Effect of Fermentation Period on the Nutrient and Anti- Nutrient Properties of Okpehe Seed (Prosopis Africana)

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ABSTRACT

Background:*The intake of adequate nutrients had been known as a major determinant factor in fighting chronic diseases. Fermentation increases the level of some nutrient, digestibility and bioavailability and also decreases level of antinutrient, increase nutrient density and nutritional value.*

Objective: *This study evaluated the effect of different fermentation period on the chemical properties of Okpehe seed.*

Methods: *The Okpehe sample was obtained from Ogige main market in Nsukka Local Government Area of Enugu State, Nigeria. The seeds were prepared and allowed to ferment at different periods of 5days, 7days, 9days, 11days, and 14days. The plant samples were analyzed for proximate, vitamin, mineral and anti-nutrient at the different fermentation periods using standard procedures.*

Results: *The result showed that fermentation significantly ($P<0.05$) increased the moisture, ash and protein content of Okpehe with values ranging from 52.69 - 54.36 mg/100g, 2.37-2.45 mg/100g and 21.31-22.43 mg/100g respectively. On the minerals, Calcium was significantly ($P<0.05$) increased with increased fermentation period with values ranging from 73.92-78.62 mg/100g with same trend for Magnesium, Potassium, Phosphorus, Iron, Sodium and Zinc. For anti-nutrient and vitamins, the fermentation of Okpehe significantly reduced the anti-nutrient and vitamin content of the samples.*

Conclusion: *The Okpehe seed could be used as alternative source of protein in the diet/protein supplement. The study recommends among others that fermented Okpehe should be employed in the food industry as they can be used in making food supplements that are rich in proteins and minerals.*

Keywords: Okpehe seed, fermented, unfermented and nutritional content

INTRODUCTION

The intake of adequate nutrients had been known as a major determinant factor in fighting chronic diseases. Studies have shown that alteration in diets could have strong effects on human health (1). According to (2), dietary adjustment may lead to disease conditions such as diabetes, obesity, Hypertension, certain cancer and cardiovascular diseases. The over-dependence on imported foods and socio-cultural changes has placed African traditional diets at distinct disadvantages (3). In Nigeria there are several methods of food processing that enhances the nutrient content of the food such as germination, fermentation, sprouting, soaking and other autolytic treatment (4) .

Fermentation is a food processing method that can be used to diversify the foods uses of some underutilized plant food like fluted pumpkin seed.

Fermentation is an age long method of processing cereals and legumes with varying duration (2days, 4days, 7days and 14days). It increases the level of some nutrient, digestibility and bioavailability and also decreases level of antinutrient, increase nutrient density and nutritional value which may result to changes in the vitamin content (5). Foods fermented includes African oil bean (Ugba), Castor seed (Ogiri), Fluted pumpkin seed (Ogiri Ugu), Soybean (Okpiye), Sorghum (Ogi) and others (6).

Okpehe seed (*Prosopis africana*) is one of the widely known legume seed crops in Nigeria, which in a fermented state, is used as a food condiment (6). It consists of about 45 species of leguminous spiny pod-bearing trees and shrubs found in subtropical and tropical regions (7). *Prosopis africana* belongs to the family Fabaceae and subfamily Mimosoideae (8). It grows widely in the Middle Belt and Northern parts of Nigeria (9, 6). This tree is characterized by a deep, fast-growing tap root. *Prosopis africana* is mostly found growing in the savanna regions of western Africa (10, 11). *Prosopis africana* has vast social, economic, cultural, medicinal and agricultural values. It is widely used and consumed in the entire country and beyond. It is very popular for its seeds, highly priced food condiment or seasoning, rich in protein, fatty acids and other vital nutrients and minerals (12, 13, 6).

Organism actively involved in the fermentation of *P. africana* is *Bacillus* species, predominantly are *B. subtilis, B.pumilus, B. licheniformis*and *B. megaterium* (14). The basic principles of *Prosopis africana* fermentation primarily involve the process of inhibiting the growth of harmful micro-organism, thereby destroying chemicals in food and add beneficial bacteria (15, 6, 11).

