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Sensory Assessment of "Ukana" Produced from Fermented African Oil Bean Seed (*Pentachletra macrophylla* Benth) using Isolated Cultures from Spontaneous Fermentation

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Abstracts

Proximate analysis revealed that the moisture content, crude protein content and crude fat content increased as the fermentation progressed. While the crude fiber, ash content and carbohydrate contents decreased with increase in the fermentation periods. This indicates the positive impact of fermentation on the amino acid and fatty acids profile but a negative effect on the minerals and fiber contents. Sensory evaluation result revealed a significant difference in the appearance and aroma of the samples tested while there was no significant difference in the taste of the samples accessed by the 20 man panelists. The result also indicates that African oil bean seed traditionally fermented after 72 h was significantly more appealing in appearance than others fermented with Lactobacillus fermentum (AOBS B_{72}) and mix culture of Bacillus substillis and Lactobacillus fermentum (AOBS C_{72}) after that same period, but not significantly different from sample AOBS A_{72} (African oil bean seed fermented with Bacillus substillis after 72 h).The aroma of sample AOBS C_{72} (African oil bean seed fermented with a mix culture of Bacillus substillis and Lactobacillus fermentum after 72 h) was more significant than samples AOBS A_{72} (African oil bean seed fermented with Bacillus substillis after 72 h), AOBS D_{72} (African oil bean seed traditionally fermented after 72 h) and AOBS B_{72} (African oil bean seed fermented with Lactobacillus fermentum after 72 h). However, sample AOBS A_{72} was appealing in aroma than sample AOBS B_{72} but not significantly different from sample AOBS D_{72}. Finally sample AOBS D_{72} was more preferred in aroma than sample AOBS B_{72}. The result of this study shows that fermentation leads to increase in the amount of protein which is highly desired to supplement the nutritional requirement of the populace.

Introduction

"Ukana" is the Ibibio name for sliced fermented African oil bean seed (*Pentaclethra macrophylla*). It is known as "Ugba" among the Igbos and "Apara" among the Yoruba speaking people of Nigeria (Enujiugha and Akanbi, 2005).

The African oil bean, *Pentaclethra macrophylla*, is a large leguminous timber tree belonging to the *Fabaceae* family and *Mimosoidae* sub-family. The tree is found in the humid and sparsely in the sub-humid zones of West and Central Africa and can reach up to about 21 m in height and 60 cm in girth. The pods are about 40– 50 cm long and 5– 10 cm wide and contain between 6 and 10 flat glossy brown seeds which vary in size. The seeds contain essential fatty acids and twenty different amino acids and are a potential source of protein and calories (Enujiugha and Agbede 2000; Enujiugha 2003). African oil bean trees are available as both wild and cultivated plants (Enujiugha, 2003). Nigerian ugba is obtained from the alkaline fermentation of African oil bean seeds. It is a popular alkaline fermented oil bean seeds product among the Igbos and Ibibios ethnic groups in Southern Nigeria. It serves both as a delicacy and a food seasoning agent. It is known as "Ukana" among the Ibibios and "Ugba" among the Igbos. It is a very important nutritional delicacy that is rich in proteins and other nutrients.
The nutritional value, the bioactive and anti-nutritional composition of *P. macrophylla* has been investigated. Consequently, the high content of flavonoids, phenols and pro-anthocyanins is associated with high antioxidant activity and the prevention of cell destruction and other diseases mediated by oxidative stress (Floegel *et al.*, 2011). It has also been reported to contain high and substantial levels of lipids, protein and dietary fibre and vitamins (Fungo *et al*., 2015).
Some of the anti-nutritional composition includes tannins and phytic acid. Variations in quantity and quality of phytochemical compounds are found to exist between the contents of these substances from one locality to the other (Ikhuoria *et al*., 2008). Studies have suggested that the differences in post-harvest handling, processing, storage conditions and stage of maturity or probably due to differences in growth conditions, genetic variation, may be responsible for variation in mineral concentration (Rodriguez-Amaya and Kimura, 2004). The lipid content of *Pentachletra macrophylla* is reportedly higher than is obtainable in most commonly consumed oil producing foods such as soybeans, Glycine max, (Alamu *et al*., 2018).
A good processing and storage techniques that can impact improvements in nutrient, texture and reduce microbial population is essential to produce "Ukana" with good sensory quality while also ensuring the elongation of its shelf-life (Udo and Ojimelukwe, 2024). This study reports on the effects of different processing methods on the nutrient and sensory properties of this important indigenous dessert..

