

PACKAGED ABBACHA IN NOODLE FORM AND CONSUMER PATRONAGE: AN IN-ROAD TO STABLE FOOD PACKAGING IN NIGERIA

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ABSTRACT

This paper aimed at exploring packaged local abbacha (African salad) in noodle form as an in road to stable food and Consumer Patronage in Nigeria. The paper adopted the meta-analysis involving the systematic survey of existing literature and applied the synthesizing of evidence. Thus, to follow the set objectives; the paper relied on empirically supported arguments and hypotheses proved already by previous studies. It was observed that the use of a good and appropriate packaging material can maintain African oil bean (AOB) and cassava chips quality during storage. It was shown from empirical papers reviewed that the AOB seeds were stored under room conditions using three different packaging materials. Samples were drawn monthly for seed viability test, water and oil content. The results showed that seed viability and oil content decreased during storage in all packaging materials. However, as was shown in various researches explored, the best packaging material for better AOB seed viability and oil content was polypropylene plastic bag. It was also revealed that the bag could still maintain the seed viability above 80% after 12 month storage but was reduced by 50% under unfavorable conditions. It was consequent upon this that the quest for this paper became eminent to explore the viability and possibility of alternative food packaging of a Nigerian delicacy and efficacy and in a manner to contribute to the body of literature on food packaging sustainability, sufficiency and patronage of made-in-Nigeria foods.

Keywords: African Oil Bean, Noodles, Packaging, Shelf life and Sustainability.

INTRODUCTION

The African oil Bean (AOB) is known in Nigeria as ugba or ukpaka, apara and ukana among the Igbo, Yoruba and Efik tribes, respectively when mixed with sliced cassava chips is called 'abbacha'. Abbacha commonly called African Salad, is a delicacy that includes cassava chips derived from the tuber, fermented African oil-bean seeds, pepper, salt, onions, stock fish and/or fried fish, garden egg leaves, Crayfish, and garden eggs and consumed with palm-wine in some cases. The ugba is prevalent in Eastern Nigeria, and is usually consumed as a snack or a condiment for preparing African salad, soup, porridge yam, cocoyam, meat (nkwobi), among others delicacies. It is a popular snacks eaten in major cities and towns in south-south and south-east region of Nigeria with over 15 million people. It is an executive meal in occasions, however, with lesser condiments are hawked around in streets (Obeta, 1983). The crop belongs to the family of Leguminosae (Mimosoideae) with no recognized varietal characterization. Consumer decision-making has been treated as a problem solving process. A decision involves choosing between two or more different behaviors (Peter & Olson 1999). There are a lot of conceptions some even misconceptions about the processing and packaging practices (especially food packaging and marketing performance). Nigeria among other developing countries is as well facing a vast difficulty in establishing a task-force or a sort of regulating bodies to supervise the activates of eateries within the country. Since the establishment of National Agency for Food, Drugs Administration and Control (NAFDAC), by the act established, food packaging have been into close watch and examination. Until the recent

past, the regulatory agency seemed to have gotten tired of its responsibility and an alarming rate of porous food packaged for consumption by the populace. Food packaging is improved based on essential requirements corresponding to consumer priorities (Market Publishers Report Database, 2021).

Besides self-service stores, technology that enables packaging forms and release of mass packaging materials played a role rapidly increase of packaging. In today's industrialized societies factories just not only produce goods, in particular offer food products to the market by making them ready to serve. Consumer tastes give direction to the packaging of the products. It is known that higher the level of life consumers allocate more share for service industry. The importance of packaging increases in parallel with the rise in living standards (Çakıcı, 1973). Today, because differences between products that are produced on industrial scale decrease and product variety begins to increase, it is getting more difficult to make difference between products and to influence the purchasing decisions of consumers. Packaging of industrial products has become more important with attention to health conditions, significance of satisfaction of consumers and mandatory protection of consumer rights (Dilber, et al, 2012). Production managers understand the importance of packaging involved and try to make a difference in the product's packaging and to give an identity to the product and influence consumer purchase decision making (Underwood, 2003). Packaging is an extension of life besides being a sales tool (Odabaşı, & Oyman, 2005).

Although consumers make choices between products, brands, or stores, they are actually choosing between different behaviors that concern the product, brand, or store. The assumption regarding consumer decision-making is that consumers have goals they seek to achieve or satisfy. In other words, consumer decision-making is considered a goal-directed, problem-solving process (Peter and Olson 1999). The basic model of the consumer problem solving process contains five stages: (1) problem recognition, for example, while preparing meal a consumer discovers an empty container of noodle (2) search for alternative solutions-the consumer goes to the local grocery store (3) evaluation of alternatives- the consumer locates the noodles and surveys the choices (4) purchase- the consumer selects a brand/ container of abbacha Noodle and takes it to the checkout counter (5) post-purchase use and reevaluation of chosen alternative- the consumer prepares dinner with the chosen pasta and determines if the choice was good one and considers a repeat purchase in the future (Peter & Olson 1999). Although the basic model of problem-solving is commonly used to introduce the process, it is considered imperfect because the consumer problem-solving process rarely occurs in a linear fashion.