Therefore, this work was designed to know the effect of different fermentation period on the nutrient and antinutrient properties of Okpehe seed.

MATERIALS AND METHODS

Preparation of Sample

Okpehe seed (*Prosopis Africana)* were purchased from Ogige main market in Nsukka Local Government Area of Enugu State, Nigeria.

Two thousand six hundred and twenty grams (2620g) of Okpehe seeds were measured.

One thousand two hundred and fifty grams (1250g) of the sample was boiled with tap water for six(6) hours to soften the seed coat using cooking pot then dehulled manually using hand pressure. The sample was washed, seed-coat removed and boiled again for 1hour 30minutes. Cotyledons were divided into five categories, each two hundred and fifty grams (250g). Wrap each portion (cotyledon) with a tradition leave and wrap the packs (cotyledons packs) with nylon The first category was kept as control (unfermented seeds) while the five categories (fermented seeds) were wrapped in blanched banana leave and tied in a polyethylene bag to provide a warm humid environment and allowed to undergo natural fermentation. The fermented samples were collected individually from the 5^{th}, 7^{th}, 9^{th}, 11^{th}, and 14^{th} day which was the end of fermentation period before analysis.

Determination of proximate composition of unfermented and fermented Okpehe seed.

Moisture and ash content was determined by the gravimetric method described by (16). Fat content of the sample was determined by the continuous solvent extraction method using a soxhlex apparatus described by (17).Crude fiber and Carbohydrate was determined by the Wende method (18). Crude protein was determined by Kjeldahl digestion method described by (16).

Determination of phytochemical composition of unfermented and fermented Okpehe seed.

The saponin, Alkaloid and Flavonoids content of the sample was determined by double extraction gravimetric method (19). The tannin content of the seeds was determined using the Folin Dennis spectrophotometric method described by (17).

Determination of mineral composition of unfermented and fermented Okpehe seed.

Iron and zinc were carried out after wet digestion using the method described by (16). Calcium content was determined by EDTA complexiometic titration method as described by (18). Phosphorous content was determined by Vanad-molydate spectrometry while Sodium and Potassium was determined by flame photometry method as described by (18).

Vitamin determination of unfermented and fermented Okpehe seed.

The spectrophotometric method by (20) was employed in the determination of vitamin content.

STATISTICAL ANALYSIS

All determinations was done in duplicate. The data generalized were entered into computer analyzed using IBMPSS (Version 20). Mean and standard deviation was calculated from the chemical analysis. Analysis of variance (ANOVA) was used to separate the mean and the level of significant difference will be accepted at P

The result showed in minerals, Calcium was significantly ($P<0.05$) increased with increased fermentation period with values ranging from 73.92-78.62 mg/100g with same trend for Magnesium, Potassium, Phosphorus, Iron, Sodium and Zinc.

The fermentation of Okpehe significantly reduced the anti-nutrient content of the samples.

The fermentation of Okpehe significantly reduced the vitamin content of the samples.

DISCUSSIONS

Table 4.1 presents the result for the effect of fermentation on the proximate composition of Okpehe seed. The result shows that the moisture content of the samples increased significantly with increase in fermentation time. From the result, the Okpehe seed sample which was fermented for up to 14 days recorded higher moisture content which was significantly ($P<0.05$) higher with a moisture content value of 54.36%. The result further revealed that the unfermented Okpehe seed recorded a significantly ($P<0.05$) lower moisture content with a value of 51.49%. The result showed that the moisture content of Okpehe seed increase significantly with increase in the days of fermentation. Moisture content is a determinant of shelf life of food samples, the lower the moisture content, the longer the shelf life of the food product. The result from this study may suggest that Okpehe seed with longer time of fermentation will definitely reduce the storage abilities of the food and may lead to quick spoilage. The result of this study is in line with the findings of (21) who found that fermentation time significantly increased the moisture content of ogiri-ahuekere and that of (22) who also found that moisture content was significantly increased with fermentation time.