RAW MATERIALS

African oil bean seeds were purchased from Fiong Arang market in Ini LGA, Akwa Ibom State, Nigeria. The plantain leaves used were locally sourced.
Reagents were of analytical quality and were sourced from a government approved agent of analytical chemical based in Aba.

Pure cultures of *B. subtilis and L. fermentum* were isolated from traditionally fermented African oil bean seed

Preparation of Traditionally Fermented African Oil Bean.

Two and half kilograms (2.5 kg) of African oil bean seeds were sorted manually to remove defective seeds and washed to remove dust and dirts. The African oil bean seeds sample was further processed by the modification of the method of Nwanagba *et al*. (2020). The seeds were boiled for 4 h and the hard coats were removed manually. The cotyledons were sliced longitudinally, washed and boiled again for 2 h. After draining, two hundred grams (200 g) of African oil bean each was put into four (4) different portions designated C24 h,C48 h, C72 h and C96 h and subjected to fermentation at room temperature (28-30^{o}C) for a period of 96 h. At every 24 h intervals, one sample was collected from the fermenting environment as individual sample, dried and packaged in airtight containers accordingly and kept for further analysis.

Determination, characterization and partial identification of the microbial flora from Traditionally Fermented Ugba

Standard Microbiological techniques described by Prescott (2004) were employed for the microbiological analysis of the fermented Ukana samples to isolate the specific organisms. Precisely 1ml from the 4th dilution was introduced into sterile petri dishes in duplicates and molten Nutrient agar, De Man Rogosa and Sharpe agar (MRS) agars were aseptically poured into the seeded plates and mixed with the inoculum. Plates were left on the bench to set (pour plate method). Nutrient agar plates were incubated at room temperature of 28^{o}C for 24h and MRS agar plates at 28^{o}C for 48h using anaerobic jar.

Morphology and phenotyping

The morphological characterization of the microbial cultures used for this study was done in the following manner: The colony appearance and colour were physically observed while the cell arrangement and the colony shape were observed by viewing a glasss slide with a sample of smeared and stained microorganisms with the help of a microscope(Fawole and Oso, 2004).

Biochemical characterization

This was done based on gram staining test, catalase test, spore test, gas production test, acid production test, alcohol production, carbohydrate utilization test using sugars like glucose. Sucrose, lactose, maltose, fructose and raffinose. The two microbial cultures were also subjected to growth in MRS agar at 15^{0}C, 45^{0}C as well as growth in nutrient Agar at room temp (30±2^{0}C).

Gram staining

This was carried out using the method of Fawole and Oso (2004) to determine the Gram status of each of the isolates.

Catalase test

A loofulof 24 h old culture was transferred into a drop of 3% Hydrogen peroxide solution on a clean slide with the aid of sterile inoculating loop. Gas seen as white froth indicates the presence of catalase enzyme (Cheesbrough, 2006)

Spore test

Spore tests were carried out to identify spore forming organisms.This was determined by the method of Cheesbrough (2006)..

Motility test

This was determined by the method of Olutiola *et al*. (2000). A 24 h old culture was picked with a sterile wire loop and streaked onto nutrient agar in petridshes. The petridishes were incubated at 37°C for 24-48 h.Non-motile bacteria had their growth confined to the stab line with definite margins without spreading to surroundings area while motile bacteria gave diffused growth extending from the surface.

