinity (mg/L)	110	275	35
Total Hardness (mg/L)	58	92	54
Chloride (mg/L)	6	64	6
Nitrates (mg/L)	3.2	8.6	2.2
Phosphate (mg/L)	0.75	0.80	0.39
Sulphates (mg/L)	0	2	0
DO (mg/L)	5.28	1.63	4.18

DISCUSSION

The pH of the waste water samples are 7.69, 7.92 and 7.97 for upstream, downstream and midstream respectively, while for well water 2, Borehole water and well water 1 are 6.2, 6.7 and 7.0 respectively are within the Lagos State Environmental Protection Agency (LASEPA) standard for waste water of (5.5 – 9.0) and W.H.O standard for portable water (6.5 - 8.5). Hence the effluents of abattoir have little or no effect on the pH of the water sample.

The temperature of the waste water samples are 29.9°C for upstream, 29.7°C for downstream and 29°C for midstream

Table 5: Trace metal contents analysis from Portable water around Ijebu-Igbo Abattoir

PARAMETER	BOREHOLE	WELL 1	WELL 2
Calcium (mg/L)	0	1.7529	0
Sodium (mg/L)	0.5129	3.6577	0.1014
Potassium (mg/L)	0.1763	1.3822	0.0526
Copper (mg/L)	0.0038	0.0060	0.0054
Manganese (mg/L)	0.0235	0.2482	0.0508
Iron (mg/L)	0.0214	0.4410	0.2036
Nickel (mg/L)	0	0	0
Cobalt (mg/L)	0.0055	0	0
Cadmium (mg/L)	0.0041	0.0048	0.0048
Sliver (mg/L)	0	0	0
Lead (mg/L)	0.0076	0	0

Table 6: Microbial analysis from Portable water around Ijebu-Igbo Abattoir

PARAMETER	BOREHOLE	WELL 1	WELL 2
Total Plate Count	5	80	80
Total Coliform Count	0	2400	2400
Confirmatory Faecal Coliform Test	-VE	+VE	+VE

Keywords: +ve= Positive; -ve= Negative

W.H.O standard which is (35-40°C). The indication of temperature means that the water is neutral.

The turbidity of waste water samples are 0.53, 0.75 and 0 for upstream, downstream and midstream, for borehole water, well water 2 and well water 1 values ranges from 0.99 - 35.4. The values obtained are within the LASEPA and W.H.O standard which is (5NTU mg/l) with the exception of well water 1 that has its value above the standards values.

The conductivity of the waste water samples are 281.9 mS/cm, 467mS/cm, and 24.39 mS/cm for upstream, downstream and midstream, for the potable water value ranges from 0.04 to 0.61mS/cm are within the standard for waste and potable water. The indication of conductivity means that the water is neutral.

The dissolved solids value ranged from 273 mg/L, 308 mg/L and 197 mg/L for the stream water as shown in Table 1. For the potable water analyzed, the TSS value falls within the standard values used (Table 4).

The acidity of the waste water samples are 71 mg/L, 135 mg/L and 144 mg/L for upstream, downstream and midstream, for potable water, well water 2, borehole fall values are 18 mg/L and 28 mg/L and well water 1 has the highest value of 48 mg/L while the standard value is 30-50mg/L.

The alkalinity of waste water samples are 270 mg/L, 225 mg/L and 205 mg/L upstream, downstream and midstream. Well water 2 shows high alkalinity of 275mg/L which reflect the high pH of the sample whereas sample well water 2 and borehole water 1 are 35 and 110mg/L fall with the standard of W.H.O which is 200mg/L.

Chloride of the waste water samples are 63 mg/L, 76 mg/L and 23 mg/L for upstream, downstream and midstream, for potable water it ranges from 6-64mg/L in well water 2, borehole water and well water 1 falls within the W.H.O standard which 250mg/L. The indication of chloride means that the water is neutral

It was observed from the analyzed water sample that nitrate fluctuated from 9.3

mg/L, 13.4 mg/L and 2 mg/L for upstream, downstream and midstream. It was observed that water samples for well water 2, borehole water and well water 1 are 2.2 mg/L, 3.2 mg/L and 8.6 mg/L and W.H.O standard is 100mg/L. From the result it shows that nitrate fall within the standard limit. Nitrate has no effect on the water.

From the water sample analyzed it shows that TSS concentration values are 2 mg/L, 2 mg/L, and 4 mg/L for upstream, downstream and midstream respectively, while for well water 2, borehole water and well water 1 the values are 0 mg/L, 7 mg/L and 17 mg/L which are within the W.H.O standard of 30mg/l.

DO is an important parameter that determines the quality of water in lakes and rivers, it plays crucial role in biological life within water body. The DO values are 5 mg/L, 5.3 mg/L and 6.08 mg/L for stream water. These values are above the standard limits. This implies that the dissolved oxygen is high and it will affect the aquatic life in the water. The BOD values ranges from 18.25 mg/L, 0 mg/L and 30.8 mg/L for upstream, downstream and midstream respectively, while LASEPA standard is 200 mg/L. For the COD, the values range from 70 mg/L to 123 mg/L while the LASEPA standard is 200 mg/L.

The calcium fluctuated from 10.8219 mg/L, 5.2245 mg/L and 4.4592 mg/L for upstream, downstream and midstream respectively while for the potable water the values range from 0-1.7529 which falls below the standard of W.H.O and LASEPA which is 200mg/L.

Copper concentration moves from 0.0312 mg/L, 0.0072 mg/L and 0.0036 mg/L for the stream water while the potable water ranges from 0.0038 to 0.0060. The W.H.O standard is 0.5mg/L and LASEPA standard is 3.0 mg/L. From the result, copper falls within the range of W.H.O standard.

Iron is also present in water but is needed in a minute concentration, from the

analysed result, iron read from 0.9971 mg/L, 0.5763 mg/L and 0.2866 mg/L for upstream, downstream and midstream respectively, while well water 1 is above the range of W.H.O standard while well water 2 and borehole is within the range of W.H.O (0.03mg/L) and LASEPA standard is 10.0mg/L for surface water. From the result, it shows that the concentration of iron is normal.

The microbial analysis shows total plate counts ranges from 30-40cfu/ml, there is also presence of coliform organisms because it was positive on MacConkey agar while faecal coliform confirmation on Eosin methylene broth was negative for the stream water, for the potable water the value ranges from 5 – 80cfu/ml for the total plate count, total coliform counts are 2400 against the W.H.O standard that is nil and lastly faecal coliform test was also positive which is against the W.H.O standard. These results are in line with the reports of Adesemoye et al., (2006) and Rabah et al., (2010).

Conclusion

The high level of contamination of stream and potable water samples obtained in this study further confirmed the dangers associated with discharging untreated waste water to the river as observed by Eze et al., (2013). It is highly recommended that the abattoir effluent needs to be treated before being discharged into the water body to ensure decontamination as well as the safety of the surrounding.

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REFERENCES

- Ademoroti. C. M. O (1996): Standard methods for water and effluents analysis. Foludex Press Ltd, Ibadan.
- Adesemoye. A.O., Opere. B.O., Makinde. S.C.O (2006): Microbial Content of Abattoir waste water and its contaminated soil in Lagos Nigeria Afr. J. Biotechnol; 5(20), pp 1963-1968.
- Alam. J.B., Islam. M.R., Muyen. Z., Mamun. M., Islam. S. (2007): Water quality parameters along rivers. Int. J. Environ. Sci. Technol., 4: pp 159-167.
- American Public Health Association (APHA) (2012): Standard methods for Examination of water and wastewater. American Public Health Association, American Water Works Association and Water Environment Federation. 22nd ed. Washington DC, USA.
- Amisu. K. O., Coker. A.O., On. S.L W., Isokpehi. R.D (2003): Arcobacter butalien strains from poultry abattoir effluent in Nigeria. East Afri. Med. J;80: pp 218-221
- Cadmus. S.I.B., Olugasa. B.O., Ogundipe. G.A.T (1999): The prevalence of zoonotic importance of bovine tuberculosis in Ibadan, Nigeria. Proceedings of the 37th Annual Congress of the Nigerian Veterinary Medical Association, October 25-31, 1999, Kaduna, pp: 883-886.
- Eze. V.I., Omeh. Y.N., Ugweje.C.D (2013): Microbiological and Physicochemical Assessment of soil contaminated with lairage effluent in Umuahia, Abia state, Nigeria. IOSR Journal of Pharmacy and Biological Science (IOSR-JPBS). Vol.8, Iss. 2, pp 50-56.

- Hinton. M. H., Mead. G. C., Rowlings. C. (2000): Microbiology Control in meat industry. Flair Flow Europe Technical Manual. F- Fe 339A/00 May 2000. (www.exp.ie/flair.html).
- Krantz. D., Kifferstein. B.(2005): Water pollution and society. <http://www.umich.edu/~gs265/society/waterpollution.htm>.
- Medalye. J., Hubbart. J. A. (2006): Abattoir effluent: Effect on the physicochemical properties of IjiOkwu River in Abakaliki.
- Nafarnda W. D., Yaji A., Kubkomawa H. I. (2006): "Impact of abattoir waste on aquatic life: a case study of Yola abattoir," *Global J. Pure and Appl. Sci.* vol. 12:2006, pp 31-33.
- Rabah, A. B., Ijah. U. J. J., Manga. S. B., Ibrahim. M. L. (2008): Assessment of Physico-chemical and microbiological qualities of abattoir wastewater in Sokoto, Nigeria. *Nigerian Journal of Basic and Applied Sciences.* 16 (2): pp145-150
- TCEQ. (2002). Draft 2002 texas water quality inventory. www.texassep.org/html/wql_2sfc.html.
- UNESCO, 2006. Water a shared responsibility. The United Nations World Water Development Report 2. New York, <http://unesco-unesco.org/water/images/001454/145405E.pdf>.

ACCESSIBILITY TO WATER SUPPLY AND SANITATION FACILITY AMONG STUDENTS OF TERTIARY INSTITUTIONS IN IJEBU NORTH LOCAL GOVERNMENT, SOUTHWEST NIGERIA

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ABSTRACT

Sanitation is the hygienic means of promoting health through prevention of human contact with the hazards of wastes as well as the treatment and proper disposal of sewages or wastewater. Water plays an important role in the vehicle of transmission of infections and diseases that is why this study focuses on the water supply as well as sanitation facility in off-campus houses populated by students of tertiary institutions in Ago-Iwoye and Ijebu-Igbo (Olabisi Onabanjo University, (OOU) Ago-Iwoye and Abraham Adesanya Polytechnic, (AAP) Ijebu-Igbo) Ogun State, Nigeria. Structured questionnaires were administered to 500 respondent's students (219 males, 281 females) to obtain information on drinking water source, rate of illness, type and usage of sanitation facilities. Data were analysed using SPSS Version 17.0. On accessibility to water supply, only 40.2% had water in their premises, while 59.8% source for water outside their premises. On the availability of sanitation facility, 462 (92.4%) of the respondents has a toilet facility while 38 (7.6%) did not have any. In testing the hypothesis, if there is any significant difference between students of Olabisi Onabanjo University and Abraham Adesanya Polytechnic in terms of sanitation and water. The t-value of 90.703 and a corresponding p-value of 0.000, indicates that there is significant difference between sanitation and water use of the students in Olabisi Onabanjo University and Abraham Adesanya Polytechnic. This study shows there is need to improve facilities for sanitary disposal and provision of safe water to avoid any outbreak of diseases among

students in the study area.