The result on ash content of the fermented Okpehe seed showed that the ash content of the Okpehe seed was significantly ($P<0.05$) increased as the fermentation time increased. The result showed that Okpehe seed fermented for 14 days had significantly ($P<0.05$) higher ash content with a mean value of 2.45% which was higher than that of the other groups. The result further revealed that the unfermented sample recorded the lowest and significant ($P<0.05$) ash content with a mean value of 2.32%. Ash content is a measure of the mineral content of the body and minerals in the body are important sources of serum electrolytes which help maintain normal body homeostasis. The result on ash content is lower than the value realized by (6), who recorded an ash content ranging from 5.31% for fermented Okpehe and (23) who recorded higher ash content for fermented *Prosopis africana* with values ranging from 5.01%.

The result on protein content of fermented Okpehe seed showed that the Okpehe seed sample fermented for 14 days recorded the highest protein content with a value of 22.43% which was significantly ($P<0.05$) higher than that of the other samples. The sample with the lowest protein content was the unfermented Okpehe seed with a protein content significantly ($P<0.05$) lower than the fermented samples at a value of 20.47%. The result implies that fermentation significantly affects the protein content of Okpehe seed and it is time dependent as the samples with longer fermentation time recorded significantly increased protein content. However the result on crude protein realized from this study is quite lower than that from some others such as (24) who recorded a crude protein value of 54.50% for fermented Okpehe seed and (6) who recorded a crude protein value ranging from 31.76% for fermented Okpehe seed.

Fiber is an important aspect of foods fiber has been predicted to be useful in aiding digestion, lowering blood sugar and cholesterol levels. The result on crude fiber showed that the unfermented Okpehe seed recorded the highest and most significant fiber content with a value of 2.46%, while the sample fermented for 14 days had the lowest crude fiber. The result implies that crude fiber significantly decreased with increase in fermentation time (24) recorded way higher result for fermented ugba with value of 27.63% while (6) recorded crude fiber values of 4.24 to 4.86% for fermented Okpehe seed. The difference in crude fiber content recorded in this study may be as a result of longer fermentation time or due to the method of fermentation process which may differ.

The fat content of fermented Okpehe seed

decreased as the fermentation time increased as well. This is showed by the result recorded by the sample which was fermented for 14 days that recorded a fat content of 17.53% which was the lowest and significant (P<0.05). The sample that recorded the highest fat content was the unfermented Okpehe seed with a fat content of 20.51% which was significantly (P<0.05) higher than that of the other samples groups. The values from this study is higher than the values recorded by other studies such as that of (6) who recorded a fat content ranging from 7.01% to 11.23%. The result implies that fermentation reduces the fat content of food samples, and food samples that are consumed for the fat content may not be allowed to ferment for a long period of time.

The result on carbohydrate showed that increased fermentation time significantly (P<0.05) decreased the carbohydrate content of Okpehe seed as the sample which was fermented for 14 days recorded the least carbohydrate content with a value of 1.66%. The unfermented Okpehe seed sample recorded the highest carbohydrate content which was significantly (P<0.05) higher than that of the other samples with a value of 2.76%. Increase in fermentation time can significantly decrease the carbohydrate content of food samples which may be because the sugars were broken down into lactic acid (25).

The result on the anti-nutrient content of the fermented Okpehe seed is presented on Table 4.3. The result showed that glycosides were significantly (P<0.05) reduced with increase in fermentation time. A closer look at the result showed that at the first few days of fermentation, the glycoside content of the Okpehe seed was significantly increased as against the value for the unfermented sample however the glycoside content reduced significantly with increased fermentation time. The glycoside value for the 5th day was 0.84 mg/100g while the glycoside value for the Okpehe after 14 days of fermentation was 0.17 mg/100g.

The result for Phytate showed that increase fermentation led to a reduction in Phytate content of the Okpehe seed samples as the sample that was fermented for 14 days recorded the lowest and significant (P<0.05) Phytate content of 0.07 mg/100g while the unfermented sample recorded the highest Phytate content of 0.32 mg/100g which was significantly higher than that of the other samples. The result on the Phytic acid content of fermented Okpehe seed in this study is quite low when compared with the result recorded by previous studies such as that of (24) who recorded a phytic acid content of 44.5 mg/100g.