Statement of the Problem

The success of packaging is determined by packages materials and packaging techniques. Plastic (polythene and polypropylen) bags and jute fibers, rami, and plastic bottles are widely used for storing seeds. Good and appropriate packaging materials enable to maintain the quality and viability of seed for a long period of time. Hasnam and Mahmud (2006) stated that *Jatropha* seeds stored in a plastic bag at a temperature of 16 °C could be maintained the viability at 80% but was reduced by 50% under unfavorable conditions. Proper storage could maintain the quality and oil content of castor seeds for at least one year (Sangwan, et al. 1992). Some packaging materials are commonly used for storing seeds, but their suitability depends on the kind or type of seeds and their protection ability to the seed in storage. Abbacha in its natural form has a short shelf-life. Vendors are actually faced with the problem of packaging, storage and shelf-life. Attempts have been made by some researchers to effectively repackage the abbacha and thus extend the shelf-life of the product but to no avail. It has also been observed that differences in the various processing and packaging methods are responsible for the variations in the products from one community to the other. Albeit, there has been no known evidence of attempting to package and

present abbacha in noodles-like form in Nigeria with a longer shelf-life. This gap captured the credence and need for this research.

Objectives of the Research

- 1) To determine the possibility of packaging abbacha in noodle-like form to make it more decent, attractive and enhance its shelf life.
- 2) To determine the extent to which producing abbacha in noodle-like form influenced consumer repeat purchase.

Literature Review

Packaging of the shreds/slices of African oil bean seeds

African oil bean seed shreds and slices are traditionally packaged by wrapping a handful with different kinds of leaves. The wrapping of the seeds with leaves is believed to aid the fermentation process. The leaves wrapping and the poor measures during handling contaminates the product (Abiodun, et al, (2002). Also, leaves-wrapping creates openings for microbes to enter the product resulting to rapid deterioration. The leaves-wrapped product has a low shelf life of not more than 5 days under tropical ambient conditions of 31 -32oC. The type and the number of leaves varies from one processor to another, and they are determined by the processor's discretion and experience. The effect of the type and number of leaves on the quality of wrapping African oil bean shreds was evaluated by (Azi, et al, 2019). Their study showed that the leaves of plantain (*Musa paradisiaca*), cocoyam (*Xanthosoma sagittifolium*) and Okpopia (*Alchornea laxiflora* Benth) did not affect the proximate composition of the product so also the number of leaves used. However, they recommended five leaves of Okpopia (*Alchornea laxiflora* Benth) for wrapping African oil bean seed slices and shreds because of the high storage quality observed. Other researchers have studied alternative ways to package and extend the shelf life of African bean seed shreds/slices. The use of canning method of packaging was studied by (Okafor, et al, 1991). They used brine, groundnut and tomato sauce as various media to extend the shelf of African oil bean slices. They observed that canning with media led to softening and colour darkening of the samples over prolonged storage time. Apart from these problems detected, another challenge would be the acceptability of those media with African oil bean slices in dish preparations. This is because the foods prepared with African oil bean does not go with any of those media as an ingredient. In their work, Adekoya, et al, (2017) evaluated bottle/cup packaging with locally adapted pasteurization technique as an alternative storage method.

Packaging practices start from the manufacturing process of food and determines present and future needs and expectations of the people and makes life easier. Food products are created ultimately for consumers, consumer attitudes and opinions play an important role in the creation of food packaging practices and thus the act influence marketing performance of eateries. In food packaging market the driving factors for growth are convenience, functionality and tolerance are consumer centered. Manufacturers and retailers need to understand packaging innovations that can offer benefits to consumers and important for consumers and affect consumer purchasing practices in order to remain competitive (Euromonitor, 2004).

New materials, designs and technologies enable packaging to respond to the rapidly evolving demands of modern consumer lifestyles (Anonymous, 2016). In today's competitive environment with rapid development of technology and increase in production packaging is used to make objects of consumption more attractive than they are to highlight their distinctive features (Yildiz, 2009). Today important scientific literature specifies that; consumers more interested in healthy food to prevent diseases and to maintain a healthy life (Krutulyte, 2010). Healthy product

preferences of consumers satisfy their basic values of a healthy lifestyle (Kearney, 2010). Increase in the number of single-person households has resulted in a growing demand for simplicity in lifestyle trends. The aging population, individualism changes in home structure, participation of women in labor, long working hours Traill, (1997), and consumer welfare Bonke, (1992) moving towards a healthy diet requires new experiences (Mintel International Group Limited, 2000).