Keywords: Nigeria, Practices, Sanitation, Tertiary, Water supply.

INTRODUCTION

Water is one of the most abundantly available substances in nature. Water is used for municipal and industrial purposes. The largest water requirement is for municipal use but the standard of purity required for this purpose is quite different from that demanded for industrial and commercial use. The availability of water, both in quantity and quality, is one of the prime factors in deciding the product of towns and cities as well as industries. Source of water supply includes: rain water, sachet water, boreholes, public taps, piped waters, protected dug wells, unprotected dug well, bottled waters, and tankers water (Haines and Rogers, 2000). Sanitation generally refers to the provision of facilities and services for the safe disposal of human urine and faeces. Sanitation is the hygienic means of promoting health through prevention of human contact with the hazards of wastes as well as the treatment and proper disposal of sewages or wastewater (Tilley et al., 2014).

The word "sanitation" also refers to the maintenance of hygienic conditions, through services such as garbage collection and waste disposal. Sanitation practice includes excreta management systems, wastewater management systems, solid waste management systems, and drainage systems for rain water (WHO 2012). Sanitation and hygiene are critical to health, survival and development. The full list of water related infections is large and varied, but most are only marginally affected by

water supply improvements. Improper sanitation can cause different hazards that can be physical, microbiological, biological or chemical agents of disease. Inadequate sanitation is a major cause of disease worldwide and improving sanitation is known to have a significant beneficial impact on health both in household and across communities (Bendahmane, 1993).

Loading of contaminant to surface waters groundwater, sediment and drinking water occurs via two primary routes (Cave and Kolsky, 1999). Firstly, point source pollution: point source pollution originates from discrete sources whose inputs into aquatic systems can often be defined in a spatially explicit manner. Examples of point source include industrial effluents (pulp and papermills, steel plants, food processing plants) municipal sewage storm water overflows resources extraction (mining) and land disposal sites (landfill sites, industrial impoundments). Secondly, non-point source pollution, in contrast originates from poorly defined, diffuse sources that typically occur over broad geographical scales. Examples of non-point source pollution include agricultural runoff, atmospheric deposition (wet and dry deposition of persistent organic pollutants such as polychlorinated biphenyls) and mercury. (Cave and Kolsky, 1999; Steven, 2006; Banerjee and Morella, 2011). Improved hygiene practices are essential if transmission routes of water and sanitation related are to be cut. Water supply and sanitation development takes place in a real world setting of scarce funds, competing priorities, human resources and other institutional limitation, social and political systems that both shape it and determine its eventual success (Bendahmane, 1993).

Water supply and sanitation standards depend on factors such as the user's perceived need, affordability, population density, soil condition, local hydrology and institutional capacities. Improvements in water supply and

sanitation are often ranked below a number of other needs. Needs vary according to the influence of social, cultural, economic, physical and technical location specific factor involved (Dangerfield, 1983). This paper reports the accessibility to sanitation facilities and water supply among students in tertiary institutions (A.A.P and O.O.U) Ogun-state, Nigeria. This is with a view to evaluating water contact patterns as it relates with human activities as its utilization could be a useful means of determine the principal human activities that create exposure to health hazards, through demand, in order to evaluate its roles in the transmission of parasitic diseases.

MATERIALS AND METHODS

Study Area and Sample Size

This study was conducted in an area inhabited by students of Abraham Adesanya Polytechnic, Ijebu-Igbo (AAP) and Olabisi Onabanjo University (OOU), all in Ijebu North area of Ogun-State, southwest Nigeria. The area lies in the tropical rainforest belt situated on 6°58' 0" North and longitude 400° 0" East. Five hundred respondents were selected from the sample population for this study.

Questionnaire Administration

Five hundred respondents (500) systematically selected were enrolled for the study after consent approval. Structured questionnaire were administered to five participants per households making a total of hundred households. The questions sought information on sex, age, education, marital status, and number of year spent in the house, source of drinking water, how many times respondent fell ill, and the type of sanitation facilities used.

Data Analysis

Data were analyzed using SPSS version 17.0 to differentiate into simple percentiles and test for significance.

Abraham Adesanya Polytechnic (AAP), Ijebu-Igbo and the remaining 50% are students of Olabisi Onabanjo University (OOU), Ago-Iwoye. Table 2 summarizes age distribution of the respondents as follows: 11-15 age (3.6%), 16-20 age (59.2%); 21-25 age (34.2%) and lastly 26-30 (3%).

RESULTS AND DISCUSSION

Two hundred and nineteen (43.8%) male and 281 (56.2%) female students filled the questionnaires as shown in Table 1. Also, 50% of the respondents are students of

DEMOGRAPHIC DATA OF RESPONDENTS

Table 1: Sex Distribution of Respondents

Sex	Valid Percent		Cumulative Percent
	Frequency	Percent	
Male	219	43.8	43.8
Female	281	56.2	100.0
Total	500	100.0	100.0

Table 2: Age Distribution of respondents

Age	Frequency	Percent	Valid Percent	Cumulative Percent
11-15	18	3.6	3.6	3.6
16-20	296	59.2	59.2	62.8
21-25	171	34.2	34.2	97.0
26-30	15	3.0	3.0	100.0
Total	500	100.0	100.0	

Source of drinking water

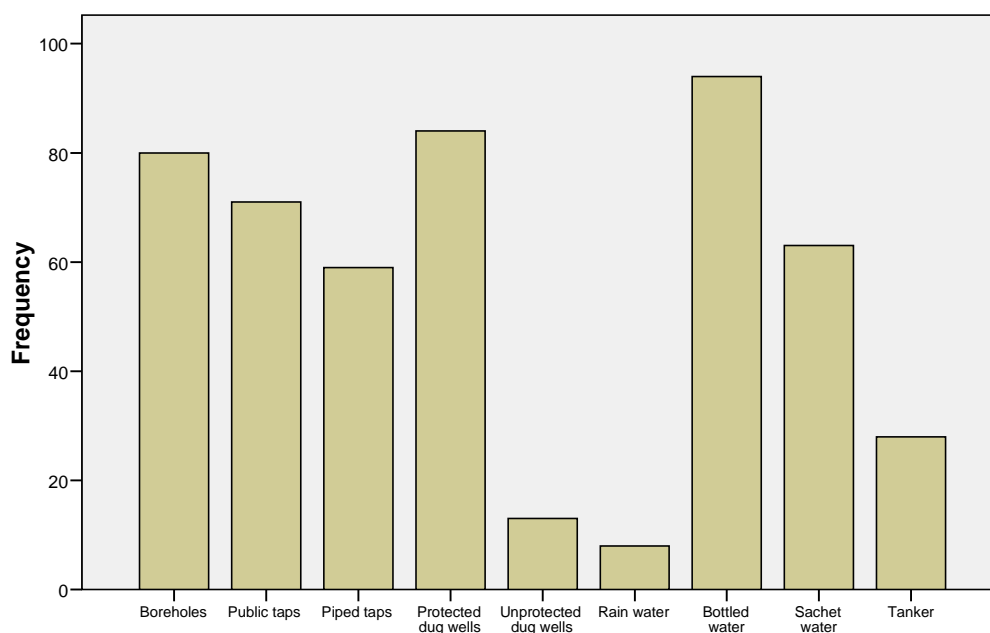


Fig.1: Respondent various source of drinking water

The Fig.1 shows the information of the respondents on how they sourced for water which include boreholes, public taps, piped taps, protected dug wells,

unprotected dug wells, rain water, bottled water, sachet water and tankers.

TABLE 3: Rate of Illness of the respondents

	Frequency	Percent	Valid Percent	Cumulative Percent
Once in a week	49	9.8	9.8	9.8
Twice in a week	36	7.2	7.2	17.0
Thrice in a week	22	4.4	4.4	21.4
Once in a month	108	21.6	21.6	43.0
Rare	180	36.0	36.0	79.0
None in a month	105	21.0	21.0	100.0
Total	500	100.0	100.0	

The above table shows that 9.8% of the respondents agreed to the fact that they did not fall ill once in a week while 7.2% falls ill twice in a week while 4.4% fall ill thrice

in a week while 21.6% fall ill once in a month while 36.0% the rate of the illness is rare and 21.0% of the respondent does not fall ill.

TABLE 4: Number of years spent in the house

No of year	Frequency	Percent	Valid Percent	Cumulative Percent
1 year	159	31.8	31.8	31.8
1-2 years	168	33.6	33.6	65.4
2-3 years	69	13.8	13.8	79.2
3-5 years	87	17.4	17.4	96.6
> 5 years	17	3.4	3.4	100.0
Total	500	100.0	100.0	

The above table shows, the number of years which the respondents spent in the house 31.8% spent a year while 33.6% spent 1-2years while 13.8% spent

2but<3years while 17.4% spent 3 but 4 years >4<5 and the same 3.4% were above 5 years.

TABLE 5: Do you have any sanitation facility?

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	462	92.4	92.4	92.4
No	38	7.6	7.6	100.0
Total	500	100.0	100.0	

From the above table, it shows that 92.4% of the respondents said yes to the question

while 7.6% said No to the questions.

TABLE 6: Type of sanitation facility

	Frequency	Percent	Valid Percent	Cumulative Percent
Water cistern closet	189	37.8	37.8	37.8
Direct flush to septic tank	122	24.4	24.4	62.2
Flush to pit latrine	89	17.8	17.8	80.0
Ventilated improved pit latrine	24	4.8	4.8	84.8
Pit latrine with slab	35	7.0	7.0	91.8
Composting toilet	41	8.2	8.2	100.0
Total	500	100.0	100.0	

From the above table, 37.8% of the respondents use water cistern closet while 24.4% use direct flush to septic tank while 17.8% flush to pit latrine while 4.8% use

ventilated improved pit latrine while 8.2% use composting toilet and the same 7.0% use pit latrine with slab.

TABLE 7: How many householders use your toilet?

	Frequency	Percent	Valid Percent	Cumulative Percent
1-5	284	56.8	56.8	56.8
6-10	170	34.0	34.0	90.8
16-20	33	6.6	6.6	97.4
>20	13	2.6	2.6	100.0
Total	500	100.0	100.0	

The above table shows the number of household that use the respondent toilet 56.8% have 1-5 household while 34.0% have 6-10 household while 6.6% have 16-20 household and the same 2.6% have above 20 households.

According to the results obtained from the two populations (Olabisi Onabanjo University, Ago-Iwoye and Abraham Adesanya Polytechnic, Ijebu-Igbo). The study revealed that majority of respondents treat their water prior to drinking by boiling

their water (54.4%), use of chlorine (8%), solar disinfection (12.2%) . About 12.8% of the respondents do not treat their water. This result shows affirmation in the United Nations Environmental Programme Reports (2010) that states contaminated water are linked to many diseases and illness as a result of polluted water causes more people die (Sam – Wobo et al.,2013) and as such considering this result, the chances of contacting water borne diseases is low.

