



EDUCATION FOR SUSTAINABLE DEVELOPMENT IN AFRICA

**REFEREED PAPERS FROM
THE 3RD UNIVERSITY OF CAPE COAST AND
UNIVERSITY OF ILORIN
JOINT INTERNATIONAL CONFERENCE**

**EDUCATION FOR SUSTAINABLE
DEVELOPMENT IN AFRICA**

Refereed Papers from
The 3rd University of Cape Coast and
University of Ilorin
Joint International Conference

Supervising Editor:
Prof. P. K. Buah-Bassuah

FOREWORD

The 3rd Joint UCC-UNILORIN Conference, which was on the theme “Education for Sustainable Development in Africa”, focused on sensitive areas that brought to bear various developmental needs of the continent and the subsequent implementation of solutions to issues raised at the plenary and clinical sessions. In order to attend to the needs of Africa’s socio-economic development, the forum enabled participants to explore various areas that could solve our national problems and enhance sustainable development.

Education seeks to supply the scientific and technological know-how of mankind by building capacities and instilling in us new skills, without losing sight of the positive and negative impact that can influence our environment and mindset. The need to package education for people in all sectors to be active and productive relies, most essentially, on continuous education through electronic and distance learning to raise awareness in environmental and health education and to place value on the knowledge imparted or acquired. The conference brought together researchers, students, lecturers, engineers, administrators, lawyers and policy makers to share their experiences from the two educational systems in Nigeria and Ghana, and to discuss the sustainability of our systems of education. The conference realised the enormous benefits which included the link established and the continuous collaboration among many faculties in the two universities.

We hope this friendly collaboration would be strengthened to foster possible expansion of this exercise into other disciplines. This volume should translate our thoughts into practice for the economic growth of our nations.

Vice Chancellor, Prof. D.D. Knuipole, University of Cape Coast.

PREFACE

publication is the third in the series of joint international conferences organized by University of Cape Coast (Ghana) and University of Ilorin (Nigeria), which was organized in Cape Coast August 11-16, 2013 on the theme "Education for Sustainable Development in Africa".

The number of papers being published in this edition on the theme is summarized under the following sub-themes in the table below:

Sub-themes	Number of Papers
Art and Law Education	2
Environmental and Health Education	6
Electronic Learning and Distance Education	3
Science and Technology Education	10
Informal and Formal Education	6

Twenty-seven (27) papers presented at the conference were peer-reviewed and accepted for publication. Out of this number, nine papers came from Ghanaian participants and eighteen from Nigerian participants. The diversity of the topics and the depth of the studies reported make these accepted papers ideal for this publication.

The editors are indebted to Mr. Peter Osei-Wusu Adueming and Miss Arlotte Kyeremah for putting together all the refereed and corrected papers and coming out with the final manuscript. We also acknowledge our Nigerian counterparts, most especially, Prof. J.O. Atteh and Prof Y. A. Quadri, for their immense contribution in coming out with this edition.

Finally, we recognize the active role played by the two Vice Chancellors, Dr. Kuupole of UCC and Prof. Is-Haq Olanrewaju Oloyede of Unilorin) helping to come out with the 3rd edition.

