# Process Optimization In The Production And Preservation Of 'Ugba', A Nigerian Fermented Food

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**Citation**

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**Abstract**

Ugba is a Nigerian indigenous, protein rich food obtained by solid state fermentation of seeds of African oil bean (Pentaclethra macrophylla) seed. It has a short shelf life of about 3-5 days. The mixed culture fermentation process converts the bitter and hard seeds to a soft, cherished protein rich product. Process optimization of the production using starter cultures, bottle/cup, packaging and locally adaptable pasteurization technique were evaluated.. Starter cultures of washed cells of Bacillus subtilis and Bacillus megaterium were used to ferment the sliced and sterilized cotyledons of the seeds in sterile round, wide – mouth bottles and aluminum cups with covers for 48 hours at room temperature (30±20C). 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'. No microbial growth was obtained from the product after the pasteurization and at the end of the storage period. The method achieved a reduced fermentation time, an increased keeping quality and a new packaging method that holds great prospects for canning and large scale production of the product.

## INTRODUCTION

'Ugba' also called 'Ukpaka' a Nigerian indigenous fermented food, rich in protein[1] is obtained by a solid-state fermentation of the seeds of African oil bean tree (Pentaclethra macrophylla). It is a popular food delicacy in Nigeria especially among the Ibo ethnic group where it serves as snack, side dish or as a food condiment. It is an essential food item for various traditional ceremonies where it is mixed with slices of boiled stock fish (ugba na okpoloko), ganished with boiled vegetables and consumed by all socio-economic class.

The unfermented seeds are bitter to taste and contain toxic alkaloids and saponins ([2]). The natural fermentation of the seeds which at present is still done at the house-hold level renders the product nutritious, palatable and non-toxic[3]. Its production, like many other African fermented foods, depends entirely on mixed fermentation by microorganisms from diverse sources, some of which may still be alive and active when the product is consumed. The method of production varies from one producer to another resulting in a none uniform product with short shelf-life.

The processes of Ugba production, the microorganisms encountered during the production and the physicochemical properties of the product have variously been reported ([4,5,6,7,8]). The food composition of ugba has also been reported. ([9,10,11]) Some of the fundamental problems associated with 'Ugba' like other Nigerian indigenous fermented foods and beverages include its short shelf life arising from uncontrollable fermentation that occurs after the normal production period and the vulnerability of the product to contamination by pathogenic microorganisms during production and keeping ([12,13]).

Some attempts to improve the packaging and keeping quality of ugba have been reported including packaging with low and high density polyethylene sachets and Aluminium foil wraps ([14]), treatment with different concentrations of chemical preservatives including 2% sodium chloride ([15]). However, none of the methods had been reported to extend the shelf-life of the product beyond eight days.

The present study was aimed at using starter culture and entirely different packaging technique involving screwable bottles and cans and locally adaptable pasteurization to produce and enhance the shelf-life of ugba.

## MATERIALS AND METHODS

The seeds of African oil bean tree (Pentaclethra macrophylla) used in this work were purchased from a local market in Awka, Anambra State, while the traditionally

prepared ‘ugba' were purchased from a local producer also in Awka.

## PRODUCTION OF

The traditional method of ugba production described by Njoku et al ( $_{7}$), was modified in this work. One kilogram (1kg) of seeds of African oil bean tree (Pentaclethra macrophylla) was boiled for five hours. The seeds were then de-hulled and the cotyledons were washed in sterile water and thereafter sliced longitudinally using sharp table knife into 4-5cm x 0.1-0.2cm slices. The slices were washed and introduced into wide month bottles and aluminum cups in 40g sizes and capped tightly with their lids. The bottles and cups containing the slices were then boiled for 2 hours. On cooling down to room temperature, each bottle and cup was aseptically inoculated with 3ml suspension each of Bacillus subtilis and Bacillus megaterium (starter culture) using sterile syringes and needles. Fermentation was allowed to proceed for 48 h at room temperature (30± 2°C). The cups and bottles with their contents were thereafter boiled/pasteurized (98-100°C) for 30 minutes. The pasteurized product was allowed to cool down to room temperature before samples were taken for physicochemical, microbiological and organoleptic analysis. Traditionally produced samples of Ugba and slices of the cotyledon of the seeds put in tightly capped cups boiled but not inoculated (control) were also comparatively analyzed.

## DEVELOPMENT OF STARTER CULTURES

Pure cultures of Bacillus subtilis and Bacillus megaterium isolated from traditionally produced ‘ugba' were developed by inoculating each of the organisms into 40ml peptone water in 100ml Erlenmeyer flask and incubated for 24h at room temperature (30±2°C). The organisms were further developed by transferring them into 100ml peptone water Ugba extract broth (PWUEB) in 250ml flask and incubated for 24h at room temperature. Each of the cultures was finally grown in 250ml sterile ugba extract broth (UEB) in 500ml Erlenmeyer flask for 18h at room temperature. The 18h old cultures were then used as the starter cultures.