Acid production test

This was determined by the method of Olutiola *et al*. (2000). A loopful of the organism was inoculated in a test tube containing 10 ml of sterile peptone water, a dunham tube was inverted into it and incubated at 37 ^{0}C for 24 h. A change in colour was observed by dipping litmus paper into the culture solution. Presence of red colour showed acid production while absence of colour showed no acid production.

Sugar fermentation test

The method of Fawole and Oso (2004) was adopted.Sugar fermentation test was carried out to determine the ability of organisms to ferment sugars with production of acid and gas. Sugar indicator broth was prepared using peptone water medium containing 1% fermentable sugar and 0.01% phenol red. Ten milliliters (10 ml) of sugar broth was dispensed into each of the test tubes anddurham tube was inverted carefully. The test tubes were autoclaved and cooled. A loopful of 24 h old culture of the test organisms each was inoculated into the different test tubes and incubated for 5 days at 36±1°C and observed daily for acid and gas production. Yellow colouration indicated acid production whiledisplacement of the medium in the durham tube indicated gas production.

Evaluation of the isolates ability to grow in MRS agar at 15^{0}C.

About 15 ml of sterile MRS agar was aseptically poured inside sterile petri dish and allowed to solidify. A loopful of the test organisms was inoculated into the dish and incubated at 15^{0}C for a period of 48h under microaerophilic condition. Presence of growth showed positive result while absence of growth showed negative result.

Evaluation of the isolates ability to grow in MRS agar at 45^0C.

About 15 ml of sterile MRS agar was aseptically poured inside sterile petri dish and allowed to solidify.A loopful of the test organism was inoculated into the dish and incubated at 45^0C for a period of 48h microaerophilic condition.Presence of growth showed positive result while absence of growth showed negative result.

Oxidase Test

Tested bacterial colony was smeared on the filter paper previously saturated with freshly prepared oxidase reagent. Positive oxidase test was recorded as the development of a blue-purple colour within 10 s (Cheesbrough, 2006).

Urease test

Slanted two millilitres of urea medium which placed in bijou bottles applied for the incubated bacterial colony at room temperature. Red-pink colour in the medium was considered as a positive test for urease induction (Cheesbrough, 2006).

Methyl red (MR) test

After adding methyl red indicator solution (TSBA, Himedia) to inoculated culturing media and incubation at 35 °C for up to 4 days, changing color to red indicate MR test positive-appearance of tested bacteria (Allen *et. al*., 2016).

Purification and Maintenance of Microbial Isolates

Discrete Colonies from Primary Culture Plates were picked for Characterization. Bacterial colonies were repeatedly sub-cultured into freshly prepared Nutrient agar and MRS agar plates by streaking method and incubated for growth at optimum temperature and condition before transferring them into agar slants (Cheesbrough, 2004). The pure Isolates of bacteria were maintained on agar slant as stock and preserved in the refrigerator for further use.

Proximate Analysis

Determination of crude protein

The crude protein was determined by the micro-kjeldahl method described by AOAC (2006).

Determination of moisture content

The moisture content was determined by the method of AOAC (2006).

Determination of ash content.

The ash content was determined by the furnace incineration method described by AOAC (2006)

Determination of fat content

The fat content was determined according to the method of AOAC (2006).

Determination of crude fibre content

The fat content was determined according to the method of AOAC (2006).

Determination of carbohydrate.

This was determined by difference.

Carbohydrate = (100- Protein+Moisture+Fat+Ash+Crudefibre)

SENSORY EVALUATION OF FERMENTED AFRICAN OIL BEAN SEED

A 20-member sensory panel was constituted, based on familiarity with ugba flavour (aroma and taste) and colour to assess the products on the characteristic sensory parameters of appearance, aroma and taste. The samples for evaluation included the fermented products using the single pure isolates, combined organisms and the traditionally fermented. A five-point scale was adopted, with five equaling like extremely and one equaling dislike extremely (Filli *et al*., 2011). Data collected from the study of the sensory properties were subjected to analysis of variance as described by Snedecor and Cochram (1976). Differences among means were separated using Duncan's multiple range test; significances were accepted at 5 per cent level ($p \leq 0.05$).