In accessing to toilet facilities, 92.4% of the respondents affirmed that they have sanitation facilities in their residences. With majority of the respondents' uses cistern-closet (37.8%), direct flush to septic tank (24.4%), flush to pit latrine with slab (7%), and composting toilet (8.2%). This study shows that majority of them uses cistern-closet which is considered to be the safest toilet facility if it is not shared by many households (WHO /UNICEF, 2010).

The study also revealed that majority of the respondents took bottled water as their main source of drinking water (18.8%), protected dug wells (16.8%), public tap (14.2%), sachet water (12.6%) and others. This is an indication that probably the qualities of water around the study area are not good for consumption.

In testing the hypothesis, if there is any significant difference between students of OOU and AAP in terms of sanitation and water. The t-value of 90.703 and a corresponding p-value of 0.000, indicates that there is significant difference between sanitation practice and accessibility to water of the students in OOU and AAP. In concluding, the result from this study observed that students could be prone to communicable diseases as evident from the study due to lack of potable water as well as good and clean sanitary facilities around most of the houses and this could be important factors in transmissions of bacterial, protozoan and helminthic infections. Drinking clean water alone do

not confer the important impact on health as studies had consistently shown that health benefit from improved water are less pronounced than those for sanitation. Benefits from improved water occur only when sanitation is improved and only when optimal water is present (Esrey, 1996).

Therefore, providing adequate levels of water supply, sanitation and hygiene in house is of direct relevance of achieving sound and good quality education as well as reduction in the rate of illness among the students. The provision of potable water supply and good sanitation services at a reasonable and affordable cost is the first step in eliminating poverty. These have been established to improve health, boost social – cultural development, and promote economic balance (Okun, 1998; Benadahamine, 1993; Olukanmi et al., 2014). More so, it is known to be the basic primary drivers of public health, personal hygiene and human dignity (WHO/ UNICEF, 2010). Finally, the benefits of improved water supply and sanitation are many including prevention of diseases, improved basic health care, better nutrition, increased access to institutions such as health centres and schools, improved water quality, increased quantity of and access to water, reduction in time and effort required for water collection, promotion of economic activity, strengthening of community organization, improvements in housing and ultimately improved quality of life (Okun, 1998).

REFERENCE

- Banerjee S. G. and Morella E. (2011):** Africa's Water and Sanitation Infrastructure: Access, Affordability, and Alternatives. The International Bank for Reconstruction and Development/ The World Bank, Washington DC, U.S.A.
- Bendahmane D. B. (1993):** Lessons Learned in Water, Sanitation and Health: Thirteen Years of Experience in Developing Countries. Arlington, Virginia: Water and Sanitation for Health (WASH) Project. Visited October 2013.
- Cave B. and kolsky P. (1999):** Groundwater, latrines and Health. WELL Study Task No:163. London school of hygiene and Tropical Medicine, WEDC, Loughborough, University, United Kingdom.

- Esrey S.A. (1996).** Water, Waste and Well-being: A Multi Country Study. American Journal of Epidemiology. 143(6): 608-623.
- Haines L. and Rogers J. (2000):** A study of drinking facilities in schools. Nurs.Times. 2000; 96;2
- Okun D.A (1998).** “The value of water supply and sanitation in development: An Assessment.” In: American Journal of Public Health, Vol.78, no 11, pp.1463-1467.
- Olukannni D.O, Akinyinka M.O, Ede A.N, Akinwunmi I.I and Ajanku K.O (2014):** “Appraisal of Municipal Solid Waste Management, its Effect and Resources Potential in a Semi – Urban City, a case study”. Journal of South African Business Research, Vol, 2014, Article ID 705695, 13pages.
- Sam-Wobo S.O, Alade R., Olaore D., Asimiea O.A., Adekunle O.N and Surakat O.A (2013):** Water supply and sanitation facility accessibility in off –campus Houses populated by students in tertiary institutions, Abeokuta, Nigeria. Nigerian Journal of Parasitology. Vol. 34(2) pp13-18.
- Steven Sudgen (2006):** Microbiology contamination of water supply, sheets/fact-sheets-htm/contamination.htm
- Tilley E., Ulrich L., Luthi C., Reymond P. H. and Zurbrugg C. (2014):** Compendium of Sanitation Systems and Technologies. 2nd Revised Edition (<http://www.sandec.ch/compendium>) .Swiss Federal Institute of Aquatic Science and Technology (Eawag), Duebendorf, Switzerland.
- United Nations Environmental Programme Report (2010):** Cleaning the waters.
- WHO/UNICEF. (2000):** global water supply and sanitation assessment 2000 Report. New York: World Health Organization and United Nation Children’s fund joint monitoring program for water supply and sanitation.
http: [//www.who.int/water_sanitation_health/Globassessment/GlasspdfTOC.htm](http://www.who.int/water_sanitation_health/Globassessment/GlasspdfTOC.htm).
- WHO/UNICEF (2010):** Joint Monitoring Programme for Water Supply and Sanitation. P.22.
- WHO (2012):** Progress on sanitation and drinking water.2012 update. WHO/UNICEF/JMP, Geneva, Switzerland.

EVALUATION OF INDOOR GAMMA RADIATION ABSORBED DOSE IN SELECTED BUILDINGS WITHIN YABA COLLEGE OF TECHNOLOGY

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ABSTRACT

This research was conducted to measure the rate of exposure of radiation in some selected buildings in Yaba College of Technology and determine whether it is within a tolerable limit recommended by standard bodies. Indoor gamma radiation measurement was carried out in five new buildings within Yaba College of Technology with a nuclear radiation monitor (PRM 9000) calibrated in microsievert per hour ($\mu\text{Sv/h}$). The device was placed at 100 cm above the ground level for effective detection. The mean readings of the values taken at each of the five different sampling locations for ten minutes was recorded for each of the locations. The results showed that the mean absorbed dose rate ranges from $0.107\mu\text{Sv/h}$ to $0.120\mu\text{Sv/h}$ while annual absorbed dose rates obtained was 588.672 ± 49.06 mSv/yr, 539.62 mSv/yr, 588.672 ± 84.97 mSv/yr, 588.672 ± 49.06 mSv/yr and 523.264 ± 28.32 mSv/yr for New Building, New Food Technology Building, Multipurpose Building, Seven-Storey Building and Bursary/Registry respectively. The values obtained in all the locations were lower than 1mSv/yr and 2.4 mSv/yr, the recommended standards of the International Commission for Radiation Protection (ICRP, 1990) and United Nations Scientific Committee on the Effect of Atomic Radiation (UNSCEAR, 2000) respectively. The result of the present study showed that the users of these buildings were exposed to insignificant radiation effects.

Keywords: Indoor, Absorbed Dose, Buildings, Gamma, Radiation.

1.0 INTRODUCTION

Radiation is the emission or transmission of energy in the form of waves or particles through space or through a material medium (Weisstein, 2007). Non-ionizing radiation is a form of radiation that has enough energy to move atoms in a molecule or cause them to vibrate but not enough to remove electrons (USEPA, 2013). Example includes Low frequency, Ultraviolet ray, Infrared, Microwave, thermal (heat) blackbody radiation. These types of non-ionizing radiations are not considered to pose a health risk. Ionizing radiation is a radiation with enough energy so that during an interaction with an atom, it can remove a tightly bound electron from the orbit of an atom causing the atom to be changed or ionized (World Health Organization (WHO), 2014).

Background radiation is the ionizing radiation that surrounds us at all times. Everyone on earth is exposed to background radiation. Exposures to background radiations could be from either natural or artificial sources. Natural source come from the atmosphere, as a result of radiation from outer space, the earth and even radiations from human body as a result radionuclides the food, water and the air we breathe. Artificial radiations are made available to our environment from consumer products, nuclear power plants and medical procedures. The largest source of man-made

radiation exposure or dose is from medical testing and treatment (NCRP, 2009).

Naturally occurring radionuclides are ever present in various degrees in all forms in our environment. In this same vein, building materials in use today contain various concentrations of radionuclides components that contribute to the indoor ambient radiation levels. Building materials are one of the potential sources of radioactivity, imparting external as well as internal dose to human beings.

The Environmental substances on earth contains radioactive nuclide, whose radiation level will not harm human health but when exposed to a very high dose irradiation or a longer period in higher radioactive level environment, people's health will be affected.

Sadiq and Agba (2012), in a related study, evaluated for indoor and outdoor radiation absorbed dose in some selected areas in Keffi, Nasarawa State, Nigeria. The indoor and outdoor radiation levels were inspected using a halogen-quenched GM detector (US made inspector Alert Nuclear Radiation monitor SN: 35440). For indoor measurements, buildings like churches, mosques and houses were used. The monitor was held at 100cm above the ground level throughout the study with equivalent dose of microsievert per hour ($\mu\text{Sv/h}$) was the measurement in the investigated study. Several readings were taken and the mean absorbed dose rate was then calculated using the recommended standard UNSCEAR (1988) for indoor occupancy factor (OF) of 0.8 which is proportional to the total time during which an individual is exposed to a radiation field. The calculated value for outdoor highest absorbed dose was 0.250mSv/yr with the occupancy factor by UNSCEAR (1988) 0.2 was used.

Ogunremi *et al.*, (2013) also in a related study evaluated the outdoor radiation absorbed dose in staff quarters Yaba College

of Technology using a radiation dosimeter (Lk 3600) calibrated in millisievert per hour (mSv/hr). The reading was taken from 25 different locations and 20cm and 100cm above the ground level measurement was observed. The annual absorbed dose was calculated using the occupancy factor of 0.2 and correlation coefficient of 0.7 for Adult and time taken of 8760hr/yr. The highest annual absorbed dose was then found to be 0.445mSv/yr for 20cm 0.355mSv/yr for 100cm respectively. This in a nutshell, shows that the occupancy factor for indoor radiation is greater than that of the outdoor radiation.

Osvaldo *et al.* (unknown date), in Cuba, also assessed the indoor gamma radiation dose in concrete buildings with a portable Reuter Stokes Environmental Radiation monitor (RSS-112) ionizing chamber, he also took his measurements at 100cm above the ground level at the center of the room. The external exposure arising indoors was estimated adopting the coefficient of 0.7Sv/Gy recommended by UNSCEAR to convert the gamma absorbed dose rate into effective dose with an occupancy factor of 0.8. He found the highest indoor absorbed dose rate to be 0.400mSv/yr.

This report is important in the sense that it will further create more awareness on exposure of sources of background radiation and possible health effect. The present study was carried out covering only the spectrum of possible radiation emission from the buildings which is a form of ionizing radiation. The evaluation of indoor radiation and distribution of absorbed dose of the selected buildings was carried out using a nuclear radiation monitor (PRM 9000) for a distance of 100cm above the ground level. The aim of this report was to measure the rate of exposure of radiation in some selected buildings in Yaba College of Technology and to determine whether it is

within a tolerable limit recommended by standard bodies.