## TRADITIONAL METHOD

The traditional method of producing ugba usually involves boiling some quantities of seeds of oil bean tree (Pentaclethra macrophylla) for 5-8h to ease the removal of the hard shell. When the shells are removed, the cotyledons are washed with water and sliced into sizes of 4-5cm x 0.1-0.5cm or more. The slices are then washed and boiled for about 1-3h and then soaked in water for about 10-12h. They are washed again and allowed to drain for ½ -1h in a basket lined with banana leaves (Musa sapietum Linn). They are then wrapped with ororompo leaves (Mallotus oppositifolius Mull) in 40-50g wraps. The wraps are allowed to stay (ferment) for 3-4 days at room temperature before use as Ugba.

## DETERMINATION OF PHYSICOCHEMICAL AND ORGANOLEPTIC PROPERTIES

The pH was determined using a WPAC10 pH meter. The total protein content (total nitrogen content) was determined by the fermol-titration method$_{16}$. The softness/texture was determined instrumentally using a portable penetrometer and subjectively by pressing the slices between the fingers. The total sugar was determined using the phenol sulphuric acid method ($_{16}$). Microbial counts were determined by the pour plate method ($_{17}$).

The organoleptic tests for taste, aroma, colour, softness and sliminess were carried out using a six-man taste panelist who is very familiar with Ugba. The rating test method was used and scoring was done using a 5-point Hedonic scale in a well lit room at roam temperature (30±2°C). Each panelist was provided with 2g of the test sample and asked to freely evaluate, comment and score the samples' taste, colour, aroma, softness and sliminess using the scale as follows, 5 – very good, 4=good, 3=fair, 2=poor, 1=very poor/unacceptable. To eliminate bias, the sample presented to a panelist at a time is not labeled and the panelists were served individually with sufficient privacy and at different times to guarantee independent judgement. The acceptability of the samples was based on the scores and remarks made by the panelists. The result of the test was assessed using the Hedonic preference test ($_{18}$). The scores for the samples were analyzed statistically using the method of analysis of variance – ANOVA ($_{19}$).

## SHELF LIFE DETERMINATION

Fresh Ugba purchased from the local dealer and the ones produced in this study were placed in plastic trays and kept for six weeks on the laboratory shelf. Every week, starting from the day the product was produced/purchased (week 1) two samples each of the laboratory product and the ones purchased from the local dealer were removed from the shelf and their physicochemical, microbial and organoleptic properties determined

## RESULTS AND DISCUSSION

The physicochemical properties of Ugba produced by the

modified method compared very well with the ones produced through the traditional method (Table 1). The boiled but uninoculated ugba slices (control) did not have features of ugba after the production period (Table 1). The effect of storage on the physicochemical properties and the microbial counts of ugba produced through the traditional and modified methods are summarized in Table 2. The result shows that whereas microbial numbers increased steadily up to the 3rd week in ugba produced through the traditional method during storage, microorganisms were not isolated from ugba produced by the modified method (Table 2). It presupposes that boiling/pasteurization at 98-100°C (boiling temperature of water) for 30 min was able to completely eliminate the organisms (starter culture) used in the fermentations. However, in an earlier trial run, a holding time of 15min at 98-100°C could not completely eliminate all the organisms. Ogbulie et al ($_{15}$) reported that pasteurizing ugba for 30 min at 60°C could not appreciably reduce the microbial load and so could not extend the shelf life of the product up to three days. But pasteurization at 90°C for 30 mins reduced the microbial load and was able to extend the shelf life to 8 days.

Bacillus spp were used as starter cultures in this work because they have severally been reported as the major microorganisms that are responsible for the physicochemical and organoleptic features of Ugba ($_{4,7}$) and their presence may explain why pasteurization at 60°C could not significantly reduce the microbial load of the ugba as Bacillus spp are known to produce resistant spores.

A reduction in fermentation time was achieved in this work and this was apparently because the starter cultures used were at their exponential growth phase and have been grown in ugba broth and so lag periods were drastically minimized and the size of inocular used may have been was sufficient to initiate and sustain a fast fermentation rate.