Furthermore, reduction in cooking skills, change of traditional meal times, less effort in activities related to meal preparation and arrangement IGD Business Publications (1998), desire for spending less time for food and shopping according to Swoboda and Morschett, (2001) contributed changes in packaging. Increased number of chain of trademarks offering a wide range of products that guarantee quality, easy shopping, cost-effectiveness and ability to compare plays a major role in the actual changes in demand. The increase in income level, women increasingly taking place in business life, increasing awareness of travel, sport and culture and as consequences of these people doesn't have enough time and increase of smart shopping rate over the internet. Aging of the population or proportion of young people directly affects packaged food consumption (Caner, 2007). Consumers are bombarded with about 3,600 selling messages a day (Rumbo 2002). Yet, because of technology allowing TV watchers to omit commercials and declining advertising budgets, there has been an emphasis on influencing the consumer at the store shelf (Furness 2003). For many products, such as seasonal items, packaging design has acquired the responsibility of advertising (often being the only advertising the product will receive) and has evolved into the "silent salesman" (Furness 2003; Rettie and Brewer 2000; Shell 1996). It is estimated that between 73% and 85% of purchase decisions are made at this point and the packaging design must play a key role because it is often the only factor that differentiates two products on a shelf (Sutton and Whelan 2004; Wallace 2001; Buxton 2000; Rettie and Brewer 2000). With a new reliance on packaging design to persuade consumers at the shelf, it is important for packaging design to be studied academically as an influence on consumer behavior.

Research in the area of consumer response to packaging design is being encouraged to assist with increased product sales and increased benefits to the integrated marketing communications (IMC) mix (Tobolski, 1994). Packaging is expected to protect and preserve its contents, differentiate from its competitors, grab the attention of the consumer, and persuade the consumer to purchase (Packaging: good shelf image 2003; Product packaging: empty promises? 2000). The vast consumer packaged goods industry continually relies upon color as a method of differentiation. Research has shown color (especially nontraditional color) attracts the attention of the consumer (Voight, 2003). Nontraditional color increases the ability to separate a product from its competitors and enhance brand identity (Voight, 2003). According to marketing research, colors allow marketers to build brand loyalty at a time when consumer loyalty has declined (Selame & Koukos 2002). With crowded product categories, manufacturers desire brand loyal consumers.

Isu and Njoku (1998) worked on the influence of temperature, relative humidity and microenvironment on the natural fermentation of oil bean seed (Ugba). Relative humidity of over 80% influences fermentation process in ugba. They opined that leaves used such as *Mallotus oppositifolium* presumably produced warmth and a humid environment while limiting the accessibility of air to the fermenting substrate. Isu and Ofuya, (2000) studied the use of pure cultures of *Bacillus subtilis* attached to cowpea and maize granules in the fermentation process. They found that in comparison with the natural fermentation changes in these indicators were more pronounced in the fermentation carried out with the immobilized cells which can be applied to the indigenous technologies of the developing countries like Nigeria. Mineral content also decreased during fermentation while no phosphorus could be found in ugba (Enujiugha & Akanbi, 2008).

Only bacteria are involved in the fermentation (Obeta, 1983; Odunfa & Oyeyiola, 1985; Ejiofor *et al.*, 1987; Ogueke & Aririati, 2004). The main fermenting microorganisms have been identified to be proteolytic *Bacillus* sp. (Obeta, 1983) which include *B. subtilis* (most predominant), *B. licheniformis*, *B. megaterium*, *B. macerans* and *B. circulans*. Their numbers increased tremendously from 10^3 at the start of fermentation to 10^8 at the end of the fermentation (72 h). Other bacteria identified in the fermenting slices include coagulase negative *Staphylococcus* sp., *Micrococcus* sp. (their numbers decreased after 72h of fermentation), *Leuconostoc mesenteroides*, *Lactobacillus plantarum*, *Streptococcus lactis*, *Proteus* sp., *Enterobacter* sp. and *E. coli*. Some workers isolated the yeasts *Candida tropicalis* and *Geotrichum candidum* during fermentation (Ejiofor *et al.*, 1987).

Since protein hydrolysis is the major biochemical change in ugba fermentation (Oyeyiola, 1981), it can be assumed that the *Bacillus* sp. are the main fermenting organisms. They were found to persist until the end of the fermentation and their numbers increased throughout the period of fermentation while the numbers of others decreased after 24 h of fermentation (Obeta, 1983). Also *Bacillus* sp. are important sources of proteases (Fogarty & Griffin, 1973). The other bacteria only managed to grow on the little carbohydrate present in the seeds, majority of which may have been lost due to leaching during the preparatory stages (Ruiz-Teran & Owens, 1999). The disappearance of these bacteria could also be due to the activities of *B. subtilis*, the predominant bacterium in the fermentation, which is known to produce the antibiotic bacitracin. The antibiotic may have inhibited the growth of these bacteria and the disappearance of *Micrococcus* sp. especially at 96 h of fermentation is believed to be due to this (Ogueke & Aririati, 2004). *Micrococcus* sp. are very sensitive to bacitracin (British Pharmacopoeia Commission, 1993).

