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Changes in the nutrient composition of the African oil bean meal "ugba" (*Pentaclethre macrophylla* Benth) subjected to solid state natural fermentation.

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ABSTRACT

Objectives: This paper investigates the effect of solid state fermentation on the nutritive value of the African oil bean meal "ugba" and the possible enhancement of the nutrient composition was highlighted.

Methodology and results: The processed African oil bean meal-"ugba" was fermented naturally for one week at 27^0C to determine the effects of fermentation on its nutrient compositions. The chemical analyses of the samples were carried out according to AOAC standard methods. Fermentation brought about an increase in the crude protein and total lipid by 30.80% and 38.80% respectively. Calcium, magnesium, phosphorus, iron and manganese increased up to the 5th day and dropped while Zinc, Na dropped from the 3rd day. The crude fibres and ash content of "ugba" decreased to 1.80% and 0.12% respectively. The values of glycine, alanine cystine valine, leucine, tyrosine, arginine and glutamic acid increased while other amino acids were found to decrease.

Conclusion and application of findings: Fermentation enhanced the nutritive value of "ugba". This contributed to the reduction of the fibre and ash contents and enhancement of other nutrients like, protein lipid, calcium, magnesium, phosphorus, iron, and manganese which are vital for growth. Thus fermented "ugba" has potential as a cheap source of protein and minerals for feeding pregnant and lactating mothers, malnourished children and feed for animals. The increase in the total lipid content means more calories for man and animals using the fermented substrates as feed or food supplement. The increased minerals like calcium, phosphorus, magnesium and iron, are important in the diet of man and animals. These increases would ensure better mineral supply for the production of healthy infants after childbirth in the case of pregnant mothers. Where shorter fermentation time does not improve the amino acid profile, supplementation with cheap synthetic essential amino acids like methionine should prove useful.

INTRODUCTION

The oil bean seeds are obtained from the African oil bean tree *(Pentaclethra macrophylla)* a large perennial leguminous plant that grows to a height of 25m. The leaves are small and reddish when young and but gradually turn to dark green (Enujiugha and Agbade, 2005). Countries of the world have been in recent times experiencing a rapid growth in population. An increase in population naturally demands an increase in food supply to meet the nutritional demands of growing population Nigeria is one of the countries of the world where chronic protein shortage exists (Achi, 2005) It has become necessary to search for alternative cheaper sources of protein and minerals as the conventional sources are expensive. The African oil bean seed has been known to be a good source of edible protein and high energy calories. It contains twenty essential amino acid and essential fatty acids (Enujiugha and Akanbi, 2005). The traditionally prepared "ugba" consumed as a snack or used as condiment in soup preparation and local porridge is produced by hydrothermally treating the seeds, dehulling the seeds to remove the hard coat, slicing the cotyledons, boiling and fermenting (Egonu and Njoku, 2006). The fermentation of the sliced oil bean seed is known to produce nutritionally better products than the raw seeds (Enujiugha and Agbede, 2005, Enujiugha *et. al,* 2006,). The microbial enzymes from the fermenting organisms aid in hydrolysis of the seed macromolecules (Enujiugha, 2003). African oil bean seed, which is rich in essential amino acids as well as fatty acids and minerals (calcium, phosphorus, magnesium) has been found to be a highly nutritive animal feed when fortified (Egonu and Njoku,2006). Animals need mineral elements for body functions such as bone formation, formation of eggshell, heart and muscle activities, nervous co-ordination, osmo-regulation and blood coagulation. Mineral elements such as calcium, magnesium, phosphorus, potassium sodium are required in macro levels while mineral elements such as iron, copper manganese and zinc are required in micro levels.

Protein is important for growth in young ones, formation of enzymes, hormones, repair of worn out tissues, egg and milk production, while carbohydrates and lipids helps in the production of energy. Fermentation of the African oil bean seed helps to remove the anti-nutritional factors as well as improve its nutrient bioavailability and digestibility (Enujiugha and Akanbi, 2005).

This paper investigates the possible enhancement of the nutrient composition of African oil bean meal "ugba".

MATERIALS AND METHODS

Collection and preparation of material: The raw "ugba" seeds were purchased from a market in Owerri Imo State, Nigeria. The oil bean was hydrothermally treated. The softened seed coat was manually removed to extract the cotyledons. The cotyledons were sliced into small pieces (4.5cm x 0.5cm). The fermentation procedure of the "ugba" followed the method of Njoku, *et, al* (1990). The prepared "ugba" was allowed to ferment in a warm place for seven days.

Proximate analysis: Chemical characterization of the samples carried out to determine the nutritional and mineral compositions of the sample was determined using the method of AOAC(1984). The samples were analysed for their crude protein, crude fibre, Ash, total lipids and moisture content. The readings for these were taken every other day.

Amino acid analysis: This was done by defatting of the samples. Technicon sequential Multi-sample (TSM), Amino Acid Analyzer, was used to analyze the amino acid content of the sample.

Statistical analysis: One way ANOVA was used to determine significant changes. When the F test was significant, LSP test was used to compare means.