2.0 MATERIALS AND METHOD

The indoor radiations of the selected buildings in Yaba College of Technology (6.5193°N, 3.3720°E) were taken using a radiation detecting device: Nuclear Radiation monitor (PRM 9000) calibrated in microsievert per hour (mSv/h) using a meter rule. The device was placed at 100cm above the ground level for effective detection. Three readings were taken at each of the five different sampling locations. The detector was switched on to absorb radiation for ten minutes counting downward from ten minutes to zero (0) minutes, the stable value shown at zero (0) minute on the screen was recorded for that particular location. The

procedure was repeated at each location for three consecutive times and three readings in microsievert per hour ($\mu\text{Sv/h}$) were recorded at each location in which the average values in micro sievert per hour ($\mu\text{Sv/h}$) were determined at each location.

The absorbed dose rate in mSv/yr was calculated using the expression:

$$D = \frac{T \cdot \square \cdot Cc \cdot \mu}{\dots\dots\dots 1}$$

- \square = Absorbed dose rate in $\mu\text{Sv/hr}$
 - T = Time in hours (8760 hours for a year)
 - D = Annual absorbed dose rate in mSv/yr
 - μ = Occupancy factor (0.8 for indoor).
 - Cc = Conversion coefficient (0.7 for adult)
- (Ogunremi *et al.*, (2013)



Figure 1: Map Showing the Study Area of Selected Buildings in Yaba College of Technology.



Fig 2: Meter Rule



Fig 3: Nuclear Radiation Monitor

3.0 RESULTS

The values absorbed dose rates obtained using the radiation measuring device (PRM - 9000) Nuclear radiation monitor and that of annual absorbed dose rates calculated using equation 1 above are shown in table 1

below. The mean absorbed dose rates for the selected buildings were calculated and illustrated in fig. 4 while the annual absorbed dose rates and the comparison with referenced standard value are illustrated in fig. 5 and fig. 6 respectively.

Table 1: The Mean Absorbed Dose Rates and Annual Absorbed Dose Rates for the Selected Buildings.

Selected Buildings	Absorbed Dose Rates ($\mu\text{Sv/hr}$)				Annual Absorbed Dose Rates (mSv/yr)			
	First Reading	Second Reading	Third Reading	Average	First Reading	Second Reading	Third Reading	Average
New Building	0.11	0.13	0.12	0.12	539.62	637.73	588.67	588.67 ± 49.06
New Food Tech Building	0.11	0.11	0.11	0.11	539.62	539.62	539.62	539.62
Multipurpose Building	0.13	0.13	0.10	0.12	637.73	637.73	490.56	588.67 ± 84.97
7-Storey Building	0.12	0.11	0.13	0.12	588.67	539.62	637.73	588.67 ± 49.06
Bursary-Registry Building	0.1	0.11	0.11	0.107	490.56	539.62	539.62	523.26 ± 28.32

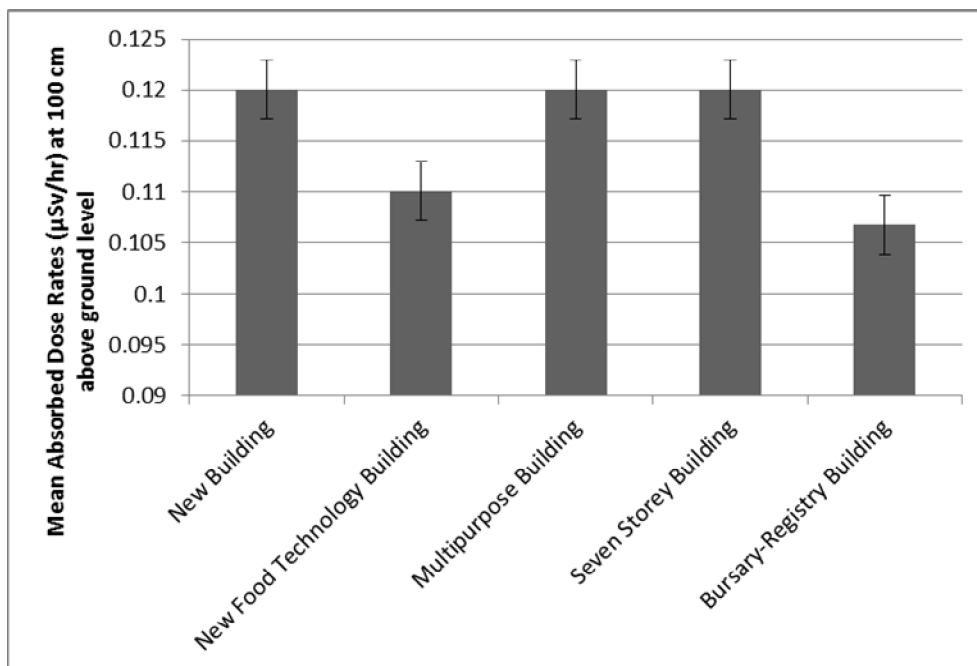


Figure 4: Mean Absorbed dose Rates ($\mu\text{Sv/hr}$) at 100 cm above ground level of selected locations

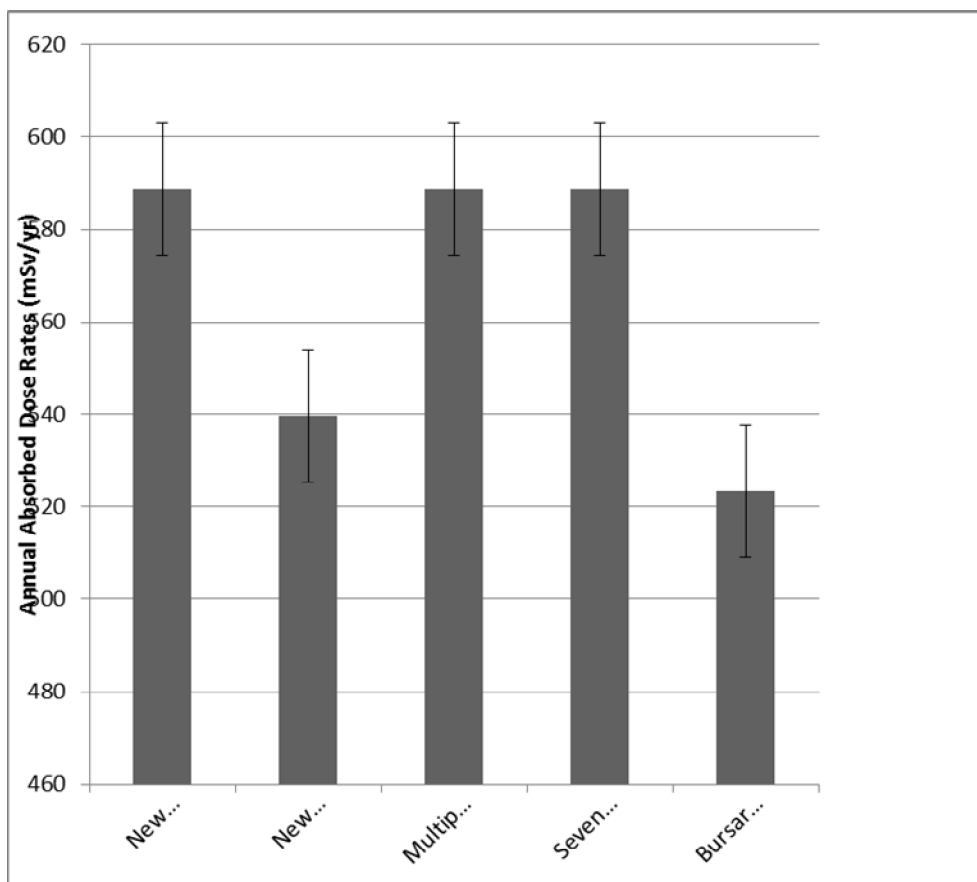


Figure 5: Annual Absorbed Dose Rates (mSv/yr) of Selected Building.

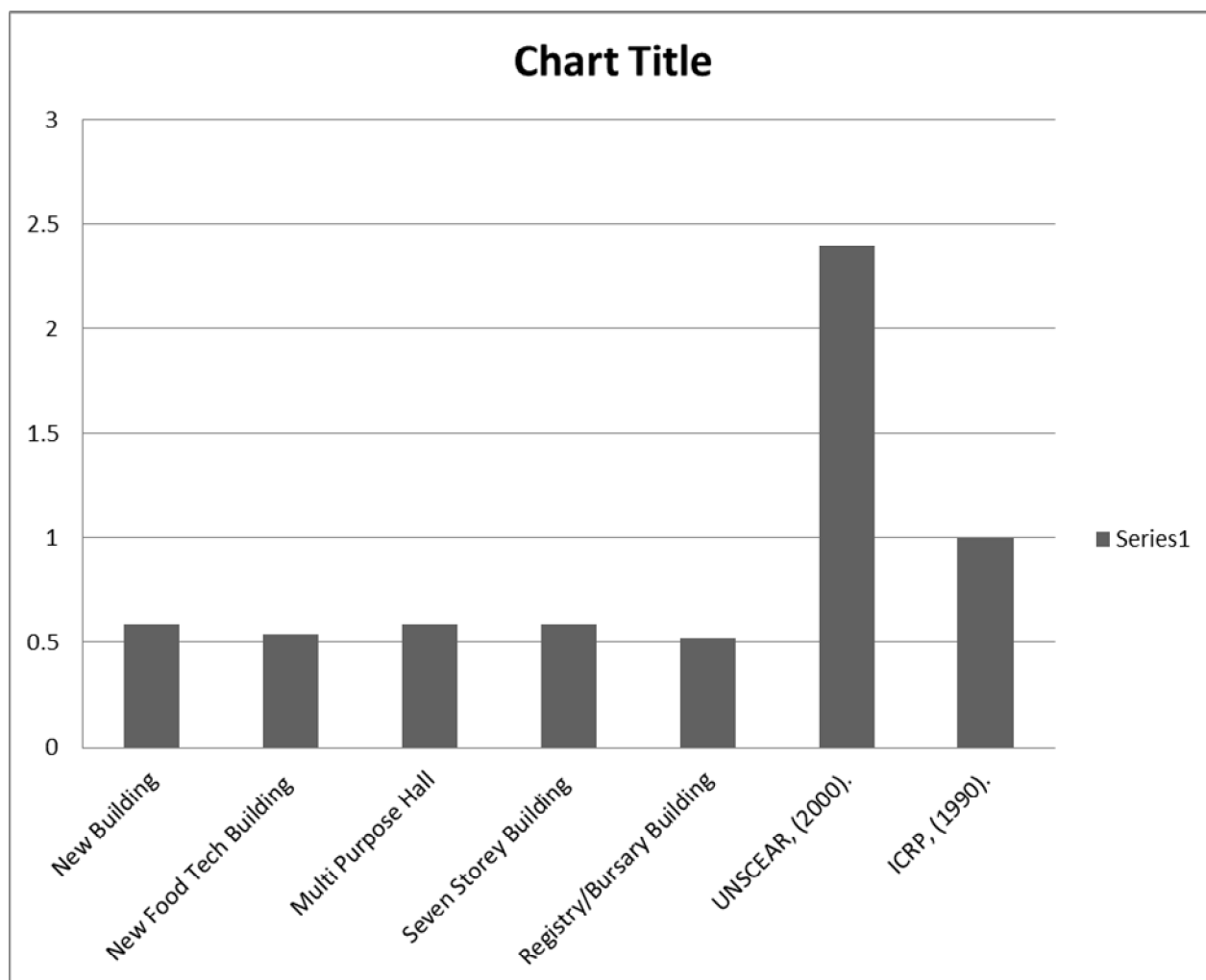


Figure 6: Comparison of Annual Absorbed Dose Rates in Selected Locations to Standards

3.0 DISCUSSION

It was observed from the results that the highest mean absorbed dose rates in an hour were recorded in three different locations; The Seven-Storey Building, Multi-purpose Hall and the New Building respectively for 100cm above the ground level with the value of $0.120\mu\text{Sv/hr}$. The New Food Technology Building gave a value of $0.110\mu\text{Sv/hr}$, 91.7% of the highest absorbed dose rate while the lowest value for the mean absorbed dose rate was recorded at the Registry/Bursary Building to be $0.107\mu\text{Sv/hr}$, 89.1% of the value obtained from Multipurpose Building, Seven Storey Building and New Building, and 97.3% of

the absorbed dose rate from New Food Technology Building.