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SECTION FIVE
INFORMAL AND FORMAL EDUCATION

STRUCTURE AND POTENTIAL OF *AMARANTHUS HYBRIDUS* L. AS A SOURCE OF DIETARY FIBRE IN FOODS

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Abstract

In recent times, nutrition expert have introduced a new food recipe with a view to improve human health. One of these ideas is to enhance dietary fibre content and to improve food digestibility and bowel movement. The known health benefits of dietary fiber intake call for increased awareness of the need to examine the potential benefits to our health through increased dietary fiber. In this study, the effect of the plant fibres on the blood sugar, live weight and packed cell volume of albino rats is studied by feeding the rats with the processed *Amaranthus hybridus* wood fibres added to the animals' normal diet for a period of 28 days across four treatments (control, 10%, 15% and 20% plant fibres). These cellulosic materials did not cause a reduction in the live weight of the experimental animals. A paired sample t-test conducted on the two sets of data indicated no significant difference ($P = > 0.05$) in the mean difference between mean initial and final haematocrit (i.e. PCV). Also, a paired t-test conducted on the initial and final blood sugar using the R statistical package showed that feeds with fibre contents have equal effects on blood sugar of rats. Therefore, the wood fibre supplemented diet did not have any deleterious effects on the quality and quantity of the rats' blood. Processed cellulosic wood fibres were also used in baking bread which did not negatively affect the physical, chemical and baking properties of bread; rather, it prolonged the shelf-life of the bread. In conclusion, since African forests are blessed with abundant economic trees, shrubs and herbs that can be tapped and used as fibres in baking products, it will be reasonable to use these plants for the purpose. This act will improve the health of people who eat such foods, and at the same time prevent further wasteful exploitation of forest resources.

Keywords: *Amaranthus hybridus* wood, blood sugar, bread nutritional diseases, live weight, PCV.

Introduction

Africa is endowed with valuable economic forest trees which are mainly exploited by majority of the rural folk for firewood. Many valuable items among which are wood fibres are derived from these trees. Fiber is defined to be the components of plants that resist human digestive enzymes, a definition that includes lignin and polysaccharides. Different types of plants vary in their amount and kind of fiber. Fiber includes pectin, gum, mucilage, cellulose, hemicellulose and lignin. Pectin and gum are water-soluble fibers found inside plant cells. They slow the passage of food through the intestines but do nothing to increase fecal bulk. Insoluble fibers also decrease cholesterol and can help lower blood glucose. Fibres have been found to considerably modulate hepatic, blood and intestinal lipids and lipoprotein profiles.

Dietary fiber comes from the portion of plants that is not digested by enzymes in the intestinal tract. Part of it, however, may be metabolized by bacteria in the lower gut (Kritchevsky, 1988; Dreher, 1987). Dietary fibre increases the bulk of stool and stimulates motion of the large intestine. It absorbs water, lubricates the large intestine, and makes defecation easier. Dietary fibre stimulates the secretion of digestive fluids and the action of "good" bacteria in the intestine; thereby, stimulating the formation of vitamin B2. Dietary fibre also prevents the accumulation of cancer-causing (or carcinogenic) materials because it shortens the retention period of waste materials.

The source of wood in this study is *Amaranthus hybridus* L. It belongs to the family Amaranthaceae. *A. hybridus*, commonly called smooth amaranth, smooth pigweed, red amaranth, or slim amaranth, is a species of annual flowering plant. The plant was used for food and medicine by several Native American groups and in traditional African setups. The raw amaranth grain contains toxins and anti-nutritional factors that can reduce its effectiveness as an animal feed. Recent research has confirmed the use of cooked or autoclaved amaranth grain for use as chicken feed, giving production results comparable to those from feeding corn/soybean ration (Acar *et al.*, 1988). *A. hybridus* and *A. retroflexus* have been successfully incorporated into feed for calves and sheep as forage, with the results obtained not significantly different from that of alfalfa (Grubben & Denton, 2004).

The present study is to determine the potential of *Amaranthus hybridus* fibre as a source of dietary fibre by examining the percentage blood packed cell

volume (PCV), blood sugar level and live weight response of experimental animals fed on diets containing the plant fibres. The study also assessed the physical parameter of laboratory-baked bread from fibre supplemented wheat flour with a view to determine the extent of acceptability of wood fibres in diets and establishing the possibility of adding processed plant fibre to baked foods.

Materials and Methods

Study Materials

The plant material used was the stem of 2 months old *Amaranthus hybridus*. Sixteen albino rats of eight weeks old were purchased along with their normal compounded feed from Biochemistry Department, University of Ilorin, Ilorin, Kwara State, Nigeria. The rats were marked for the purpose of identification and were acclimatized for two weeks in cages with access to their normal diet and water. Wheat flour was mixed with wood fibre of *Amaranthus hybridus* to bake loaves of bread.