Since the bean seeds were boiled for hours before fermentation the microorganisms involved in the fermentation could not have originated from the beans. The bacteria involved in the fermentation probably were introduced through the air, water, utensils, leaves used in wrapping or by handling during the preparatory stages (Obeta, 1983; Odunfa & Oyeyiola, 1985). Example *Staphylococcus* sp. are more commonly associated with the skin and hence are easily disseminated through handling. Also addition of salt would selectively favour the growth of *Staphylococcus* and *Micrococcus* sp. which are known to be salt tolerant (Adam & Moss, 1999).

Changes that occur during fermentation: Various biochemical changes occur during the fermentation. Obeta (1983) found that pH increased from 6.5 at 0 h to 9.0 at 48 h and declined to 7.1 at 72 h. The rise in pH has been attributed to the abundant production of ammonia during the fermentation due to protein hydrolysis and deaminase activity. The increase in pH would encourage the growth of *Bacillus* sp. which have been found to grow well at pH 7.0 to 8.0 (Odunfa and Oyeyiola, 1985). The drop in pH to 7.1 at 72 h could be attributed to the fact that *B. subtilis* and *B. licheniformis* use ammonia as nitrogen source (Odunfa, 1986b). However, Odunfa and Oyeyiola (1985), Njoku and Okemadu (1989) and Ogueke and Aririati (2004) found that pH rose throughout the fermentation from 5.0-5.7 at 0 h to 7.9-8.7 after 3-5 days of fermentation.

The temperature of fermentation was observed to increase from about 30.8 to 34.5-38.5°C within the first 24-36 h of fermentation and decreased gradually afterwards to 30-32.5°C at the end of fermentation (Odunfa & Oyeyiola, 1985; Njoku & Okemadu, 1989). Thus ugba fermentation is exothermic. This initial increase in temperature has been attributed to the intense metabolic activities of the microorganisms (period of maximum microbial activity) and represents the most active and important period of the fermentation. This is because enzyme studies (Njoku & Okemadu, 1989) have revealed that the α -amylase, proteolytic and lipolytic enzyme activities attained their maximum levels at 24-36 h of fermentation. Thus it could be the enzymes already produced rather than the presence of the microorganisms that continued the fermentation later.

Moisture content was also found to increase throughout the period of fermentation (52-56.90% to 71.20-73%) (Odunfa & Oyeyiola, 1985; Njoku & Okemadu, 1989; Ogueke & Aririati, 2004). The

increase in moisture is believed to be due to the hydrolytic activities of the microorganisms. However, the high moisture level has been suggested to predispose the product to rapid spoilage (Odunfa & Oyeyiola, 1985; Ogueke & Aririatu, 2004).

Njoku and Okemadu (1989) detected α -amylase, proteolytic and lipolytic enzymes from the start of ugba fermentation. These enzymes attained their maximum levels at 24-36 h. They suggested that this could be assumed to be the period of maximum microbial activity. The initial enzyme activity detected could be due to the activity of the natural microflora of the oilbean which developed particularly during the soaking of the cooked beans. Njoku and Okemadu (1989) therefore suggested that it could well be that fermentation began much earlier during the soaking of the sliced beans. Some workers (Enujiugha *et al.*, 2002, 2004) have demonstrated that the raw seeds contain both α -amylase and lipase. They observed that the specific activity of the purified α -amylase from the raw and fermented seeds were $0.037 \text{ mL}^{-1} \text{ min}^{-1}$ and $0.88 \text{ mL}^{-1} \text{ min}^{-1}$, respectively. They also claimed that these enzymes complement the bacterial enzymes during fermentation. However, since the seeds were boiled for several hours before fermentation they could not have contributed to the fermentation as the boiling must have inactivated them. The proteinase enzyme is considered the most important enzyme in ugba fermentation. Njoku and Okemadu (1989) detected a sevenfold increase in the level of amino nitrogen while Enujiugha (2003) also observed a steady increase in the level of amino nitrogen from 1.23 to 13.68 mg Ng^{-1} DM after 72 h of fermentation. Only a two fold increase in reducing sugar was found, while the activity of lipase was minimal compared to the other two enzymes (Njoku & Okemadu, 1989). This agrees with the report of Achinewhu (1986) that fermentation has no appreciable effect on the fatty acid content of *P. macrophylla*. The minimal activity of the lipase could be attributed to the effect of NaCl that is usually added during fermentation. Enujiugha *et al.* (2004) in their study of the lipase activity in dormant seeds of African oilbean seeds observed that the activity of lipase isolated from the seeds were inhibited up to 36% by NaCl. However, they found that presence of Ca^{2+} increased the activity of the enzyme by 64%.

Optimization of ugba fermentation: Several workers have conducted studies on ways of optimizing the production of Ugba. Most of the studies have been on the modification of some parameters that affect the fermentation such as temperature and Relative Humidity (RH), the use of starter cultures and immobilized cells in the fermentation process. Isu and Njoku (1998) the influence of temperature, relative humidity and microenvironment on the natural fermentation of Ugba. Their results suggested that fermentation may have been faster at 80% relative humidity. They suggested that the traditional method of wrapping with leaves of *Mallotus oppositifolium* presumably produced warmth and a humid environment while limiting the accessibility of air to the fermenting substrate. Thus the 80% RH created a more humid environment than the atmospheric RH of 74.5% which was more favourable for the fermentation process. They also found that a temperature of 35°C was most suitable for the fermentation generating a peak amino-nitrogen content of 19.6 mg N/100 g dry matter within 48 h. Thus reducing fermentation time by 24 h. as against the 72-96 h. in the traditional fermentation process.