The annual absorbed dose rates, which represents effective dose in a year, were calculated using the formula discussed above in equation 1. Similar results as regard the highest mean absorbed dose rates values were recorded at the Seven - Storey Building, Multi – purpose Hall and The New Building each with a value of $588.672\pm 84.97\text{ mSv/yr}$, 539.62 mSv/yr was obtained for New Food Technology Building while the lowest annual absorbed dose rate was recorded at the Registry/Bursary Building with a value of

523.264±28.32 mSv/yr. The results show that the exposure to radiation in New Food Technology Building and Registry Building was lower by 8.1% and 10.9 % respectively than the exposure to radiation in Seven - Storey Building, Multi – purpose Hall and the New Building.

These results suggest that some, if not all, of the building materials of the selected locations may be radioactive including their surrounding environments. The results indicated that there is ongoing radiation activity in the selected buildings where their absorbed dose distribution varies. The results obtained from this present study was compared to that of the recommended standards (Fig.6). The annual absorbed dose rates obtained from Seven - Storey Building, Multi – purpose Hall and the New Building was about 24.5 % of 2.4 mSv/yr, the maximum annual absorbed dose recommended by United Nations Scientific Committee on the effect of Atomic Radiation (UNSCEAR, 2000) and 58.9 % of 1 mSv/yr recommended by the International Commission for Radiation Protection (ICRP, 1990) while the value obtained was lower than these recommended standards in New Food Technology Building and Registry Building.

CONCLUSION

This study revealed that there is ongoing radiation activity in the selected locations with un-evenly distributed adsorbed dose rates. The highest calculated annual absorbed dose rate was 0.589mSv/yr observed in three different buildings; the Seven-Storey Building, Multipurpose Hall and New Building. This value is lower than the recommended standards of 1mSv/yr by (ICRP), 1990 and 2.4mSv/yr by (UNSCEAR), 2000 respectively. The implication of the result of the study is that the users of the buildings are however exposed to insignificant radiation effects.

Based on the results from the present study, it is strongly recommended that this same experiment should also be carried out in Epe Campus so as to ensure that the students, lecturers and members of staff are free from harmful radiation exposure.

REFERENCES

- “Christensen, D. M., Iddines, C. J. and Sugarman L. L., (2014).“Ionizing radiation injuries and illnesses”. *Emergency Medicine Clinics of North America*, Vol. 32 (1): pp 245–265.
- ICRP. (1990). International Commission on Radiological Protection. Age dependence Dose to the member of public from intake of radionuclides. *Part 1. Pergamon Press Oxford*.
- ICRP. (2007). International Commission on Radiological Protection. 2007. The Recommendations of the International Commission on Radiological Protection. *ICRP Publication 103. Annals ICRP*, Vol. 37:2– 4.
- James, I.U., Moses, I. F., Vandi, J.N. and Ikoh, U.E. (2015). Measurement of Indoor and Outdoor Background Ionising Radiation Levels of Kwali General Hospital, Abuja. *Journal of Applied Sciences and Environmental Management*, Vol. 19 (1): 89 – 93.
- NCRP. (2009). National Council on Radiation Protection. National Council on Radiation Protection and Measurements.
- Ogunremi, A. B., Adewoyin, K. A., Fayemi, B. O., Ike, C. M. and Ogunmoyede, O. A. (2013). Evaluation of Outdoor Gamma Radiation and Annual Absorbed Dose Distribution in the Selected Area in Yabatech. *International Journal of Science and Society*, Yabatech. Volume 3(1):34-38.
- Sadiq, A. A. and Agba, E. H., (2012). Indoor and outdoor ambient radiation level in Keffi, Nigeria. *Facta Universitatis series: Working and Living Environmental Protection*. Vol. 9 (1): pp. 19 – 26.

- Sakellariou, K., Angelopoulos, A., Sakelliou, L., Sandilos, P., Sotriou, D. and Proukatis, Ch. (1995). Indoor Gamma Radiation Measurement in Greece. *Radiation Protection Dosimetry*, Vol. 60 (2): 177-180.
- UNSCEAR. (1988). Ionizing Radiation: Sources and Biological Effect. *United Nations Scientific Committees on the Effects of Atomic Radiation Report to the General Assembly (New York: United Nation)*.
- UNSCEAR. (2000). United Nations Scientific Committee on the Effects of Atomic Radiation. "Sources and Effects of Ionizing Radiation". *UNSCEAR 2000 Report, to the General Assembly with Scientific Annexes. United Nations Publication, United Nations, New York. Vol. 1*
- USEPA. (2013). United States Environmental Protection Agency. Radiation Protection. Retrieved September 23, 2015 from epa.gov/rpdweb00/understand/ionize_nonionize.html
- WHO. (2014). World Health Organization. Ionizing Radiation. Retrieved September 23, 2015 from http://www.who.int/ionizing_radiation/about/what_is_ir/en
- Weissten, E.W. (2007). Radiation. Eric Weissten's world of Physics. Wolfram Research. Retrieved September 24, 2015 from <http://www.scienceworld.wolfram.com/physics/Radiation.html>

THE ASSESSEMENT OF NATURAL RADIONUCLIDES FROM WATER SAMPLES CONSUMED IN YABA- TECH AREA OF LAGOS STATE.

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ABSTRACT

Water which is one of the most indispensable and precious natural resources is expected to be free from pollution and therefore should be given highest priority in terms of environmental contaminations. The assessment of natural radionuclide concentrations of samples from Yaba College of Technology and the environs were conducted using sodium iodide detector in this research. Thirty samples of both sachet and bottled water samples were collected and analyzed. The results show that the activity concentrations of Radium (^{226}Ra), ranged from 8.49 ± 4.59 to 26.25 ± 3.99 , with the mean value of 12.93 ± 3.10 , the activity concentrations of Thorium (^{232}Th) also ranged from 6.09 ± 3.01 to 25.14 ± 1.00 while potassium (^{40}K) activity concentrations values ranged from 101.18 ± 45.75 to 315.34 ± 38.00 . The result shows that the absorbed dose rate and the annual effective dose were lower than the global acceptable values. In order words, all the sachet and bottled water sold in Yaba College of Technology are safe for drinking according to the recommendation by the regulatory bodies. Thus, the contribution from these radionuclides does not pose any significant radiological health problem to the consumers.

Keywords: Assessment, natural, concentration, bottled, radionuclide, absorbed}. Corresponding author: ayorinde12@yahoo.com.

INTRODUCTION

Water is a geologic material and has been an essential necessity of life. It is a major constituent of the human body and the environment. It is used for various purposes ranging from agriculture to industrial power generation and domestic consumption etc. Natural radio nuclides can enter the human body through ingestion of water and food. The occurrence of natural radionuclides in drinking water poses a problem of health hazard, when these radionuclides are taken to the body by ingestion (Meltem. and Gursel 2010). Radionuclides in drinking water causes human internal exposure, caused by the decay of radionuclides taken into the body through ingestion indirectly when they are incorporated as part of the human food chain (Malanca et al., 1998). Their presence in water is determined by their concentration in bedrock. It has been noted that radiation is part of the natural environment and it is estimated that approximately 80% of all human exposure comes from naturally occurring radioactive materials (Ahmed et al., 2014).

Measuring the levels of natural and artificial radiation in the environment is crucial in implementing appropriate controls for the sake of radiological protection (Kinyua et al., 2011). The increasing consumption of these portable water by people of all ages – infants, children and adult alike – calls for evaluation of its suitability for consumption since its quality varies from source to source. Depending on the origin of groundwater, it might have high amount of the primordial radionuclide or radioactive elements such as uranium, thorium, potassium, and their radioactive decay products (UNSCEAR., (1988),

Amurani., (2002). Montero et al. (1999)) stated that the radiological safeguards of drinking water are based on the control of natural and anthropogenic radionuclide concentration.

According to Forte et al. (2007) both ground and freshwater usually contain variety of radionuclides with the freshwater usually exposed to artificial radionuclide contamination as a result of radioactive fallouts. Ibrahim et al., (2011) suggested that groundwater in some parts of Yemen are not safe to be used as drinking water due to their higher activity concentrations of ^{226}Ra and ^{232}Th . They further concluded that high activity concentrations for ^{226}Ra and ^{232}Th in groundwater points to high activity levels in aquifer rocks which establishes a strong relationship between groundwater and bedrock with regards to radionuclide contamination.

Through this study, adequate data on natural radionuclide concentrations will be established. This will help in assessing any possible radiological hazard that the Yaba College Of Technology staff and students could be exposed. Such a detailed baseline data will be made available to guide all stakeholders involved in the monitoring of the environment for environmental pollutants including radiation exposure.

EXPERIMENTAL PROCEDURE

Study area

The study area, Yaba College of Technology is situated in the central part of Lagos state. The College is densely populated with many offices, commercial and industrial activities going on within the premises and environs.

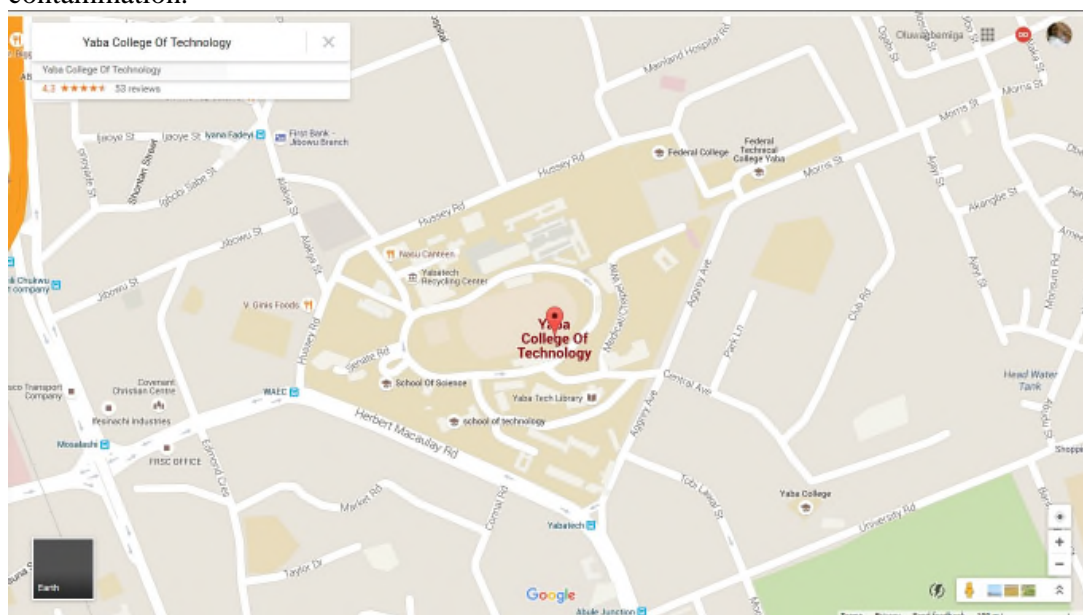


Fig 1. Map of Lagos showing Yaba College of Technology

Water Sample Preparation.