The result on oxalate recorded similar result as increase in fermentation recorded a significant (P<0.05) decrease in the oxalate content of the sample with values ranging from 0.12 mg/100g to 0.29 mg/100g for the fermented samples. However, the unfermented Okpehe seed sample recorded the highest and significant (P<0.05) oxalate content at a value of 0.39 mg/100g. On the contrary, (24) recorded much higher oxalate value of 164.99 mg/100g for some fermented local foods.

For tannins, the sample of fermented Okpehe seed recorded significantly (P<0.05) reduced tannin which was time dependent ranging from a value of 0.08 mg/100g to 0.18 mg/100g. However it is observed that the onset of fermentation significantly increased the tannin content at a value of 0.18 mg/100g which was later reduced as fermentation time increased.

The result on flavonoids and alkaloids showed that fermentation of Okpehe resulted in a significant decrease in the antioxidants. The values of flavonoids and alkaloids for the unfermented Okpehe was 0.67 mg/100g and 0.53 mg/100g respectively which were significantly (P<0.05) reduced to 0.56 mg/100g and 0.38 mg/100g for flavonoid and alkaloids respectively after 5 days of fermentation and then subsequently 0.46 mg/100g and 0.25 mg/100g for flavonoids and alkaloids respectively after 14 days of fermentation.

The result on saponins likewise showed a significant reduction in saponins content for fermented Okpehe samples with increase in fermentation time with a value ranging from 0.12 mg/100g to 0.25 mg/100g, while the unfermented sample recorded significantly higher saponin content with a value of 0.41 mg/100g. Anti-nutrients are plant compounds that reduce the body's ability to absorb essential nutrients. They are not a major concern for most people, but may become a problem during periods of malnutrition, or among people who base their diets almost solely on grains and legumes. The result on anti-nutrient content of fermented Okpehe revealed that fermentation of the plant will significantly reduce the anti-nutrient content of food samples.

A vitamin is an organic molecule that is an essential micronutrient which an organism needs

in small quantities for the proper functioning of its metabolism. Some of this vitamins contain antioxidant compounds that are useful in combating non-communicable diseases (25). The result for the vitamin composition of the fermented Okpehe is presented on Table 4.4. The result showed that carotene content of the Okpehe samples decreased significantly ($P<0.05$) as the fermentation time increased. From the results, Okpehe seed at 14 days of fermentation recorded a carotene value of 2.27 mg/100g while the unfermented Okpehe seed recorded a carotene value of 3.85 mg/100g. The study recorded small amounts of vitamin B2 which was significantly decreased as fermentation time increased. Vitamin B3 recorded the same results where increased in fermentation time resulted in a significant ($P<0.05$) decrease in vitamin B3 of the fermented Okpehe seed sample. Vitamin C recorded significantly higher values in the unfermented Okpehe sample when compared to the fermented samples, vitamin B9 and vitamin B6 also showed decreased values for increasing fermentation same with vitamin B12. The findings of this study is similar to that recorded by previous studies such as that of (21) who recorded significantly decreased vitamin values for fermented ogiri which was time dependent, Moreso, (26) also recorded decreased vitamin content after fermentation which was significantly decreased with increase in time. The reduction in the vitamin content of the fermented Okpehe seed may be attributed to the fact that micro-organisms also require vitamins to survive and thus may use up the vitamin content of the Okpehe seed.

The result on the mineral content of the fermented Okpehe seed is presented on Table 4.2. The result on calcium content showed that the Okpehe seed that was fermented for 14 days recorded the highest calcium content which was significantly ($P<0.05$) higher than that of the other samples with a calcium value of 78.62 mg/100g. The unfermented sample recorded the lowest and significantly ($P<0.05$) different mineral content. The result implies that an increase in the time of fermentation increased the mineral content of Okpehe seed. Calcium is necessary for strong and healthy bones in the body, with an RDA of 1000 mg, fermented Okpehe seed may be a good source of dietary calcium.