The use of immobilized cells of *Bacillus* sp. in the fermentation process has also been carried out by some workers. Isu and Ofuya (2000) studied the use of pure cultures of *Bacillus subtilis* attached to cowpea and maize granules in the fermentation process. These workers monitored changes in pH, amino-nitrogen and protease activity which they said were the fermentation indicators. They found out that in comparison with the natural fermentation changes in these indicators were more pronounced in the fermentation carried out with the immobilized cells (Table 4). For example the protease activity increased from 4.5 to 27.65 mg N/min for the immobilized cells as against 10.5 mg N/min produced by the natural fermentation.

The use of the immobilized cells resulted in the reduction of the fermentation time to 48 h. as compared to 96 h. for the natural fermentation process. The authors attributed the increased

activity observed with the immobilized cells to the increase in cell density per unit reactor and enhanced cell wall permeability and metabolism. Their sensory evaluation studies also showed that the products from immobilized cell fermentation were well accepted. The cultures were also stable and viable for 6 months on the granules of cowpea.

The use of starter cultures of *B. subtilis* and the spores in association with cowpea granules were studied by Isu and Abu (2000). They observed that the viability of the cells in association remained stable at 94.5% for 6 months at 30°C and up to 10 months at 4°C while the viability of the spores in association remained at 96% for up to 10 months at both 4 and 30°C. They also observed that the indicators of fermentation were more pronounced than in the natural fermentation and fermentation was completed within 48h. The use of such cultures for fermentations can be applied to the indigenous process standardization and uniform product quality (Isu & Ofuya, 2000). It will also eliminate the chances of contamination by potential food poisoning and other disease causing and spoilage microorganisms.

Nutritional value of ugba: Table 5 shows the mineral and vitamin content of the seeds. The vitamin content of the seeds is low while they are poor sources of calcium and phosphorus (Duke, 1981). Odoemelam (2005) has also shown that the seeds contain sodium (236.2 ppm) and potassium (181.3 ppm). The contents of niacin and riboflavin have been found to decrease during fermentation. Mineral content also decreased during fermentation while no phosphorus could be found in ugba (Duke, 1981).

However, since ugba is usually eaten with fish or added as a condiment to soup containing animal proteins, much of the needed calcium and protein may be obtained from these sources (Odufa, 1986a). The major sugars found in the seeds are stachyose, galactose and fructose while saponins constitute about 2.1% of the seeds (Achinewhu, 1983). These saponins when hydrolysed would yield glucose, arabinose, rhaminose, oleanolic acid and hederagenin. The content of these carbohydrate decreased significantly as fermentation time increased (Monago *et al.*, 2004).

However, Enujiugha (2003) has shown that fermentation for 72 h slightly increased the crude protein and ash contents of ugba. The amino nitrogen increased steadily from 1.23 mg N g⁻¹ DM prior to fermentation to 13.68 mg N g⁻¹ DM after 72 h of fermentation. He also found that the principal fatty acid linoleic acid increased from 60.68 to 67.57% of the total fatty acids while oleic acid decreased from 26.95 to 22.59%. Palmitic acid and other saturated fatty acids in the seed oil were also slightly affected by the fermentation. However, Onwuliri *et al.* (2004) found that fatty acid concentrations did not change appreciably with processing and fermentation. There was also accumulation of formic acid, acetic, lactic and butyric acids and got to 0.20, 0.18, 0.35 and 0.41 mg g⁻¹ respectively after 72 h of fermentation.

Isichei and Achinewhu (1988) studied the nutritive value of African oil bean (AOB) seeds. The seeds were high in energy with a slight difference between the gross energy value of unfermented and fermented oil bean seeds. They also stated that the results obtained from the estimated protein energy ratio (p^e%) and net dietary protein calorie percent (NDpCal%) showed that the two processed forms of the seed have the potential to satisfy human protein and energy requirements. Feeding of rats with unfermented and the fermented seeds resulted in weight loss (-0.82 g and -0.11 g, respectively). However, the average daily intake by the rats was higher for the fermented (5.06 g) than the unfermented (4.72 g). The unfermented and fermented seeds produced a negative protein efficiency ratio (PER) in rats. The protein digestibility was also low. Although, the oil bean seeds are rich in protein (Achinewhu, 1982), they suffer source nutritional drawback as they could not promote nor maintain growth of rats. The poor performance has been attributed to the presence of toxic components in the seeds which impair protein utilization (Isichei and Achinewhu (1988). Mbadiwe (1978) attributed the poor nutritional quality to the presence of growth-depressing factors. Onwuliri *et al.* (2004) have shown that the seeds contain some anti-nutritional factors which included cyanide, phytate, tannin and oxalate. The raw seeds were found