RESULTS AND DISCUSSION

Proximate composition of Ukana

Fermentation brought about changes in the nutrient composition of "Ukana". The protein content rose from 17.37% in raw seed to 24.00% at the 96 h of fermentation as can be seen from Table 4.5. The value of 17.37% is close to 22.32% obtained by Enujiugha and Akanbi, (2005) for the raw seed. The optimum period of protein content enhancement was about three days. The increase in crude protein content of "Ugba" was because of protein synthesis during the period. This agrees with the finding by Okechukwu, *et al.* (2012) on changes in nutrients of the African oil bean meal under natural fermentation. According to Pearson, (1976) a plant food that provides more than 12% of its calorific value from protein is considered a good source of protein, hence fermented African oil bean seed is a veritable source of protein and should be encouraged to be part of our delicacies.

The crude fibre conten of samples reduced during the fermentation process. It decreased from 5.2% in raw seed to 0.71% at the 96 h. This is close to 7.57 % in raw seed obtained by Eze, *et al*.

(2014) and 0.17% in fermented seed as reported by Enujiugha and Akanbi (2005). The reduction observed in crude fibre content was due to action of cellulolytic micro-organisms present in the fermenting substrate. This is in-line with the report of Nwanagba *et al*., (2020), who opined that the reduction in the fibre content of fermented African oil bean samples may be attributed to the dissolution effect on the fibre as well as enzymatic degradation of the fibrous materials during fermentation. Isu and Ofuya (2000) reported an over 35% loss of cellulose during the solid-state fermentation of cassava peel.

The moisture content increased from 30.31% in raw seed to 42.89% at 96 h. This shows that the fermented seed is more predisposed to deterioration if not properly handled. This result agrees with the observations of Ogueke and Aririatu, (2004) who opined that high moisture level of food product increases the chances of its rapid spoilage. This is because several biochemical reactions and physiological changes in food depend very much on its moisture content (Onwuka, 2018). Eze (2013) reported in kinetic analysis of the thermo-stability of peroxidase from African oil bean seed that a major problem in the storage and marketing of processed oil bean seed is its high deterioration rate due to the activity of peroxidase.

The fat content increased from 21.7% in raw seed to 30.1% at 96th hour. The value 21.7% in raw seed agrees with the value 20.80% obtained by Akubugwo, *et al*. (2008) and 19.72% obtained Eze, *et al*. (2014). Enujiugha and Akanbi (2005) obtained 53.98 % in raw seed and 61.35% in fermented seed. Kar and Okechukwu, (1978) reported that the oil content could be as low as 38% which is close to 30.1% obtained from this study. However, this study and that by Enujiugha and Akanbi, (2005) showed that fermentation increases the fat content of the African oil bean seed. This means more calories for man and animals. It also shows that it is a source of edible fats and oil for which when ingested metabolizes to provide energy and other fat-soluble vitamins.

The carbohydrate content decreased from 24.19% in raw seed to 2.15% in fermented seed. This agrees with the findings of Monago, *et al*. (2004) which states that carbohydrate decreased significantly as fermentation time increases. The value of 24.19% is close to 27.72% obtained by Okechukwu, *et al.* (2012) and 19.16% obtained by Enujiugha and Akanbi (2005) in raw seeds, respectively. The value 2.15% obtained in the fermented seed differs significantly from 17. 48% obtained by Enujiugha and Akanbi (2005) in fermented seed. The disparity could be due to fermentation conditions, analytical methods or the species used in the different studies.