The result on magnesium showedthat fermented Okpehe seed samples recorded significantly ($P<0.05$) higher magnesium content than the unfermented Okpehe seed. However the result revealed that the magnesium content increased as the fermentation time increased with the sample that was fermented for 14 days recording the highest and significantly ($P<0.05$) higher Mg content than the other fermented samples. Okpehe seed recorded Mg content ranging from 32.39 mg/100g to 34.81 mg/100g for the fermented samples but a value of 31.53 mg/100g for the unfermented sample. Magnesium is a nutrient that the body needs to stay healthy. Magnesium is important for many processes in the body, including regulating muscle and nerve function, blood sugar levels, and blood pressure and making protein, bone, and DNA repair. The RDA for Mg is around 400-420 mg daily for men and 310-320 mg for women which implies that the fermented Okpehe seed may be a good source of Mg.

The result on potassium (K) showed that fermented Okpehe seed samples recorded significantly ($P<0.05$) K content than the unfermented Okpehe seed. However the result further revealed that the K content of the fermented Okpehe seed samples were dependent on fermentation time. This can be seen by the significantly ($P<0.05$) higher result recorded by the sample that was fermented for 14 days as against those who received lower fermentation time. From the result, the K value for Okpehe seed fermented for 14 days is 185.56 mg/100g while that of the unfermented Okpehe seed was 182.49 mg/100g. A diet rich in K helps to offset the effect of sodium overload in the body (25). The average RDA for K is 3400 mg, which implies that the fermented Okpehe seed may be a good source of dietary K.

The result on Iron (Fe) content of the fermented Okpehe seed showed that the Okpehe seed samples recorded increased Fe content as the fermentation time increased. The value of Fe recorded by the fermented Okpehe seed samples ranged from 2.86 mg/100g to 3.24 mg/100g, and the result showed that the increase in Fe content with fermentation time was significant ($P<0.05$). The result showed that the unfermented Okpehe seed sample recorded significantly ($P<0.05$) lower Fe content with a value of 2.74 mg/100g. Iron is an essential element for the production of blood in the body it aids in oxygen transport, DNA synthesis and electron transport. The RDA for Fe is 8 mg for men

and 18 mg for women. The result from this study suggests that Okpehe seed is a good source of dietary Fe.

The result on the Na and Zn showed that the mineral recorded significantly higher values for the fermented Okpehe seed sample. The result revealed that the minerals recorded significantly ($P<0.05$) increased values in the Okpehe seed as the fermentation time increased with values ranging from 45.85 mg/100g to 47.49 mg/100g for the Na and 2.38 mg/100g to 3.15 mg/100g for the Zn. The result showed that the unfermented samples recorded significantly ($P<0.05$) lower values of 44.41 mg/100g for Na and 2.34 mg/100g.

The result from this study showed that fermentation of the Okpehe seed samples led to a significant increase in their mineral content which may be attributed to the presence of micro-organisms that were responsible for the fermentation process.

CONCLUSION

The results obtained from the present study showed that fermented Okpehe seed had good nutritional profile. Fermentation as a way of food processing improves nutritional quality of food and enhances sensory qualities of food. Fermentation reduced the level of anti-nutrients in the Okpehe seed used in this study. However; some quantity of the nutrients could still not be available due to the presence of the anti-nutrients. For example, oxalate, tannin and hydrogen cyanide will negatively affect the mineral level (ash), carbohydrate and nitrogen free extract. This can be attributed to the unavailability of these nutrients. Phytic acid negatively affects protein content, lipid and fibre. The vitamin content of the fermented Okpehe seed significantly decreased because the micro-organisms involved in the fermentation process require vitamins for survival thereby depreciating the vitamin pool of the fermented Okpehe seed as the fermentation progressed. Notwithstanding, in view of the nutrient availability, low anti-nutrient content and high level of proteins and fats present in the Okpehe seed after fermentation, it could be used as alternative source of protein in the diet/protein supplement. The values for each parameter checked may be lower or higher than other values reported in other studies. These variations may be due to different species of Okpehe seed used, the climate and environmental conditions which plant grow.