to contain the highest concentrations of all the anti-nutritional factors except oxalate with the highest concentration (937.5 mg/100 g) in the boiled seeds. However, they observed a progressive reduction in the level of all the anti-nutritional factors at the different stages of processing and fermentation. The fully fermented ugba had a reduction of 73.49% for cyanide, 79.41% for tannin, 76.92% for oxalate and 45.98% for phytate. Akindahunsi (2004) studied the effect of salting, soaking before cooking and fermentation on the proximate, anti nutritional and mineral content of the bean seeds. They significantly decreased protein content by 10.5, 9.9 and 8.0%, respectively. However, the energy levels increased from 312.5 kcal mol⁻¹ in raw seeds to 450.9, 440.5 and 405.9 kcal mol⁻¹, respectively after treatments. The zinc levels increased while Mg, Na and K levels decreased.

Toxicology of ugba: The unfermented oil bean seeds contain a number of anti nutritional and toxic factors. Achinewhu (1983), showed the presence of saponins while Duke (1981) reported the presence of a poisonous alkaloid, paucine in the oilbean seeds. Mbadiwe (1979) reported the presence of caffeoylputrescine, a growth depressant. However, hemagglutinins were not found in the oil bean seeds (Toms and Western, 1971). The presence or absence of these toxic substances in the fermented beans has not been investigated. It is, however, believed that these substances are eliminated during the processing and fermentation of the seeds, especially during the soaking, where they can leach out into the water used for soaking. Other anti-nutritional factors in the beans have been shown to reduce progressively during processing and fermentation (Onwuliri *et al.*, 2004). Ruiz-Teran and Owens (1999) have also shown that such substances are leached out during soaking in soya bean tempeh production. However, Akindahunsi (2004). observed that salting and soaking before cooking and fermentation did not have any effect on the level of tannins while the level of phytate increased. Thus these may be responsible for the poor performance of the bean seeds during feeding studies in rats by Isichei and Achinewhu (1988). However, there has not been any reported case of health problems resulting from the consumption of ugba over the years.

Although saponins have been reported to be toxic, they may be beneficial since they have been found to lower plasma cholesterol. Monago *et al.* (2004) have shown that ugba fermented for up to four days decreased the level of plasma cholesterol in rats, the rate of decrease increasing with the time (days) of fermentation. Thus consumption of the well fermented product promotes health. Chidozie (2006) has shown that administration of the fermented seeds as a food supplement have greatly reduced the risk of cancer and some tobacco related diseases and cancer patients who had regular fermented oil bean seeds as food supplement showed marked improvements in regaining quality health.

Flavour components of ugba: Fermented African oilbean seeds have typical aroma and flavour. These are due to the various volatile compounds produced by the fermenting microorganisms in the course of their metabolism. Not much work has been done in this direction. However, Kabuo *et al.* (2007) studied the various flavour and aroma components present in the beans fermented with pure cultures of microorganisms isolated from ugba. The sample fermented with *B. subtilis* and *B. licheniformis* were found to produce the best ugba with its typical aroma and flavour. The compounds identified were ethyl stearate (3.60%), ethyl oleate (4.70%), ethyl linoleate (14.14%), ethyl phenol (6.94%) and ethyl phenol (6.94%) and ethyl octanoate (2.69%). The control (naturally fermented) contained ethyl benzoate (18.40%), ethyl carbonate (5.557%), methyl pentanone (1.67%) and ethyl octanoate (4.72%).

Microbiological safety of ugba: Various microbiological studies conducted on ugba (Obeta, 1983; Odunfa & Oyeyiola, 1985; Ogueke & Aririatu, 2004) showed that food pathogens such as *Clostridium perfringens*, *C. botulinum*, *Salmonella* sp., *Shigella* sp. and *Vibrio* sp. have not been isolated from ugba. However, such bacteria as *E. coli* and *Staphylococcus aureus* have been isolated. These are bacteria capable of causing food infections/poisoning. But since the

preparation of the delicacy or addition as condiment to soup involves heating, they will be eliminated during the process. Azubuine and Isu (2006) studied the fungal contamination of the fermenting product. They isolated *Aspergillus flavus*, *A. niger*, *Penicillium chrysogenum* and *Fusarium* sp. This poses a serious health risk as these are moulds that produce mycotoxins in foods. This calls for the observation of Good Manufacturing Practice (GMP) during the production. However, application of starter cultures and immobilized cells in the fermentation process will eliminate these possibilities of contamination with unwanted organisms. However, their numbers decreased with increase in the number of days of fermentation. Thus the environment was not suitable for their growth and toxin production, especially with the increasing pH of the fermenting slices into the alkaline region.