Wood Anatomical Studies

From freshly collected wood disc sample (of 2 months old), a shorter wood disc of about 2cm was cut by means of razor blade and immediately fixed in formal-acetic-alcohol (FAA) contained in a labeled specimen bottle (Jane, 1970). Thin transverse sections (TS) and tangential longitudinal sections (TLS) of about 10 microns were cut from the wood blocks by the use of a freezing stage microtome. Staining was in phluoroglucinol and concentrated HCl for 5min and mounting was done using dilute glycerine. A total of eight slides (four for each of TS and TLS) were prepared for observation.

Tissue Maceration

Tissue maceration was done by boiling a small block of wood for 5min in concentrated Nitric acid (HNO_3) to which a few crystals of potassium chlorate had been added (Ademiluyi and Okeke, 1975). The softened tissue was washed in several changes of water, transferred onto a microscope slide and teased out by tapping gently with a glass rod for some minutes. Staining in Safranin 'O' and mounting in glycerine then followed. The prepared slides were examined under a CARTON monocular light microscope and observations on the TS photographed. The percentage composition by volume of wood tissue in respect of fibres, vessels, axial parenchyma and

rays were also determined from the slides of plant TS. In doing this, an ocular micrometer with an area of 100 squares was used. An area of four squares on the micrometer was used at a time and each tissue type that fell within this area was noted. Twenty five (25) of such observations were made within the 100 squares area. The combination by volume of a tissue type was determined as a simple percentage of the total number of occurrences within the 100 squares of the micrometer. Four of such slides were observed and the mean value reported. A standard ratio, namely the fibrous tissue-to-non fibrous tissue ratio (F/NF) was then computed from the data.

The mean number of cells of each tissue type, number of fibres, vessels, axial parenchyma and rays per mm^2 were determined, using the TS and TLS slides. In each case, the ocular grid of 100 squares whose dimension had been calculated was used. The slide was made to pass over the grid at known objective lenses and the number of cells of each tissue type occurring within the grid was counted. This number was then converted into the appropriate number in one mm^2 of wood by simple ratio, the sample size being 30.

With regard to the slides of tissue maceration, attention was focused on such fibre properties as the type, shape and dimensions. Fibre length (L), diameter (D), lumen width (I), and wall thickness (C) were determined with the aid of a calibrated ocular micrometer fitted in to the microscope. The sample size in each case was 30. From the various cell dimensions, two derived ratio namely coefficient of flexibility (I/D) and relative fibre length or fibre slenderness (L/D) were calculated.

Preparation of Plant Fibres Use in Feeding Albino Rats

The stem was rinsed in several changes of distilled water. This is to ensure that unwanted particles like sand, stones and insects were removed. After rinsing, the stem was then sun dried for days to reduce its moisture content. This is to allow for easy grinding of the stem. The ground plant fibre was later allowed to pass through a fine sieve number 40 (i.e. 450 μm) and stored in a labeled plastic bags.

Feeding Trials of Albino Rats with Wood Fibres as a Supplement

After the period of acclimatization, the rats were divided into four diet groups, each containing two males and two females. The initial live weight of all the rats was determined in grammes with the aid of a weighing balance. The percentage blood packed Cell Volume (PCV) and blood sugar

level of each rat was also determined (see below). The first group which was fed on normal diet served as the control (Feeding Trial 1). The second was placed on 10% plant fibre mixed with 90% normal feed (Feeding Trial 2); the third on 15% plant fibre mixed with 75% normal feed (Feeding Trial 3) and the fourth on 20% plant fibre mixed with 80% normal feed (Feeding Trial 4). Each of the groups was supplied with the same quantity of feed in powdered form and water for a period of four weeks.

Percentage Feed in take

The percentage feed intake per week was taken as the diet's preference index for each of the four treatment levels. This was determined as a percentage, using the formula of Ogunkunle *et al.* (2003).

$$\frac{T_c - T_1}{T_c} \times 100$$

Where T_c = cumulative weight of rat meal supplied to a group in one week
 T_1 = left over of the meal at the end of the week

The live weight of all the rats was taken weekly for four weeks. Our choice of albino rat was because it has the closest alimentary and digestive system with human.