Ash is the measure of mineral content. The ash content decreased from 1.51mg/g to 0.15mg/g. The 0.15mg/g obtained in fermented seed from this study is very close to 0.17mg/g obtained by Okechukwu, *et al.* (2012) at the fifth day of fermentation and 0.32 mg/g reported by Nwanagba *et al*., (2020) after 96 h of fermentation. Animals need minerals elements for proper body functions such as formation of egg shell, heart and muscle activities, nervous coordination and blood coagulation (Okechukwu, *et al.,* 2012).

Table 4.5: Changes in the proximate content of the African oil bean seed during fermentation

PARAMETERS (%)	RAW	COOKED	24h	48h	72h	96h
Protein	$17.37^{d}\pm0.11$	$18.20^{d}\pm0.06$	$20.00^{c}\pm0.00$	$22.2^{b}\pm0.01$	$23.56^{a}\pm0.06$	$24.00^{a}\pm0.00$
Fat	$21.7^{d}\pm0.01$	$22.75^{d}\pm0.04$	$25.28^{c}\pm0.02$	$27.87^{b}\pm0.02$	$29.21^{a}\pm0.02$	$30.1^{a}\pm0.01$
Crude Fibre	$5.2^{a}\pm0.02$	$4.32^{a}\pm0.30$	$3.27^{b}\pm0.01$	$2.10^{c}\pm0.00$	$1.20^{cd}\pm0.03$	$0.71^{d}\pm0.32$
Moisture	$30.31^{e}\pm0.01$	$33.33^{d}\pm0.00$	$37.01^{c}\pm0.06$	$40.25^{b}\pm0.21$	$42.10^{a}\pm0.01$	$42.89^{a}\pm0.06$
Ash	$1.51^{a}\pm0.04$	$0.48^{b}\pm0.11$	$0.31^{b}\pm0.01$	$0.23^{b}\pm0.04$	$0.19^{b}\pm0.22$	$0.15^{b}\pm0.04$
Carbohydrate	$24.19^{a}\pm0.02$	$20.24^{b}\pm0.01$	$14.13^{c}\pm0.03$	$7.34^{d}\pm0.03$	$3.74^{e}\pm0.05$	$2.15^{e}\pm0.01$

Sensory evaluation of selected products of fermented African oil bean seed product

The slide below depicts the appearances of AOBS after 24 h, 48 h, 72 h and 96 h of fermentation. The AOBS fermented with *Bacillus substillis* after 24 h had more of the slices turned light green than those fermented with *Lactobacillus fermentum* but almost the same colour to the sample fermented with the mix culture. However, AOBS traditionally fermented showed slight change from the appearance of the sample at zero hour fermentation. At 48 h, there was sharp green colour observed in the samples traditionally fermented and that fermented with *Bacillus substillis.* But samples fermented with the mixed culture had a little deeper green colour change than those fermented with *Lactobacillus fermentum.* AOBS fermented with *Bacillus substillis* after 72 h showed a glossy stainless green colour with sharp ammoniacal smell. The sample fermented with mixed culture had a dirty green colouration probably due to the competing action of the two organisms resulting in the formation of more flavouring compound. However, AOBS traditionally fermented had a dirty green colour dotted with some condensate probably due to the presence of several microorganisms.

Plate 1.1: AOBS fermented with *Bacillus substilis* and *Lactobacillus fermentum* after 24 h.

Plate 1.2: AOBS fermented with *Lactobacillus fermentum* after 24 h.

Plate 1.3: AOBS fermented with *Bacillus substilis* after 24 h.

Plate 1.4: AOBS traditionally fermented after 24 h.

Plate 1.5: AOBS fermented with *Bacillus substilis* after 48 h.

Plate 1.6: AOBS fermented with *Lactobacillus fermentum* after 48 h.

Plate 1.7: AOBS fermented with *Bacillus substilis* and *Lactobacillus fermentum* after 48 h.

Plate 1.8: AOBS traditionally fermented after 48 h.

Plate 1.9: AOBS fermented with *Bacillus substillis* after 72 h.