Two samples per brand of ten different bottled water samples, making a total of 20 samples and ten different sachet water, altogether 30 samples of package water were bought from their different retailer in Yaba college of Technology, Yaba Lagos Nigeria. Samples were later transported to

the processing laboratory of the department of Pure and Applied Physics of Ladoke Akintola University, Ogbomosho Nigeria. At the laboratory, Marinelli type beakers (2 litre in capacity) were used to process and measure the water samples. The beakers were made contamination-free by cleaning them well using light

hydrochloric acid solution and de-ionized water. The beakers were then dried using a temperature-controlled oven and filled with appropriate amount of water sample. Finally, the sample-filled beakers were closed by caps, wrapped with thick vinyl tape around their necks and kept for four weeks to achieve the secular equilibrium between gaseous and non-gaseous decay products of naturally occurring radionuclide series. The samples were then analyzed using Sodium Iodide detector.

Instrumentation.

Using a well calibrated Sodium Iodide Detector NaI (TI) and well shielded detector couple to a computer resident model quantum MCA2100R Multichannel analyzer, each sample was counted for 36,000s (10hrs). An empty container under identical geometry was also counted for the same time. The 1460KeV gamma-radiation of ^{40}K was used to determine the

concentration of ^{40}K in the sample. The gamma transition energy of 1764.5KeV ^{214}Bi was used to determine the concentration of ^{238}U while the gamma transition energy of 2614KeV ^{208}Tl was used to determine the concentration of ^{232}Th and ^{137}Cs was detected by its 661.6KeV gamma transition. The efficiency calibration of the detector was done using a reference standard mixed source traceable to Analytical Quality Control Service (AQCS, USA), which has certified activities of the selected radionuclides and has a geometrical configuration identical to sample container. The standard sources contain ten known radionuclide. The energy calibration was also performed by using the peaks of the radionuclide present in the standard sources. The channel number is proportional to energy; the channel scale was then converted to an energy scale. This produces an energy calibration curve, i.e. energy versus channel.

RESULTS AND DISCUSSION.

The measured activity concentration of ^{226}Ra , ^{232}Th and ^{40}K in the water samples are presented in table 1 below.

Samples	K-40	Ra-226	Th-232
1	315.43±38.00	17.43±3.19	12.03±5.16
2	201.18±45.75	18.25±3.99	10.88±2.65
3	104.16±70.01	9.19±3.01	7.83±2.08
4	135.60±35.55	8.49±4.59	6.09±3.01
5	125.16±45.77	10.04±3.38	6.54±3.64
6	104.16±70.01	26.25±3.99	12.03±5.16
7	109.36±2.70	16.92±3.00	10.06±1.40
8	142.31±1.40	10.06±1.90	15.44±2.30
9	312.44±3.20	11.14±2.20	15.45±1.20
10	210.62±3.90	14.50±1.70	15.14±1.00
11	115.43±38.00	17.43±3.19	12.03±5.16
12	101.18±45.75	13.25±3.99	10.88±2.65
13	204.16±70.01	9.19±3.01	17.83±2.08
14	135.60±35.55	8.49±4.59	6.09±3.01
15	125.16±45.77	10.04±3.38	6.54±3.64
16	109.36±2.70	12.92±3.00	14.06±1.40

17	242.31±1.40	10.06±1.90	15.44±2.30
18	112.44±3.20	12.14±2.20	11.45±1.20
19	210.62±3.90	24.50±1.70	25.14±1.00
20	101.18±45.75	11.25±3.99	10.88±2.65
21	215.43±38.00	17.43±3.19	12.03±5.16
22	101.18±45.75	11.25±3.99	10.88±2.65
23	204.16±70.01	9.19±3.01	17.83±2.08
24	236.60±35.55	8.49±4.59	6.09±3.01
25	125.16±45.77	10.04±3.38	6.54±3.64
26	104.16±70.01	12.25±3.99	11.03±5.16
27	109.36±2.70	1.92±3.00	12.06±1.40
28	142.31±1.40	10.06±1.90	11.44±2.30
29	312.44±3.20	11.14±2.20	12.45±1.20
30	110.62±3.90	14.50±1.70	15.14±1.00
Mean	162.64±30.82	12.93± 3.10	11.91± 2.68
Std	67.44±25.10	4.42±0.90	4.17 ±1.36

Table 1. Results of activity concentration in drinking water samples. The activity concentration of ^{226}Ra , ^{232}Th and ^{40}K ranged from 8.49 to 26.25Bq/kg , 6.09 to 25.14Bq/kg and 101.18 to 315.64Bq/kg respectively. Sample 6 had the highest activity concentration of ^{226}Ra while samples 4, 14, 24 had the lowest activity concentration. The highest activity concentration for ^{232}Th was found in

sample 19 while the lowest activity concentrations were found in samples 4, 14 and 24. Samples 1,9 and 29 had the highest activity concentration of ^{40}K and samples 12, 20 and 22 had the lowest activity concentration. All the Samples analysed in this present research satisfy the safety criterion. Hence ,the samples under consideration does not pose any health hazard to the consumers.

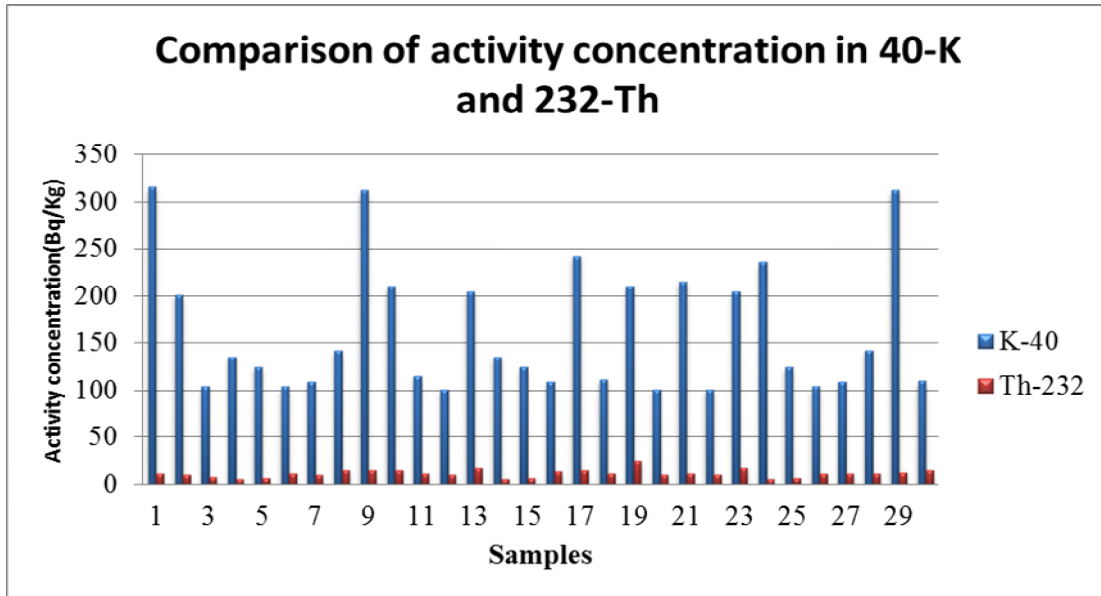


Fig.1 Activity concentration of ^{40}K and ^{232}Th in Potable water.

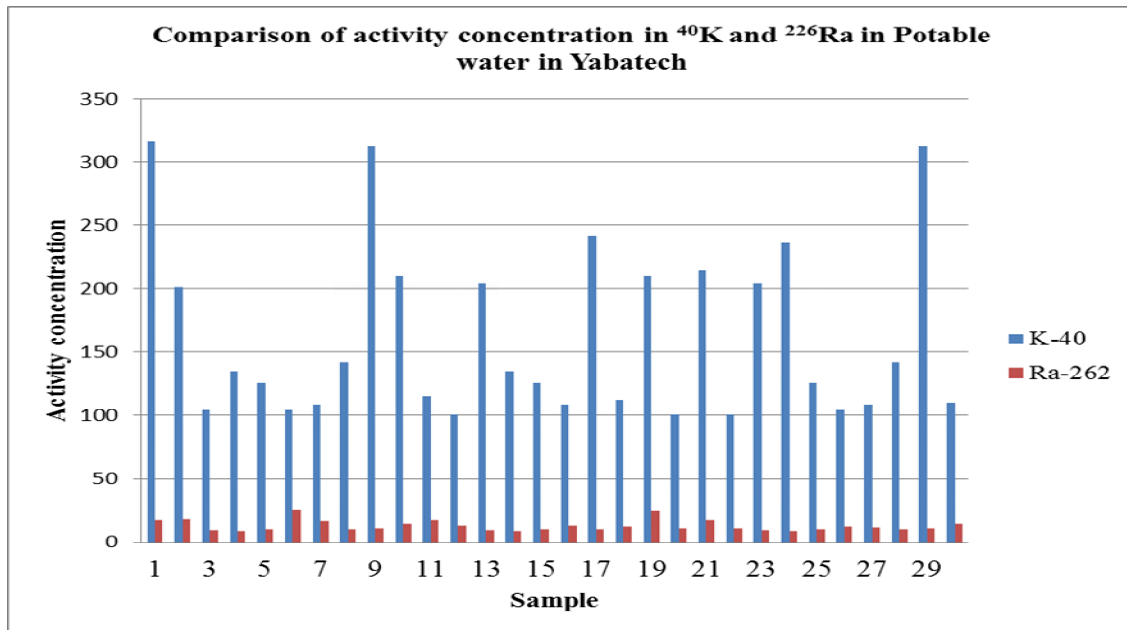


Fig.2 Activity concentration of ^{40}K and ^{226}Ra in Potable water.

Radium Equivalent Activity (Ra eq):

For the purpose of comparing the radiological effect or activity of materials that contain ^{226}Ra , ^{232}Th and ^{40}K by a single quantity, which takes into account the radiation hazards associated with them, The Raeq index $\{\text{Raeq}\} = A_{\text{Ra}} + 1.43A_{\text{Th}} + 0.077A_{\text{K}}$

Where A_{Ra} , A_{Th} and A_{K} are the activity concentrations $\{\text{Bq/kg}\}$ of ^{226}Ra , ^{232}Th and ^{40}K respectively in the samples. The calculated Raeq was 42.48 Bqkg^{-1} . This value is less than the world acceptable value of 370 Bqkg^{-1} .

a common index termed the radium equivalent activity (Raeq) is used. This activity index provides a useful guideline in regulating the safety standards on radiation protection for the general public residing in the area under investigation.