**Figure 1**

Table 1: Physicochemical Properties of Ugba produced by traditional and the modified methods

| Sample | pH | Colour | Texture | Protein (mgN/g) | Sugar mg/g | Microbial count (cfu/g) |
|---|---|---|---|---|---|---|
| a | 8.0 | Light brown | Soft and slime | 6.4 | 8 | $6.2x10^6$ |
| b | 7.6 | Light brown | Soft and slime | 6.6 | 7.6 | 0 |
| c | 5.6 | Dark brown | hard | 2.3 | 3.5 | 0 |

*Key: a= ugba purchased from the local dealer*
*b= ugba produced in this work*
*c= slices of the seed boiled but not inoculated (control)*

**Figure 2**

Table 2: Effect of Storage on the Properties of Ugba

| | A | | | | | | B | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Storage period (week) | pH | Colour | Texture | Protein (mg/kg ) | Sugar (mg/g) | Microbial Count (cfug-1) | pH | Colour | Texture | Protein (mg/kg ) | Sugar (mg-1) | Microbial count (Cfug-1) |
| 1 | 8.0 | Light brown | Soft and slime | 6.4 | 8 | $6.2x10^6$ | 7.6 | Light brown | Soft and slime | 6.6 | 7.6 | 0 |
| 2 | 8.6 | Dark brown | Very slime | 6.7 | 7.5 | $8.2x10^6$ | 7.7 | Light brown | Soft and slime | 6.5 | 78 | 0 |
| 3 | 8.8 | Dark brown | Very slime | 7.4 | 7.2 | $27.3x10^3$ | 7.7 | Light brown | Soft and slime | 6.4 | 7.6 | 0 |
| 4 | 9 | Dark | Dry | 7.0 | 6.8 | $7.1x10^5$ | 7.6 | Light brown | Soft and slime | 6.6 | 7.5 | 0 |
| 5 | 9 | Dark | Dry and hard | 6.8 | 6.8 | $6.8x10^4$ | 7.7 | Light brown | Soft and lime | 6.5 | 7.6 | 0 |
| 6 | 9 | Dark | Dry and hard | 6.2 | 6.0 | $5.5x10^4$ | 7.7 | Light brown | Soft and slime | 6.4 | 7.5 | 0 |

*Key: a= ugba produced and packaged through traditional method*
*b= ugba produced and packaged by the modified method*

The effect of storage on the organoleptic properties of ugba is presented in Table 3. The result shows that all the organoleptic parameters of ugba considered in the study became bad after the first week for ugba obtained from the local dealer while the parameters remained virtually the same throughout the six weeks storage period for ugba produced in this study (Table 3).

The major problems of ‘ugba' are its poor shelf life often associated with the uncontrolled fermentation and poor packaging which often allows maggots to develop on the product as a result of eggs laid by flies that gained entry into the wrapped product. The production process also renders the product vulnerable to contamination by pathogenic microorganisms. These difficulties were overcome in the present work by using known organisms (starter culture), a packaging system that does not allow the entrance of extraneous organisms into the product and the use of a pasteurization method that can easily be adapted by the local producers.

Colour, aroma, texture and sliminess are important organoleptic indices of a well fermented ugba and thus are inevitable in its shelf-life determination. These attributes of Ugba were achieved and maintained for six weeks in Ugba produced in this work but dark brown colour, loss of sliminess and production of pungent ammoniacal odor which are signs of spoilage were observed in Ugba purchased from the local dealer during the six weeks storage (Tables 2 and 3). The off flavour was also reported by Ogbulie et al ($_{15}$) and it was said to be due to increase in ammonia nitrogen during storage as a result of increased hydrolytic activities of microbial enzymes. This explanation was also used to explain the steady rise in pH during the storage (Table 2).

The result of this work not only provided advances for mass production of Ugba with a standardized operational method but also provided means for the production of uniform

product with reduction in fermentation time and enhanced product shelf-life. The study has also shown that Ugba can be packaged in returnable and sterilizable containers. The packaging is environment friendly as it will not litter the streets as the leaves used in traditional packaging.

### Figure 3

Table 3: Effect of storage on the organoleptic properties of ugba

| Period of storage (weeks) | a | | | | b | | | |
|---|---|---|---|---|---|---|---|---|
| | Taste | Colour | Aroma | Softness | Taste | Colour | Aroma | Softness |
| 1 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 29 |
| 2 | 12 | 14 | 10 | 24 | 30 | 30 | 29 | 30 |
| 3 | 10 | 10 | 8 | 12 | 30 | 28 | 29 | 30 |
| 4 | 6 | 6 | 6 | 6 | 30 | 30 | 30 | 30 |
| 5 | 6 | 6 | 6 | 6 | 28 | 29 | 29 | 30 |
| 6 | 6 | 6 | 6 | 6 | 30 | 30 | 29 | 30 |

Key: a = *panelists' scores for ugba produced by the traditional method and stored for 6 weeks*
b = *Panelists' scores for ugba produced by the modified method and stored for 6 weeks*
30= *maximum additive scores of the 6 panelists for each parameters*
6= *The least additive scores of the 6 panelists for each parameter.*

## CORRESPONDENCE TO

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