Blood Packed Cell Volume (PCV) and Blood Sugar Level

The percentage blood Packed Cell Volume (PCV) of each rat was determined with the aid of haematocrit centrifuge (Barrelet, 2004) at University of Ilorin Teaching Hospital (UITH), Ilorin, Nigeria. The blood sugar level was determined with the aid of a glucometer. The percentage blood PCV and blood sugar were observed at the beginning of the first week and at the end of the fourth week of feeding rats with diets containing wood fibres.

Baking of the Bread

Flour doughs of bread (one control and three experimental doughs) were prepared at The University's Bakery. The liquid ingredient was first prepared (recipe for dough preparation: wheat flour 50g; dried yeast 0.8g; warm water 30ml; sugar 0.1g; salt 0.1g). The appropriate quantity of flour was then added little by little with stirring in a neat bowl. The paste that resulted was kneaded gently with thumb and finger index for about 5mins. A piece of clean wood roller was then used to thoroughly mix the dough on a

wooden platform. The dough was covered and left for about 25mins before it was rolled into a small ball and placed in a rectangular baker's can of 8cm x 16cm which had been oiled inside.

To each of the experimental dough liquid ingredient, 0.25g, 0.5g and 1.0g of the processed wood fibre was respectively mixed thoroughly with 50g of wheat flour before dough preparation. Each of the four sets was prepared in four replicates and placed in the oven at 120°C for about 1 hour. The bread was confirmed baked when tapping the can underneath which gave a hollow sound.

Assessment of the Loaves of Bread

All the 16 loaves of bread were assessed for acceptability for colour, texture, and flavour. The 25 randomly selected individuals scored the three parameters over a two-point scale acceptable or unacceptable. Also, some mean dimensional characteristics of the loaves of bread such as mean weight (g), height (cm), area (cm²) and volume or size (cm³) were determined. The height of a loaf was measured by inserting a long needle through the thickest portion of it, marking off the height and determining the extent in centimetre on a metre rule. The area occupied by a loaf was calculated in cm² using the graphical method. The data on the height and area of loaves were used to compute their volume in cm³.

The shelf life of the four categories of bread was determined by exposing the loaves to the open laboratory conditions and observing them closely by means of hand lens for one week. The number of days that passed before any noticeable infestation by fungus was taken as the shelf life of the loaf of bread.

Statistical Analyses

A paired-sample T-test was conducted on the initial and final haematocrit and blood sugar values for all the rats. One-way ANOVA was also conducted at 3 different levels (Bailey, 1995) on the data from albino rat feeding trials. There are four treatments that were analyzed, namely the weekly data for four weeks with four replications within each treatment. In all, the life weight of the rat was taken as a dependent variable. The other sets of data that were analyzed by means of one-way analysis of variance included the mean of weekly percentage feed intake of rats, the mean weight, and mean volume of each loaf of bread. Tukey's test was used to find

significant differences between treatment means of the live weight of the rats as well as their preference index.

Results and Discussion

Wood Anatomy

Shown in Fig. 1 where the fibres in *A. hybridus* are found is the portion of the fibre by volume composition of wood is 45.10%; vessel 7.81%; axial parenchyma 8.87%; and ray 38.21%. Moreover, the number of fibres per mm² of the wood far outstrips the number of axial parenchyma or ray. The fibres in *A. hybridus* wood are all of the libriform type. The mean fibre length of 58.00mm is long within the context of wood anatomical definitions but they are sufficiently thin-walled and the relative length of 45.10 is high. The fibres are also not flexible, as indicated by a low coefficient of flexibility or measure of fibre slenderness (i.e. 0.01). Furthermore the vessels are relatively thin-walled and narrow (Table 1). These vessels would, therefore, readily collapse and blend with the libriform fibres during mechanical processing. Because of their flexibility and microscopic sizes, these two cellulosic materials would likely make a good mix with regular bakery products and other special types of food.