Total viable counts after 6 months of storage were 9.3×10^3 , 1.7×10^4 , and 6.0×10^3 cfu g⁻¹ in brine, refined groundnut oil and tomato sauce respectively while the free fatty acids content (g oleic acid) were 3.12, 2.54 and 3.98 respectively. The peroxide values obtained after storage were 11.63, 9.54 and 10.02 meq kg⁻¹, respectively while the acid values (mg NaOH g⁻¹ oil) were 6.43, 5.10 and 7.92, respectively. Sensory evaluation of the canned products showed that the groundnut-oil canned product was least acceptable in terms of aroma and overall acceptability although all the products showed increased softening and colour darkening with the prolonged storage.

Preparation of ugba: Methods for ugba preparation vary from one community to the other. In this method described by Obeta (1983), the seeds are boiled in water for 16-18 h to remove the tough testa. The cotyledons are then sliced, boiled again for 30 min and left overnight in water at room temperature. The sliced cotyledons are then washed in water and packaged in leaves of banana.

Another method described by Odunfa and Oyeyiola (1985) and Odunfa (1986a) shows that the seeds are boiled in water over an open fire for 4-5 h or even up to 12 h. The cotyledons are then removed from the seed coats and washed. The cotyledons are again boiled overnight over a low flame, allowed to cool, drained and washed several times to remove bitter components in the cotyledons and soaked for a period of 6 h. The cotyledons are then cut into long thin slices which are mixed with salt, put in a clean pot, covered and fermented for up to 5 days at room temperature. Usually after 2-3 days of fermentation the sliced cotyledons are wrapped in banana leaves and tied tightly.

Njoku and Okemadu (1989) also described another production method. The seeds are boiled for 5-8 h, after which the hard shells are removed. The cotyledons are cooled, washed and sliced into 4-5x0.1-0.2 cm slices. These are washed again and boiled for another 1-2 h, cooled and soaked in water for about 10-12 h. They are washed and allowed to drain for ½-1 h. in a basket lined with banana leaves (*Musa sapientum* linn). They are then wrapped about 40-50 g of slices using another leaf (*Mallotus oppositifolius*) and incubated for 72 h at room temperature.

Another method has been described by Sokari and Wachukwu (1997). These workers said toasting the bean seeds in hot (100°C) sand and holding for a further 30 min at 100°C significantly improved dehulling. They also said that slicing to 1 mm, boiling for 30 min and soaking for 2 h removed the bitter taste associated with the seeds. They claimed that the technique reduced the general production time by 2 days and the quality of ugba produced from this process was the same as that produced from the rather more cumbersome and time-consuming traditional technique.

Chemical composition of seeds: The oilbean seeds contain 4-17% carbohydrate, 44-47% oil which has been found to be rich in oleic acid (Nwokedi, 1975; Odoemelam, 2005) and linoleic acid (Onwuliri *et al.*, 2004). Onwuliri *et al.* (2004) also found out that the saturated fatty acid, lignoceric acid, occurred in high amounts constituting about 10% of the total fatty acid concentration. Some workers said that the oil content could be as low as 38% (Kar and Okechukwu, 1978). They also reported that the oil contains about 75% saturated fatty acids and

25% unsaturated fatty acids. Table 1 (Achinewhu, 1983) shows the fatty acid content of the seeds. Both saturated and unsaturated fatty acids are found in the seeds. For the saturated fatty acids, lignoceric acid appears to be present in the largest amount constituting about 12% while palmitic acid is the least with 3.4%. Behemic acid is also present with 5.2%. The major unsaturated fatty acid in the seeds is linoleic acid constituting 42.8%. Oleic acid is also present in appreciable amounts (29.0%). Linolenic and gadoleic acids are present in very small amounts (3.2 and 0.28%, respectively). The presence of appreciable amounts of behenic and lignoceric acids is not desirable for edible oils (Odunfa, 1986a).

However, Odoemelam (2005) believes that the high degree of unsaturation makes it suitable for cooking purposes and for use as a drying oil for cosmetics, paints and varnishes. Also they have been found to contain 36.2-43.89% crude protein which contains the 20 essential amino acids. However, the sulphur containing amino acid content is much lower than those found in other plant proteins (Mbadiwe, 1978; Mba *et al.*, 1974; Odoemelam, 2005). The high content of other essential amino acids makes the seeds a potential source of protein (Achinewhu, 1982). Table 2 shows the amino acid profile of the seeds. Glutamic acid appears to be the largest amino acid contained in the seeds. This may be responsible for its use as a flavouring for soups in south eastern Nigeria. Aspartic acid, lysine and phenylalanine are also present in appreciable amounts in the seeds. The quantity of ugba produced annually is not known, since the seeds are collected by individuals and sold in the market to ugba producers. Fermented African Oil-bean Seeds and Tapioca in Ibo land is called abbacha otherwise known as African salad.

Nature of the plant and the seeds: Oilbean seeds for ugba production are obtained from a perennial legume tree, *Pentaclethra macrophylla*, *Bentham*, commonly called the oilbean tree. The trees are often planted along the sides of roads as shade trees and around communities as cash crops. The fruit is a black, hard and woody pod measuring about 35-36 cm long and 5-10 cm broad. When mature it splits open explosively to release about eight flat, glossy brown seeds measuring about 5-7 cm in diameter and weighing between 15-20 g (Keay *et al.*, 1964; Odunfa, 1986a).