Plate 1.10: AOBS fermented with mix culture of *Bacillus substillis* and *L. fermentum* after 72 h.

Plate 1.11: AOBS fermented with *Lactobacillus fermentum* after 72 h.

Plate 1.12: AOBS traditionally fermented after 72 h.

Sensory properties of fermented "Ukana" samples.

The samples at 72 h fermentation were used for sensory analysis. AOBS A_{72} (African oil bean seed fermented with *Bacillus substillis* after 72 h ; AOBS B_{72} (African oil bean seed fermented with *Lactobacillus fermenteum* after 72 h ; AOBS C_{72} (African oil bean seed fermented with mix culture of *Bacillus substillis* and *Lactobacillus fermentum* after 72 h and AOBS D_{72} (African oil bean seed traditionally fermented after 72 h) were analyzed sensorily for their appearance, aroma and taste on a 5-point scale where 1 represent dislike extremely; 2 represent dislike slightly; 3 represent neither like nor dislike; 4 represent slightly liked and 5 represent like extremely. Table 2 shows the results of sensory analysis.

Table 2: Sensory Properties of "Ukana" Fermented for 72 h using different Microorganisms.

Sample	Appearance	Aroma	Taste
AOBS A_{72}	3.60^{ab}	3.55^{b}	3.60^{a}
AOBS B_{72}	2.85^{c}	2.30^{c}	3.20^{a}
AOBS C_{72}	3.25^{bc}	4.25^{a}	3.25^{a}
AOBS D_{72}	3.90^{a}	3.25^{b}	3.80^{a}

AOBS A_{72}= African oil bean seed fermented with *Bacillus substillis* after 72 h ; AOBS B_{72}= African oil bean seed fermented with *Lactobacillus fermenteum* after 72 h ; AOBS C_{72}= African oil bean seed fermented with mix culture of *Bacillus substillis* and *Lactobacillus fermentum* after 72 h; AOBS D_{72}= African oil bean seed traditionally fermented after 72 h. From the above table, any two sample means not followed by the same letter (s) superscripts are significantly different at 5 % level ($P < 0.05$).

Appearance

Table 3 indicates that the variance ratio (F- calculated) is higher than F-tabulated (2.76), this shows that there is significant difference among the appearance of the samples at 5 % level of freedom (*). As significant different is established at 5% level. The result indicates that African oil bean seed traditionally fermented after 72 h was significantly more appealing in appearance than others fermented with *Lactobacillus fermentum* (AOBS B_{72}) and mix culture of *Bacillus substillis* and *Lactobacillus fermentum* (AOBS C_{72}) after that same period but not significantly different from sample AOBS A_{72} (African oil bean seed fermented with *Bacillus substillis* after 72 h). However, AOBS A_{72} was significantly more attractive than sample AOBS B_{72}.

Table 3: Analysis of Variance table for Appearance

Source of Variation	Df	SS	MS	F
Sample	3	12.3	4.1	4.02
Panelist	19	16.7	0.89	0.87
Error	57	58.2	1.02	
Total	79	87.2		

F-Tabulated = 2.76 at 5 % level
Since the variance ratio (F- calculated- 4.02) is higher than F-tabulated (2.76), there is significant difference among the samples at 5 % level of freedom (*).

The acceptable colour of ugba or ukana is light brown or green; darker brown colours are undesirable. The colour changes are believed to be the result of both enzymatic and nonenzymatic browning. Polyphenol oxidase (a major enzyme contained in oil bean seed cotyledons) catalyzes the oxidation of phenolic substances to quinines, which spontaneously polymerize to form a brown pigment (Enujiugha and Akanbi, 2005a). Bacillus sp is a notable producer of enzymes responsible

for the breakdown of proteins, starch and fats into their simple forms. One of the major biochemical changes in African Oil Bean Seeds is the hydrolysis of protein (Chelule *et al*., 2010) in which Bacillus sp produces proteases, an enzyme responsible for the breakdown of proteins into amino acids and short peptide chains (Eluchie *et al*., 2021). As observed in the study, samples in which *Bacillus substillis* was involved in its production was more appealing than sample AOBS B_{72} which was fermented with Lactobacillus fermentum alone.