Fig. 1: The Transverse Section of the Wood of *Amaranthus Hybridus*

Percentage proportion by volume					Number/mm ²		Fiber dimensions (μm)							Vessel dimensions (μm)		
	Fibre	Vessels	Parenchyma	Ray	Fibre	vessels	Parenchyma	Ray	Length	Diameter	** RFL	Lumen	Wall thickness	*Coeff of flex	Diameter	Wall thickness
Mean	45.10	7.81	8.87	38.21	5.8	10	11.20	49	2410	180	14.14	155	12.5	0.85	11.20	8.75
Standard error	±5.80	±1.52	±0.65	±5.24	±.98	±2.26	±1.39	±8.86	±274.39	±20	±2.43	±20	±0.00	±0.01	±37.58	±1.53

Table 1: Some Wood Dimensional Characteristics in *Amaranthus Hybridus*

*coefficient of flexibility = fibre lumen width/fibre diameter.

**Relative Fibre Length (RFL) = fibre length/fibre diameter.

Response of Albino Rats to Cellulose Fibre Supplemented Diet

The responses of albino rats to the four feeding trials are shown in Table 2. Although the preference index of rats diet increased with increasing wood fibre content in their meal, the treatment means did not show any significance differences between them, $P = 0.00599$ (Table 2). This implies that although the fibre-free diet was least preferable to the rats, the other treatment was acceptable to them. The constantly high and close values of the preference indices at the third and fourth weeks for the four treatments corroborate this assertion.

Table 2: PCV, blood sugar and live weight response of albino rats to four feeding trials diets over a period of four weeks

Feeding trial	Parameter	Initial value	First week	Second week	Third week	Fourth week	Mean
Control (100% normal diet)	*Preference index (%)		46.86	68.71	68.14	57.85	60.39
	**Body weight (g)	162.50	142.30	186.00	191.00	181.50	
	% weight increase					11.70	
	PCV (%)	47.75				60.75	
	Blood sugar	3.75				2.7	
10% Wood fibre	Preference index (%)		68.71	77.61	74.86	75.57	74.19
	Body weight(g)	235	226.50	227.50	224.25	194.75	
	% weight increase					17.13	
	% weight reduction					146.41	
	PCV (%)	49.50				57.50	
	Blood sugar	2.95				3.15	
15% wood fibre	Preference index (%)		70.92	85.59	86.82	68.29	77.91
	Body weight (g)	135.50	193.50	220.75	209.75	204.75	
	% weight increase					51.11	
	% weight reduction					436.81	
	PCV (%)	51.52				54.25	
	Blood sugar	2.80				2.85	
20% wood fibre	Preference index (%)		90.42	84.42	89.85	76.71	85.35
	Body weight (g)	227.80	215.30	220.25	203	201.25	
	% weight increase					11.66	
	% weight reduction					99.62	
	PCV (%)	45.75				54.00	
	Blood sugar	3.33				2.78	

*(i) Preference index or diet index is the % food intake per week.

**% body weight reduction for each experimental level= %weight increase for the level/%weight increase for control X 100

Feed Preference Index

Due to the nature (quantitative) and structure (one-way) of the data set arising from the experiment on preference index of rats, one-way analysis of variance (ANOVA) was conducted, using R statistical package (<http://www.CRAN.org>). Analysis showed (Appendix 1) that average feed intake was not the same for all the rats. It then becomes necessary to proceed to conduct a multiple comparison test using Tukey's Honestly Significant Difference Test (Tukey's HSD). From the Tukey HSD (Appendix 2) and boxplot (Fig. 2), it is evident that only feed contents (Trial 2 and control) and (Feeding Trial 2 and Feeding Trial 1) are significantly different. This implies that the most preferred feed by the rats is the feed with 20% fibre content (Feeding Trial 3), followed by the feed with 15% fibre content (Feeding Trial 2) and 10% fibre content (Feeding Trial 1) respectively while least preferred is the feed with 0% fibre content. The line across each box represents median feed content consumed by the rats while the tick line across the diagram is the overall mean average feed content consumed.