Table 4.1: Nutritional Composition of Okpehe Samples Proximate Composition (% per g of sample)

Fermentation period	Moisture content	Ash content	Protein content	Fibre content	Fat content	Dried moisture	Carbohydrate
Sample 1/ 5th day	$52.69^{d}\pm0.13$	$2.37^{d}\pm0.01$	$21.31^{c}\pm0.01$	$2.27^{b}\pm0.04$	$19.57^{b}\pm0.04$	$47.31^{b}\pm0.13$	$1.79^{b}\pm0.24$
Sample2/7th day	$52.79^{d}\pm0.01$	$2.39^{c}\pm0.01$	$21.64^{b}\pm0.02$	2.18 ± 6.00	$19.31^{c}\pm0.16$	$47.21^{b}\pm0.01$	$1.69^{b}\pm0.21$
Sample3/9th day	$53.53^{c}\pm0.11$	$2.39^{c}\pm0.00$	$21.85^{b}\pm0.01$	$1.94^{d}\pm0.00$	$18.74^{d}\pm0.00$	$46.48^{c}\pm0.11$	$1.56^{b}\pm0.12$
Sample4/11thday	$53.77^{b}\pm0.04$	$2.42^{b}\pm0.00$	$21.69^{b}\pm0.29$	$1.68^{e}\pm0.00$	$18.67^{d}\pm0.99$	$46.23^{d}\pm0.04$	$1.77^{b}\pm0.24$
Sample5/14thday	$54.36^{a}\pm0.08$	$2.45^{a}\pm0.00$	$22.43^{a}\pm0.04$	$1.59^{f}\pm0.01$	$17.53^{e}\pm0.11$	$45.64^{e}\pm0.08$	$1.66^{b}\pm0.21$
Unfermented	$51.49^{e}\pm0.01$	$2.32^{d}\pm0.00$	$20.47^{d}\pm0.01$	$2.46^{a}\pm0.00$	$20.51^{a}\pm0.02$	$48.51^{a}\pm0.01$	$2.76^{a}\pm0.05$

Values shows means of triplicate analysis of each sample ± standard deviation

Values with different superscripts in the column are significantly different at ($P<0.05$)

Table 4.2: Mineral Composition of Okpehe Samples (mg/100g)

Samples	Ca	Mg	K	P	Fe	Na	Zn
Sample 1/ 5th day	$73.92^{d}\pm0.87$	$32.39^{e}\pm0.01$	$183.62^{d}\pm0.03$	$168.59^{d}\pm0.56$	$2.86^{e}\pm0.01$	$45.85^{c}\pm0.01$	$2.38^{d}\pm0.03$
Sample 2/7th day	$75.71^{c}\pm0.16$	$32.72^{d}\pm0.03$	$184.76^{b}\pm0.06$	$168.71^{c}\pm0.01$	$2.91^{d}\pm0.02$	$45.87^{c}\pm0.04$	$2.48^{c}\pm0.04$
Sample 3/9th day	$76.27^{c}\pm0.04$	$33.73^{c}\pm0.11$	$184.82^{b}\pm0.11$	$169.81^{b}\pm0.01$	$3.12^{c}\pm0.00$	$46.27^{c}\pm0.04$	$2.86^{b}\pm0.00$
Sample 4/11th day	$76.81^{b}\pm0.01$	$34.34^{b}\pm0.08$	$185.56^{a}\pm0.34$	$170.84^{a}\pm0.01$	$3.19^{b}\pm0.01$	$46.81^{b}\pm0.01$	$2.91^{b}\pm0.01$
Sample 5/14th day	$78.62^{a}\pm0.03$	$34.81^{a}\pm0.01$	$185.39^{a}\pm0.13$	$170.79^{a}\pm0.01$	$3.24^{a}\pm0.00$	$47.49^{a}\pm0.01$	$3.15^{a}\pm0.01$
unfermented	$72.81^{e}\pm0.01$	$31.53^{f}\pm0.11$	$182.49^{d}\pm0.01$	$168.20^{d}\pm0.42$	$2.74^{f}\pm0.02$	$44.41^{d}\pm0.55$	$2.34^{d}\pm0.02$