Aroma

Since the variance ratio, F-calculated is higher than F-tabulated, there is significant difference among the aroma of the samples at 1 % level (Appendix II-5). Least significance difference was then used to determine the difference. From the means separation result, any two sample means not followed by the same letter superscript are significantly different at 1% level of probability ($P < 0.01$).

Table 4: Analysis of variance table for aroma

Source of Variation	Df	SS	MS	F
Sample	3	40.85	13.62	27.24
Panelist	19	22.25	1.17	2.34
Error	57	28.65	0.50	
Total	79	91.75		

F- Tab = 4.13 (1%), 2.76 (5%)
Since the variance ratio, F-calculated is higher than F-tabulated, there is significant difference among the flavor of the samples at 1 % level.

From the above results (Table 2 and 4), the aroma of sample AOBS C_{72} (African oil bean seed fermented with a mix culture of *Bacillus substillis* and *Lactobacillus fermentum* after 72 h) was more significant than samples AOBS A_{72}(African oil bean seed fermented with *Bacillus substillis* after 72 h), AOBS D_{72} (African oil bean seed traditionally fermented after 72 h) and AOBS B_{72} (African oil bean seed fermented with *Lactobacillus fermentum* after 72 h). However, sample AOBS A_{72} was appealing in aroma than sample AOBS B_{72} but not significantly different from sample AOBS D_{72}. Finally sample AOBS D_{72} was more preferred in aroma than sample AOBS B_{72}. From the result of flavor profiling, it was observed that samples fermented with mixed culture of *Bacillus substillis* and *Lactobacillus fermentum* eluted many flavor volatiles than those fermented with single isolated cultures. Moreso, it was noticed that samples in which *Bacillus substillis* were involved in its production have pleasant aroma than *Lactobacillus fermentum* fermented sample. This is so because *Bacillus substillis*is a notable producer of enzymes responsible for the breakdown of proteins, starch and fats into their simple forms(Chelule *et al*., 2010). More esters, aldehydes, ketones, amides and hydrocarbons which are the simple forms of the above organic components, were eluted when African oil bean sample were fermented using mix culture of *Bacillus substillis* and *Lactobacillus fermentum, Bacillus substillis* and traditional method. Findings from several studies have demonstrated that some very important aromas are not produced as a result of the presence of a unique characterizing compound; but rather, as a result of

a reproducible blend of a particular number of components in proper balance as observed in this present study where several aromatic compounds have been profiled (Dresow and Bohm, 2009).

Taste

The variance ratio of the taste (F – Calculated) is 2.28 while F-tabulated is 2.76 (Table 5). Since the F- calculated is less than F – tabulated, then there is no significant difference among the taste of the sample (Table 5 and table 2).

The result indicates that the 20 man panelists could not find any significant difference in the taste of the fermented African oil bean seed using both pure starter and natural fermentation after 72 h.

Table 5: Analysis of variance table for Taste

Source of Variation	Df	SS	MS	F
Sample	3	5.5	1.8	2.28
Panelist	19	24.8	1.31	1.66
Error	57	45.5	0.79	
Total	79	75.8		

F-Tabulated = 2.76

CONCLUSION

Fermentation of "Ukana" for 96 h leads to an increased in the protein and fat contents of the samples. However, this leads to the reduction in the mineral and fibre contents of this product. The increased moisture shows that this nutritional dessert is susceptible to rapid spoilage; hence a process should be device technologically for the preservation of Ukana.

Sensory evaluation result showed that, sample AOBS A_{72} and AOBS D_{72} were most preferred in appearance while sample AOBS C_{72} was most preferred in aroma. However, there was no significant difference in the taste of the samples accessed by the panelist.

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