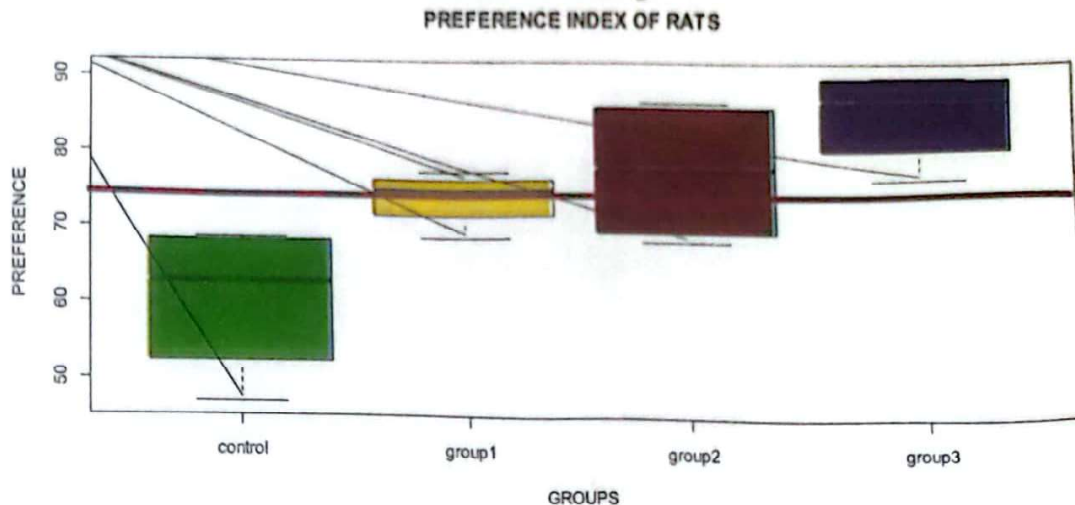


Fig. 2: Preference Index of Rats

Packed Cell Volume (PCV)

When paired t-test was conducted on the initial and final PCVs using the R statistical package, it was observed that only true difference between average initial and final PCV for the rats is zero for all the groups. It is, therefore, evident that feeds with fibre contents have no effect on PCV of rats (Appendix 3).

Data Analysis on Blood Sugar

Paired t-test was conducted on the initial and final blood sugar, using the R statistical package. It was evident that true difference between average initial and final blood sugar for all the treatments is zero. It is, therefore, evident that feeds with fibre contents have equal effects on blood sugar of rats (Appendix 4).

Live Weight of the Albino Rats

The mean live weight of all the albino rats used increased throughout the four weeks of experimentation (Table 2). At the end of the first week, the lowest mean weight of 135g was recorded in the rats fed at 15% fibre level while the highest (227.50g) was in those fed at 10% fibre level. Similarly, at the end of the fourth week, the lowest and highest mean live weight of 53g and 66.50g were recorded in these two categories of rat. The ANOVA table shows that effects of feeds on weight of rats are not the same (Appendix 5). We, therefore, proceed to conduct a multiple comparison test using Tukey's Honestly Significant Difference Test (Tukey's HSD) to investigate significant differences between pairs of feed contents. From the Tukey HSD (Appendix 6) and the box plot (Fig. 3), it is evident that only effects of the feed contents (Feeding Trial 1 and control), (Feeding Trial 3 and control) and (Feeding Trial 3 and Feeding Trial 1) are significantly different. The most effective feed content on weight of rats is the feed with 10% fibre content (Feeding Trial 1), followed by the feed with 20% fibre content (Feeding Trial 3) while feed with 15% fibre content has the least effect on live weight of rats. The line across each box represents median live weight of rats while the tick line across the diagram is the overall average feed live weight of rats.