RESULTS

The results of the proximate analysis are presented in Table 1, given as a percentage of dry matter content. The crude protein and total lipid were found to increase as fermentation time increased, with the highest increase being observed during the 3rd day of fermentation. Crude protein recorded a total increase of 30.80% while total lipid led 38.80%. Crude fibre decreased to 1.80% while total ash recorded an overall drop of 0.12% calcium, magnesium, phosphorus, manganese and iron values rose and dropped during the fermentation period (see table 2). At the end of seven days of fermentation their values had dropped to 3.20%, 0.26, 20.10%, 11.40%, and 8.50% respectively. The results of the effect of natural fermentation on the amino acid composition of "ugba" were given in g/100g of protein in table 3. Fermentation of "ugba" caused a boost in the levels of glycine, alanine, cystine, valine, leucine, tyrosine, arginine and glutamic acid. Proline, methionine, isoleucine, phenylalanine, lysine, histidine, aspartic acid, threonine and serine were depressed. pH of "ugba" continued to increase without dropping up to 7.40 while the temperature dropped on the third day and increased a little on the 5th and 7th days (see table 4).

Table 1: The effects of fermentation on the nutrient composition of African oil bean "ugba" (% Dry matter).

Fermentation period (day)	Crude protein	Total lipid	Crude fibre	Moisture	Total ash
0	18.86	20.98	4.50	28.61	0.32
3	28.02	37.16	2.80	51.88	0.24
5	29.40	38.40	2.20	42.40	0.17
7	30.80	38.80	1.80	41.70	0.12

Table 2: The effects of fermentation on the mineral composition of "ugba" (% Dry matter).

Fermentation period (day)	Calcium	Magnesium	Phosphorus	Sodium	Zinc	Manganese	Iron
0	0.1	0.17	52.30	60.21	11.76	15.70	9.67
3	2.04	0.58	60.40	59.42	10.41	16.50	10.50
5	5.40	0.79	62.40	30.34	7.00	17.60	10.60
7	3.20	0.26	20.10	30.56	5.40	11.40	8..06

Table 3: Amino acid composition of the fermented and non-fermented "ugba" (g)/100g of protein)

Amino acid	Non-fermented	Fermented
Proline	1.55	1.17
Glycine	1.21	1.69
Alanine	3.75	4.41
Cystine	0.40	1.40
Valine	5.36	6.89
Methionine	1.34	0.96
Isoleucine	5.41	4.32
Leucine	8.54	9.75
Tyrosine	4.64	6.31
Phenylalanine	3.03	2.62
Lysine	3.65	2.37
Histidine	1.81	1.43
Arginine	5.17	6.70
Aspartic acid	10.12	9.10
Threonine	3.58	2.25
Serine	4.45	2.67
Glutamic acid	9.80	16.90

Table 4: The PH and temperature changes of the non-fermented and fermented "ugba"

Fermented time(day)	pH	Temperature °C
0	5.7	33
3	6.68	36
5	7.28	37
7	7.40	35

DISCUSSION

Fermentation brought about changes in the nutrient composition of "ugba". The optimum period of protein content enhancement was three days. This is derived from the fact that the observed rise in crude protein was significant ($p<0.05$) only up to 3 days period of fermentation. After that, the crude protein value rose non-significantly. This finding agrees with that of Onyimba et al, 2007 and 2009 who worked with sweet potato leaves and spent sorghum grain solid state fermentations recorded a rise in crude protein in the first few weeks of study. The increase in the crude protein content of the fermented "ugba" was as a result of protein synthesis during the fermentation process, during the period. The crude fibre content of fermented "ugba" reduced during the period of fermentation. Ofuga and Nwajiba (1990) reported an over 35% loss of cellulose, a major component of crude fibre, during, during the solid state fermentation of cassava pell with *Rhizopus sp*. and *Aspergillus niger* grown on rice straw. The reduction observed in the crude fibre content was due to the action of cellulolytic microorganism present in the fermenting substrate. The increase in the total lipid content means more calories for man or animal using the fermented substrates as food/feed supplement. Onyimba et, al, 2009 also observed increase in the total lipid content during their studies on solid state fermentation of spent sorghum grain. Though fermentation reduced the ash content, zinc, and sodium composition of "ugba", calcium, magnesium, phosphorous, manganese and iron contents were found to increase. Animals need mineral elements for body functions such as bone formation, formation of eggshell, heart and muscle activities, nervous co-ordination, osmo-regulation and blood coagulation. This increase would ensure better mineral supply for the production of healthy animals. The increase in pH observed from the 3rd day, indicates that less acid is being produced and that the products of protein fermentation which are alkaline accumulated in the fermentation medium. The fermentation of tree amino acids from protein metabolism causes the release of ammonia resulting in increase in the pH values (Achi, 20056).

The temperature of the fermenting samples was found to increase slightly. This was due to heat being generated as a result of exothermic reactions mediated by microbial enzymes. This was also observed by Onyimba et.al, 2009 on their studies on solid state fermentation of spent sorghum grains. In this study, there were drops in the values of some amino acids like proline and methionine. The reason may be that, during the fermentation process, some of the free amino acids are utilized in building up the protein sector of the substrates. The increases observed in some like glutamic acid, glycine, and alanine, were due to the synthesis of amino acid biosynthesis, a 5-c intermediate compound metabolism reacts with ammonia and are converted to an amino acid which in turn is useful in the formation of other amino acids nester et.al, 1973. A number of workers have reported the production of amino acids as a result of fermentation. Tosaka et al, (1983) reported the production of lysine as a result of substrate fermentation with *Candida glutamicum* and *Escherichia coli.*

In conclusion, fermentation enhanced the nutritive value of African oil meal "ugba". Thus making fermented "ugba" a potential source of protein and minerals for feeding pregnant, lactating mothers and for animal feeds.

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