----- 1

Estimation of absorbed dose rate (D):

In order to provide a characteristic of the external gamma-ray, the absorbed dose rate D in air at 1 m above the ground (in nGyh^{-1}) was calculated using the equation below (UNSCEAR, 2000, Veiga et al., 2006) i.e

$$D (\text{nGy h}^{-1}) = 0.0417A_{\text{K}} + 0.462A_{\text{Ra}} + 0.604A_{\text{Th}} \quad \text{----- 2}$$

Where A_{Ra} , A_{Th} and A_{K} have their usual meaning as in equation 1. The absorbed dose value calculated in this work has the value 19.94 nGy / h . The Absorbed dose calculated is lower than the world average of 55 nGy h^{-1} .

In natural environmental radioactivity situations, the effective dose is calculated from the absorbed dose by applying the factor 0.7 Sv/Gy (UNSCEAR, 1993) and outdoor occupancy factor 0.2

$$\text{Effective dose rate } (\mu\text{Sv yr}^{-1}) = D (\text{nGyh}^{-1}) \times 8760 \text{ h} \times 0.2 \times 0.7 \text{ Sv Gy}^{-1} \times 10^{-3} \quad \text{----- 3}$$

The Effective dose rate obtained was $24.45 (\mu\text{Sv yr}^{-1})$.

Estimation of annual Gonadal Equivalent Dose (AGED)

The gonads, bone marrow and bone surface cells are considered as organs of interest by UNSCEAR (1988) because

they are the most sensitive parts of human body to radiation. An increase in AGED has been known to affect the bone marrow. This situation results in blood cancer (leukemia). AGED is calculated with activity concentrations ^{226}Ra , ^{232}Th and ^{40}K . (Bq /kg) using this relation:

$$\text{AGED (mSv /yr)} = 3.09A_{\text{Ra}} + 4.18A_{\text{Th}} + 0.314A_{\text{K}}$$

Where A_{Ra} , A_{Th} and A_{K} are the activity concentrations of ^{226}Ra , ^{232}Th and ^{40}K . (Bq /kg) in water samples respectively. The calculated AGED result was $140.807 (\text{mSv /yr})$.

CONCLUSION.

The radionuclide contents, activity concentrations and radiological impact of the sachet and bottled water samples sold from the food village in Yaba College of Technology, Yaba Lagos state and its radioactivity concentrations of ^{226}Ra , ^{232}Th and ^{40}K were relatively lower than the world average values. The mean

environs were investigated by means of Sodium Iodide Detector in the present study. A total of Thirty samples were collected and analysed. The results indicated that natural radionuclides were present in the samples. The natural values of absorbed dose rate, annual effective dose and the radium equivalent

activity were lower than the global average values. In order words all sachet and

bottled water sold in Yaba College of Technology are very safe for drinking according to UNSCEAR standards.

REFERENCES

- Ahmed S. Abdullahi , John S. Mathew and Chifu E. Ndikilar (2014) .An Assessment Of Gross Beta Radioactivity Concentration In Underground Water In Nassarawa Town of Nasarawa State, Nigeria. *International Journal of Latest Research in Science and Technology* 3(5) P. 71-74.
- Amurani D, 2002. Natural radioactivity in Algerian bottled mineral waters. *Journal of Radioanalytical and Nuclear Chemistry*, 252,(3): 597–600
- Forte, M., Rusconi, R., Cazzaniga, M. T., & Sgorbati, G. (2007). The measurement of radioactivity in Italian drinking waters. *Journal of Microchemical*, 85(2), 98–102.
- Ibrahim, A., El-mageed, A., El-kamel, A. E., Abbady, A. E., Harb, S., & Issa, I. (2011). Natural radioactivity of ground and hot spring water in some areas in Yemen. *Desalination*, 5, 2009–2012.
- Malanca,A, Repetti. M., Macedo. H.R, Gross alpha and beta activities in surface and ground water of Rio Grando do Norte, Brazil, *Appl. Radiat. Isot.* 49 (7) (1998) 893–898.
- Montero, M. P. R., Go, V., Escobar, Â., Sa, A. M., & Vargas, M. J. (1999). Radioactivity in bottled mineral waters. *Applied Radiation and Isotopes*, 50, 1049–1055.
- Meltem. D and Gursel. K(2010). Natural radioactivity in various surface waters in Adana, Turkey *Desalination* 261 (2010) 126–130 Elsevier B.V. at Science Direct.
- Kinyua R1, Atambo VO, Onger RM (2011). Activity concentrations of ^{40}K , ^{232}Th , ^{226}Ra and radiation exposure levels in the Tabaka soapstone quarries of the Kisii Region, Kenya. *Afr. Journal. Of Environmental Science and Technology*, 5(9): 682-688.
- UNSCEAR, 1988, United Nations Scientific Committee on the Effects of Atomic Radiation. Sources and Effects of Ionising Radiation, Report to the General Assembly, United Nations, New York.
- UNSCEAR. (1993). " Sources, effects and risks of ionizing radiation". United Nations, New York,
- UNSCEAR (United Nations Scientific Committee on Effect of Atomic Radiation) Report to the General Assembly. (2000). Report volume 1 Sources and Effects of ionizing Radiation. New York. United Nations.
- UNSCEAR. (2000b). Dose assessment methodologies. Report to the General Assembly, Annex A, ISBN 92-1-142228-7 (pp. 20–25).
- UNSCEAR. (2008). United Nations Scientific Committee on sources and effects of ionizing radiation, Report to the General Assembly, United Nations (Vol. I, p. 223). New York.
- UNSCEAR. (2010). Report of the United Nations Scientific Committee on the Effects of Atomic Radiation, Summary of low-dose radiation effects on health (pp. 6–9).
- Veiga, R. G., Sanches, N., Anjos, R. M., Macario, K., Bastos, J., Iguatemy, M., Auiar, J.G., Santos, A. M. A., Mosquera, B. ,Carvalho, C., BaptistaFilho, M., and Umisedo, N. K. (2006): "Measurement of natural radioactivity in Brazil Guidelines for drinking Water Quality World Health Organization (WHO), Fourth (4th) Edition.

PHYTOCONSTITUENTS, PROXIMATE AND MINERAL INVESTIGATIONS OF LEAVES OF *SECURIDACA LONGEPEDUNCULATA*

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ABSTRACT

The high incidence of death of children less than five years in developing countries like Nigeria due to incidence of persistence diarrhoea is raising an immense concern. Hence, this study was aimed at investigating the phytochemical and nutritional compositions of the leaves of *Securidaca longepedunculata* (violet tree) (Polygalaceae) plant from Ibadan, Oyo state Nigeria was carried out using standard methods. The phytochemical screening of the ethanol crude extract revealed the presence of flavonoids, terpenoids, alkaloids, saponin, tannins, phenols, cardiac glycosides and Phlobatannins. The proximate result confirmed that the leaf of *S. longepedunculata* have high protein (57.56 ± 0.02) and appreciable fibre content (10.50 ± 0.02). It follows the order protein > carbohydrate > fibre > ash > moisture > lipid. The mineral analysis results revealed: calcium (149.20 ppm), sodium (111.40 ppm), potassium (21.42 ppm), magnesium (13.84 ppm), iron (7.48 ppm), zinc (2.03 ppm) and copper (0.70 ppm). The results could justify the use of *Securidaca longepedunculata* in management of diseases in ethnomedicine.

Keywords: *Securidaca longepedunculata*, phytochemical, proximate, mineral, diarrhoea

INTRODUCTION

Medicinal plants have been employed from ancient times in management of diseases such as diabetes, infertility, cancer, skin infections, malaria and diarrhoea. World Health Organization have estimated that more than 80% of the world population still depend on plants as source of primarily health care needs. Plant

kingdom provides a huge reservoirs of biologically active compounds with distinctive chemical properties which can prevent or cure diseases (Rahman *et al.*, 2103). Diarrhoea is a gastrointestinal disorder characterized by an increase in stool frequency and change consistency (Amole and Salahdeen, 2010). WHO initiated Diarrhoea disease control program to combat the menace of diarrhoea by study of traditional medicine practices and prevention approaches (Darmiki and Siva, 2011). Medicinal plants have been reported as potential source of anti-diarrhoea drugs (Darmiki and Siva, 2011). *Securidaca longepedunculata* plant (Polygalaceae), commonly known as (violet tree), Ipeta in Yoruba, uwar magunguna' in Hausa and 'eze ogwu' in Igbo; is highly regarded as medicinal and magical tree. It occurs in the North-West and Limpopo provinces of South Africa and Mozambique and widely distributed in tropical Africa. It is available between April and August each year (Ojewale, 2008).

Traditionally, the plant was used in treatment of inflammations, abortion, ulcers infertility, tuberculosis, venereal diseases, and toothache (Schmidt *et al.*, 2002). Secondary metabolites such as tannins, phlobatanins, alkaloid, flavonoid and cardiac glycoside have been reported from the root powder (Schmidt, *et al.*, 2002). The present study was to investigate the phytochemicals and nutrient composition of the leave of *S. longepedunculata*.

MATERIALS AND METHOD

Collection and Preparation of Plant Materials

The leaves of *S. longepedunculata* were collected from Ibadan, Oyo State, Nigeria. It was authenticated (LUH 6108) by Mr Oyebanji of the

University of Lagos Herbarium, washed, air-dried, pulverized and kept ready for use.

Extraction of Plant Material

100g of pulverized whole plant of *S. longepedunculata* was extracted with methanol for 72 h and filtered. The filtrate was concentrated to dryness using *vacuum oven* at 40°C to obtain a crude dark green extract. The crude extract was kept in refrigerator at 4°C for further use.

Preliminary Phytochemical Screening

Phytochemical tests were done using methanol extracts and pulverized leaf of *S. longepedunculata* to determine the presence of the active phytochemicals (such as alkaloids, phenols, tannin, cardiac glycosides, quinone, steroids flavonoids, terpenoids, cardenolide, saponin, anthraquinones and photobatanin). The metabolites were determined using adopted standard methods (Asekun *et al.*, (2013)

Proximate analysis

Analysis for proximate contents of the coarse leaves powder of *S. longepedunculata* was done by methods described by Association of Official for Analytical Chemistry (AOCS., 2000). The sample was analyzed for moisture contents, carbohydrates, crude fibre, crude protein, total ash, crude fats (lipids). The nitrogen value which is the precursor for protein of a substance was determined by micro kjeldahl method. The nitrogen value was converted to protein by multiplying to a factor of 6.25. All the proximate values were reported in standard deviation (Okwu, (2004), (Akindahunsi and Salawu, 2005)

Mineral analysis

The minerals content of the leaves of *S. longepedunculata* plant was investigated according to analytical methods (AOAC., 2003), for its elemental composition by using atomic absorption spectrophotometer (AAS). The solution for the determination of mineral element was prepared by wet digestion using the aqua-regia method.