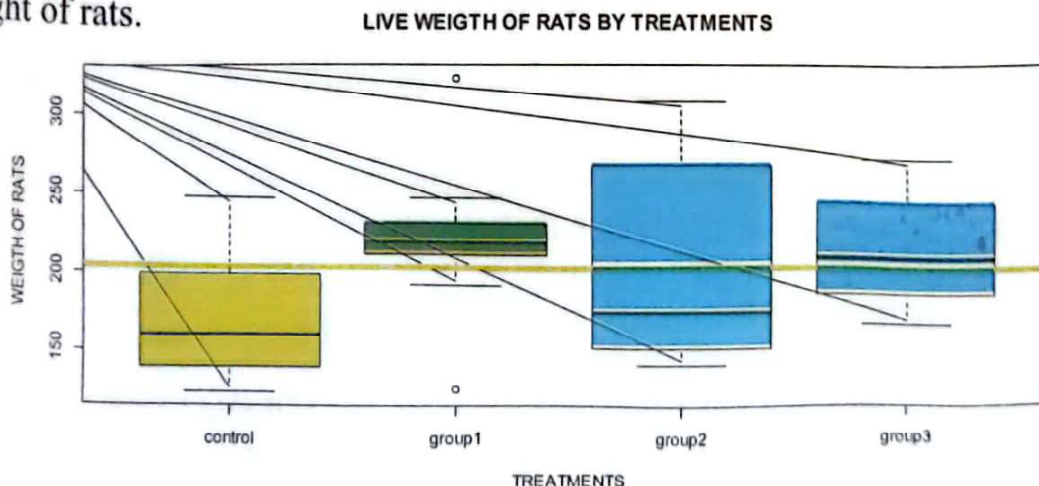


Fig. 3: Live Weight of the Albino Rats

The result of the ANOVA conducted on the live weight responses of the rats showed a high significance at three factor levels namely; treatments, weekly responses and replication ($P < 0.001$). A further test of the least significant difference (LSD) between them shows that there is no significant difference between the control on one hand and the 10% or 15% fibre levels of treatment on the other, P being $>$ than 0.05. Moreover, a high level of significant difference ($P, 0.001$) was obtained for the mean difference in the weight of rats of the control and the 20% fibre level treatment. The mean difference is highly significant and the level of significance is indicated i.e. $P < 0.001$.

These statistical results would probably elicit an immediate suggestion that the 10% and 15% treatment levels would be more appropriate for the body weight regulation in albino rats. Such a suggestion would, however, be erroneous. This is because the statistical results were based only on the mean live weight differences which incidentally were consistently high for all the rats under 20% fibre treatment rights from the pre-experimental weeks (Table 2). These weights were, however, relatively low and consistently so in the other three treatments prior to and throughout the period of the experiment.

The more reliable body weight data would probably be the relative percentage body weight increase within the period of the experiment. If one calculates the percentage live weight increase for the four treatments, one obtains 11.70% for the control and 17.13%, 51.11% (the highest) and 11.66% for the other three treatments respectively. This shows that the 10% fibre level treatment might have caused a body weight reduction by 9%; the 15% level by about 5% and 20%, level 10% relative to control. Osilesi *et al.* (1992) observed that cellulose (an insoluble fibre) did not lower plasma cholesterol nor did it bind bile acids *in vitro* or *in vivo*. Our findings are in contrast to this position because the cellulose fibres used did lower the live weight of our experimental animals by between 5% and 10%.

Haematocrit Values

The mean initial and final haematocrit values for the experimental rats are shown in Table 2. In all but the 20% fibre level of treatment, the percentage blood PCV increased by between 0.5% and 6.0% within the four weeks of experimentation. A paired statistical T-test conducted on the two sets of data indicated no significant difference ($p > 0.10$) in the mean difference between

them. A null (27) at 95% confidence limits gave the normal (PCV) of adult rats as 37-53% for males and 35-49% for females. Since the final mean haematocrit values fell within this acceptable standard (Appendix 2), the wood fibre supplemented rat diet could not have had any deleterious effects on the quality and quantity of rats' blood.

Characteristics of Laboratory-baked Bread

The colour of the loaves of bread ranged between a light brown with cream tint in the control to pale chocolate brown in the 1.0g fibred loaves (Table 3; Figs. 4A – D). Of the 25 respondents whose opinion was sought, 14 (i.e. 56%) preferred of the 0.25g and 0.5g fibre loaves, the other respondents (i.e. 44 %) preferring the cream-tinted light the light brown colours brown of the control loaves. The flavour of both the controls and experimental loaves was, however, 100% acceptable to all the respondents. These results indicate that the colour and flavor of the wood fibre supplemented bread were equally acceptable to the potential consumers as those commercially available loaves in the market. ANOVA shows that effects of feeds on dimensional characteristics of bread are the same (Appendix 7).