The method of production varies from one producer to another resulting in a non-uniform product (Njoku & Okemadu, 1989). The beans that have been fermented for more than three days are taken as a delicacy. Well fermented beans are added to soup as flavouring (Odunfa and Oyeyiola, 1985). Ogbulie *et al.* (1998) made attempts to package the product in low and high density polyethylene sachets and aluminium foil wraps as well as treatment with chemical preservatives such as 2% sodium chloride. However, none of the methods could extend the shelf life beyond 8 days. Mbata and Orji (2008) in their study applied a process of pasteurization at a temperature of 98-100°C for 30 min, which they said completely eliminated all the organisms present including the organisms used for the fermentation. This was able to extend the shelf life to 8 days. They also made attempts to package them in returnable and sterilizable bottles/cups. The containers were sterilized before use and the products pasteurized in the containers. These were able to keep for six weeks. The colour, taste, aroma, softness and other physicochemical properties of the product before and after keeping for six weeks compared favourably well with the locally produced ugba. Enujiugha and Akanbi (2008) used conventional batch retort procedures. The sliced and fermented beans were canned in three different media (brine, refined groundnut oil and tomato sauce). The product was able to keep for 6 months at ambient temperature storage.

Theoretical Framework

Two theories, the Dynamic Capabilities Theory (DCT) developed by Teece, Pisano and Shuen in 1997 and the Match-up-Theory developed by Khatri in 2006 underpins this paper. The DCT assumed that the combinations of resources and competences can be developed, deployed and protected to enhance the performance of a project. Whereas the Match up Theory specifically

assumed that the physical attractiveness of a food packaging enhances the evaluation of the product's characteristic, only if the characteristic of the product matches up with the image conveyed by the food. Companies must match product or companies' image to the features of the target market and the personality of the food, in order to establish effective messages, and the determinants of the match between celebrities and the brands depends on the degree of perceived association between the brands (Brand name, attributes and food image) (Khatri, 2006; Okorie, 2010).

METHODOLOGY

This paper adopted the meta-analysis involving the systematic survey of existing literature and applied the synthesizing of evidence. Thus, to follow the set objectives; the study relied on empirically supported arguments and hypotheses proved already by previous studies.

Research Needs of African Oil Bean Seed and Cassava Chips as Noodle

In order to maximize the potential of African oil bean (AOB) research, there is an urgent need for researchers to look into the following research areas for the crop: Development of improved varieties of African oil bean seed; Optimization of the oil yield of African oil seed; Characterization of the oil from African oil bean seed; Evaluation of the drying kinetic of African oil bean shreds/slices for improved shelf life, Effects of drying on the proximate, phytochemical, mineral and vitamins contents of the African oil bean seed; Technological development of a proper packaging method for African oil bean seed; and Process optimization of Ugba preparation. The research should be focused on repackaging of abbacha in a noodle-like form with the various condiments inserted alongside with the view to increasing the shelf-life and presentation of this our popular and traditional stable food for ultimate consumers in all parts of Nigeria and across the borders.

SUMMARY

The enormous pressure put upon the staple food availability of the people, and imported foods are relatively expensive and unaffordable to the majority of the populace due to poverty and sequel to the growing population of developing nations. To ensure food security in these regions, research on nutritious but neglected crops that grow and flourish with little or no special care, like AOB, should be encouraged. Considering the nutrient attribute, the phytochemical, proximate, mineral and vitamin constituents of African oil bean; the crop could be regarded as a great complementary food for household nourishment and an essential raw material for food and pharmaceutical industries. AOB seed has great prospect of improving the economy of households and the nation through value addition. The exploration of the oil potentials of AOB seed could see the crop compete in world oil-seed trade. Moreover, it brings a high return to investors. Improving the postharvest operations of AOB seed through research could help to tackle food insecurity. Furthermore, there is need to package the Abbacha in the form of noodles, work towards improving varieties for increased production, and improved research on the post harvest challenges of the crop. Thus, any value added on the AOB seed and its packaging to extend its shelf life could possibly create wealth and jobs for the teeming population of these regions and also improve sustained consumer patronage and preference.

RECOMMENDATIONS

It is recommended that more research should be embarked for the:

- a) development and production of packaging wrappers for the abbacha and various condiments;
- b) procurement of the cassava tubers, oilbean seeds, pepper, salt, onions, potash, stock fish and/or fried fish, garden eggs, Crayfish, and garden leaves,

- c) development and procurement of machine for slicing the cassava tubers and oil bean seed into noodle-like form.
- d) development and Procurement of the machines for drying abbacha into noodle-like form and packaging in various sizes.
- e) development and procurement of facilities for fermenting the oil bean seeds
- f) determination of scientific nature and types of the preservatives for the abbacha to ensure longer shelf life.

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