Values shows means of triplicate analysis of each sample ± standard deviation

Values with different superscripts in the column are significantly different at ($P<0.05$)

Table 4.3: Anti-nutrient Composition of Okpehe Samples (mg/100g)

Fermentation period	Glycosides	Phytate	Oxalate	Tannin	Flavonoid	Saponins	Alkaloid
Sample 1/ 5th day	0.84^{b}±0.00	0.23^{b}±0.00	0.29^{b}±0.01	0.18^{b}±0.00	0.56^{b}±0.02	0.25^{b}±0.00	0.38^{b}±0.00
Sample 2/7th day	0.65^{c}±0.00	0.18^{c}±0.00	0.25^{c}±0.01	0.16^{c}±0.01	0.52^{c}±0.00	0.22^{c}±0.00	0.35^{c}±0.00
Sample 3/9th day	0.32^{d}±0.00	0.15^{d}±0.00	0.21^{d}±0.00	0.12^{d}±0.00	0.48^{d}±0.00	0.19^{d}±0.00	0.33^{d}±0.01
Sample 4/11th day	0.28^{e}±0.00	0.09^{e}±0.00	0.17^{e}±0.01	0.09^{e}±0.00	0.44^{e}±0.01	0.16^{e}±0.00	0.28^{e}±0.00
Sample 5/14th day	0.17^{e}±0.00	0.07^{f}±0.00	0.12^{f}±0.00	0.08^{e}±0.00	0.46^{e}±0.01	0.12^{f}±0.00	0.25^{f}±0.00
unfermented	0.25^{a}±0.01	0.32^{a}±0.00	0.39^{a}±0.01	0.09^{a}±0.01	0.67^{a}±0.02	0.41^{a}±0.01	0.53^{a}±0.01

Values shows means of triplicate analysis of each sample ± standard deviation

Values with different superscripts in the column are significantly different at (P<0.05)

Table 4.4: Vitamins Composition of Okpehe samples (mg/100g)

Fermentation period	Carotene	B_1	B_2	B_3	Vit C	B_9	B_6	B_{12}
Sample 1/ 5th day	3.76^{b}±0.01	0.73^{b}±0.00	0.04^{b}±0.00	0.09^{b}±0.00	0.45^{e}±0.00	0.43^{b}±0.00	0.38^{b}±0.00	0.28^{b}±0.00
Sample 2/7th day	3.53^{c}±0.01	0.64^{c}±0.00	0.03^{c}±0.00	0.08^{c}±0.00	5.76^{b}±0.08	0.36^{c}±0.01	0.35^{c}±0.01	0.25^{c}±0.00
Sample 3/9th day	3.52^{c}±0.04	0.48^{d}±0.00	0.02^{d}±0.00	0.08^{d}±0.00	5.61^{c}±0.01	0.29^{d}±0.01	0.32^{d}±0.00	0.21^{d}±0.01
Sample 4/11th day	3.45^{d}±0.00	0.35^{e}±0.00	0.02^{e}±0.00	0.08^{e}±0.00	4.29^{d}±0.01	0.25^{e}±0.00	0.29^{e}±0.00	0.18^{e}±0.00
Sample 5/14th day	2.27^{e}±0.01	0.28^{f}±0.00	0.01^{f}±0.00	0.07^{f}±0.00	4.23^{d}±0.00	0.19^{f}±0.01	0.26^{f}±0.01	0.15^{f}±0.00
unfermented	3.85^{a}±0.01	0.75^{a}±0.00	0.05^{a}±0.00	0.09^{a}±0.00	6.88^{a}±0.03	0.55^{a}±0.01	0.42^{a}±0.00	0.33^{a}±0.01

Values shows means of triplicate analysis of each sample ± standard deviation

Values with different superscripts in the column are significantly different at (P<0.05)

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