Table 3: Some Qualitative and Quantitative Characteristics of the Laboratory-Baked Loaves of bread

Type of loaf	Colour	Flavour	Mean weight (g)	Mean height (cm)	Mean area (cm ²)	Mean volume (cm ³)	Shelf life (days)
Control	Light brown with cream tint	Acceptable	70.50*	3.58	283.38	130.5*	3
0.25 Fibre level	Light brown with cream tint	Acceptable	74.75*	3.80	311.33	1183.05*	5
0.50 Fibre level	Light brown with cream tint	Acceptable	74.00*	3.88	303.7	1178.36*	5
1.00 Fibre level	Light brown with cream tint	Acceptable	73.00*	3.85	311.58	1199.56*	4

Within the four different treatments, mean values with the same superscript are not significantly different ($p>0.05$) while those with different superscripts are significantly different ($p<0.05$).



A



B



C



D

Fig. 4: Two laboratory-baked loaves of bread without wood fibres (A), two loaves of bread each baked with 0.25g wood fibre in 50g of flour (B), two loaves of bread each baked with 0.5g wood fibre in 50g of flour (C) and two loaves of bread each baked with 1.0g wood fibre in 50g of flour (D).

The control loaves of bread have the shortest shelf life of 3 days and the 1.0g fibred loaves of 4 days. A shelf life of 5 days was, however, recorded for both the 0.25g and 0.5g fibred loaves (Table 3). These differences are probably due to the presence of sugary media by the fungus that were provided by the cellulose-free loaves. Again, these results show that fibred loaves can adequately compare with those commercially available.

Some dimensional characteristic of the laboratory-baked loaves of bread are shown in Table 9. The 0.25g fibred loaf was the heaviest (74.75g) and also of substantial height (3.8cm). The loaves with the lightest mean weight as expected were of the group 1 (73.00g) but had the lowest mean height 1.5cm and occupied the widest area (87.00cm²). The statistics show that there was no significant difference ($p>0.05$) in the mean weight of the four categories of bread (Appendix 2). These imply that the addition of wood fibres at the stated concentrations did not have a noticeable effect on bread weight.

The mean volumes of bread range between 130.5cm³ in the control to 1199.56cm³ in the 1.0g fibred loaf. Experimental loaves were generally larger than those in the the control group (Appendix 3). The ANOVA carried out on the loaves of bread with respect to their volume showed no significant difference ($p<0.05$) across the 4 treatment levels. Furthermore, the Duncan multiple range tests indicated significantly larger sizes (Appendix 3). These results showed that the addition of cellulose fibres to wheat flour dough does not adversely affect its baking properties. Instead, it enhances bread quality and size. With wood fibres as additives, therefore, reduce amount of wheat flour would be required for bread baking.

The fibres of *A. hybridus* are potential insoluble dietary fibre with the prospect for human consumption. Increased consumption has also been associated with increased satiety and weight loss with the 10% fibre content having the highest effect and 15% having the lowest effect. By carefully selecting the appropriate type and amount of fiber, bakers can have a significant impact on the nutritional value and shelf -life of their bakery products. Previously, plant species such as *Gmelina arborea* (Ogunkunle *et al.*, 2003), *Vitellaria paradoxa* (AbdulRahaman *et al.*, 2012), *Glicirium sepium* (AbdulRahaman *et al.*, 2013a), *Daniella oliveri* (AbdulRahaman *et al.*, 2013b) and *Ficus exasperata* (AbdulRahaman *et al.*, 2013c) had been used for the same purpose and positive results were obtained just as it was obtained in this present work. However, empirical data and information on the safety of *A. hybridus* wood consumption and metabolism obtained on experimental animal models are required to be undertaken in order to support the results of this study.

In conclusion, since African forests are blessed with abundant economic trees that can be tapped and used as fibres in baking products, it will be reasonable to use these trees for the purpose. This act will improve the health of people who eat such foods, and at the same time prevent further wasteful exploitation of forest resources. However, empirical data and information on

the safety of *A. hybridus* wood consumption and metabolism obtained on experimental animal models are needed to be undertaken in order to support the results of this study.

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