Pulverized plant sample (5g) was accurately weighed into a crucible and transferred into a preheated muffle furnace at 550°C for 5 hours. To the ash sample, 10ml of aqua regia (nitric acid and hydrochloric acid, 1:3) was added and made up to 50 ml with de-ionized water. The resulting solution was stirred and filtered through a whatman no 540 filter paper and the filtrate taken for analysis. The elements magnesium, calcium, iron, copper, chromium, cadmium, potassium, sodium and zinc were determined from the above solution using the Atomic Absorption Spectrophotometer Analyst 200 model.

Statistical Analysis

Results were presented in simple concentrations based on percentages and all data were expressed as Mean \pm S.D of three independent values for each variable.

RESULTS AND DISCUSSION

The result of phytochemical screening of *S. longepedunculata* is as shown in table 1. The phytochemicals such as alkaloid, phlobatannin, flavonoid, tannins, cardiac glycoside, terpenoids, saponin and phenol were present from this study. The result correlates with tannins, phlobatannins, alkaloids, flavonoids and cardiac glycoside in the root as reported (Schmidt, *et al.*, 2002). Saponins have been reported to show tumor inhibiting activity on experimental animals (*Rattus novergicus*) (Akindahunsi, and Salawu, 2005). The terpenes function as antioxidants, protecting lipids, blood and other body fluids from assault by free radical oxygen species (Higdon, 2007). The biological activities of flavonoids include action against allergies, inflammation, free radicals, hepatotoxins, platelet aggregation, microbes, ulcers, viruses and tumors (Osuntokun and Olajubu, 2014).

The result of proximate analysis is as follows fiber (10.50 ± 0.02), moisture content (10.50 ± 0.02), total ash (5.30 ± 0.07), lipids (3.58 ± 0.04), protein (57.56 ± 0.02), and carbohydrate (18.37 ± 0.01). The nutrient compositions follow the descending order: Protein> carbohydrate> fiber> Ash>

moisture> Lipid. The result revealed *S. longepedunculata* as a potential source of protein and fiber which need to be harnessed for health. The protein content from this study was very high (57.56%) compared to (22.31%) as reported (Gidado *et al.*, 2013). The ash content was lower (5.30 %) than that (16.73%) reported (Gidado *et al.*, 2013). The health benefits of protein include the involvement of its essential and non-essential amino acids as building block for protein synthesis, not only for growth of infants and children, but also for the constant replacement of turnover of the body protein in adults (Akindahunsi and Salawu, 2005). Fibre lowers the body cholesterol level, thus reducing the risk of cardiovascular diseases and diabetes (Higdon, 2007).

Mineral analysis results (Table 3) indicated high concentrations of calcium (Ca), sodium (Na) and magnesium (Mg) potassium and iron in the leaves of *S. longepedunculata*. The mineral contents in descending order: Ca → Na → K → Mg → Fe → Zn → Cu. The calcium and sodium content of *S. Longepedunculata* (Ca = 149.20 ppm and Na = 111.40 ppm) from this study were higher than the result (Ca = 71.50 ppm and Na = 52.76 ppm) reported for *Vernonia amygdalina* (Asaolu, *et al.*, 2012). Minerals play vital role in the function, effectiveness and absorption of certain vitamins. Calcium is desired in herbs because it helps to ease insomnia and helps regulate the passage of nutrients through cell walls, without calcium the muscles in the body cannot contract correctly, the blood in the body will not clot and the nerves will not carry message (Payne, 1990). Sodium helps in the production of osmotic pressure and also regulates fluid exchange between the cell and the surrounding tissues in the body (Long *et al.*, 2007). Magnesium is needed in diet because it is an active components of several enzyme systems in which thiamine pyrophosphate (TPP) is a co-factor (McDowell, 1992). Iron performs several functions in the body hence desired in herbs for maintenance of good health. It helps in formation of blood, transfer of oxygen and carbon dioxide from one tissue to another (McDonald *et al.*, 1995). Iron is an important trace element in the human body, it

plays crucial roles in haemopoiesis, control of infection and cell mediated immunity (Bhaskaran, 2001). The deficiency of iron has been described as the most prevalent nutritional deficiency and iron deficiency anemia is estimated to affect more than one billion people worldwide (Trowbridge and Martorell, 2002). The consequences of iron deficiency include reduced work capacity, impairments in behavior and intellectual performance and decrease resistance to infection (Dioxon and Haris, 2004). Zinc plays a vital role in gene expression, regulation of cellular growth and participates as a co-factor in several enzymes responsible for carbohydrates, protein and nucleic acid metabolism (Lehninger, 1990).

CONCLUSION

The presence of secondary metabolites such alkaloids, phenolic compounds, saponins and anthraquinones, nutrients such as lipids, fiber and protein; and minerals like Mg, Fe, K, Na, Ca and Zn in *Securidaca. longepedunculata* may be responsible for its use in ethno-medicine. There is therefore, need to quantify the phytochemicals present and isolate the bioactive metabolites which may be a novel lead compound for drug discovery.

REFERENCES

- Agbaje, E. O. and Adekoya, M. E. (2012). Toxicology profile of aqueous root extract of *Securidaca longepedunculata* Fresen, *International Journal of Toxicology and Pharmacology Research*; 4(1): 5-11
- Akindahunsi, A. A. and Salawu, S. O. (2005). Phytochemical screening of nutrient-antinutrient composition of selected tropical green leafy vegetables *Afr. J. Biotech.*, 4: 497 – 501
- Amole, O. O. and Salahdeen, H. M. (2010). Evaluation of the antidiarrheal effect of *Lennar welwitschii* Hiern (Anarcardiaceae) bark extracts. *Afr. J. Pharmacol*, 4(4): 165-169

- AOAC** (2003). Official Methods of Analysis of the Association of Official's Analytical Chemists, 17thedn. Association of Official Analytical Chemists Arlington, Virginia
- AOCS** (American Oil Chemist Society) (2000). Official methods of analysis 5th edition. Association of official analytical chemists, Washington, DC, USA
- Asaolu, S. S., Adefemi, O. S., Oyakilome, I. G., Ajilbulu, K. E., and Asaolu, M. F.** (2012). Proximate and Mineral Compositions of Leafy Vegetables, *Journal of Food Research*; **1**(3) 214-218
- Asekun, O. T., Asekunowo, A. K. and Balogun, K. A.** (2013). Proximate Composition, Elemental Analysis, Phytochemistry and Antibacterial Properties of the Leaves of *Costus afer* KER GAWL and *Cedrela odorata* L. from Nigeria, *Journal of Sci. Res. Dev.***14**: 113 – 119
- Bhaskaran, P.** (2001). Immunobiology of mild nutrient deficiency. *Br. J. Nutr.*, 85S75-S80.
- Darmiki, L. and Siva, H.** (2011). Ethnomedicinal plants used for diarrhea by tribal of Meghalaya, North east India. *Pharmacogn Rev.* **5** (10) 147-154.
- Dioxon, B. M., and Haris, E. M.** (2004). Nigeria food consumption and nutrition survey, 2001-2003
- Gidado, O. G., Kibon, A., Gwargwor, Z. A., Mbaya, P. and Baba. M. J.** (2013). Assessment of Anti-Nutritive Factors and Nutrient Composition of some Selected Browse Plants use as Livestock Feeds in Taraba State. *Inter Journal Applied Science Engineer*, **1**(1): 5-9
- Higdon, J.** (2007). An Evidence – Based Approach to Dietary Phytochemicals Theime. ISBN 978-1-58890-408-9
- Lehninger, A. L.** (1990). Principles of Biochemistry 2nd Ed., Royal Offset Press, Delhi, India: 249-264.
- Long, Y., Fu, C. Y., Tian, X. Z., Chen, J., Han, M. and Wang, R.** (2007). Mechanism of relaxing response induced by rat/mouse hemokinin-1 in porcine coronary arteries: Role of potassium ion and nitric oxide. *Eurp. J. Pharmacol*, **569**(1-2): 119-125.
- McDonald, A., Edwards, R. A., Greenhulgh, F. D. and Morgan, C. A.** (1995). Animal Nutrition; Prentices Hall, London. 101-122
- McDowell, L. R.** (1992). Minerals in animal and human nutrition; Academic Press, Inc. New York: 1-77
- Rahman, M. K., Barua, S., Islam, M. F., Islam, M. R., Sayeed, M. A., Parvin, M. S., and Islam, M. E.** (2013). Studies on the anti-diarrheal properties of leaf extract of *Desmodium puchellum*. *Asian Pacific journal of tropical biomedicine*, **3**(8), 639-643.
- Ojewale, J. A.,** (2008). Analgesics, anti-inflammatory and hypoglycemic effects of *Securidaca longepedunculata* (Polygalaceae) root back aqueous extract. *Inflamma pharnacology* **16**(4):174-181
- Okwu, D. E.** (2004). Phytochemicals and Vitamin content of indigenous spices of South-Eastern Nigerian, *Journal of Sustaining. Agric. Environ* **6** (1):30-37.
- Osuntokun O. T and Olajubu F. A.** (2014). Comparative Study of Phytochemical and Proximate Analysis of Seven Nigerian Medicinal Plants, *Applied Science Research Journal.* **2** (1)10 – 26
- Payne, W. J. A.** (1990). An Introduction to Animal Husbandry in the Tropics. Longman Publishers, Singapore. 92 -110
- Schmidt, E., Lotter, M. and McClelland, W.** (2002). Trees and Shrubs of Mpumalanga and Kruger National Publication Park. Jacana. Publication, Haughton, Johannesburg.
- Trowbridge, F., and Martorell, M.** (2002). Forging effective strategies to combat iron deficiency. Summary and recommendations. *J. Nutri.*, **85**, 875-880. <http://dx.doi.org/10.1079/BJN2000297>
- WHO** (2004). World Health Report (R) Geneva: WHO; p 120-125

TABLES AND FIGURES

Fig 1: *Securidaca longepedunculata* Plant



Table 1: Phytochemical Screening of leaves of *S. longepedunculata*

Phytochemicals	Methanol Extract
Alkaloid	+
Flavonoid	++
Tannins	+
Saponin	+
Phenols	+
Terpenoids	++
Quinones	ND
Anthraquinones	ND
Glycosides	++
Cardenolides	ND
phlobatannins	++

Key: ++ = Highly present;
+ = present;
ND = Not detected

Table 2: Results of Proximate Analysis of leaves of *S. longepedunculata*

Proximate	% Composition
Fiber	10.50 ± 0.02
Moisture	4.70 ± 0.05
Total Ash	5.30 ± 0.07
Lipids	3.58 ± 0.04
Protein	57.56 ± 0.02
Carbohydrate	18.37 ± 0.01

Results = mean ± SD of three determinants

Table 3: Mineral composition of *S. longepedunculata*

Elements	Concentration (ppm)
Calcium	149.20 ± 0.51
Magnesium	13.57 ± 0.10
Iron	7.48 ± 0.07
Copper	1.17 ± 0.04
Potassium	21.42 ± 0.20
Zinc	2.03 ± 0.01
Sodium	111.40 ± 0.45

Results = mean ± SD of three determinants

Mineral composition of *S. longepedunculata*

