The Production Of Tempeh-Like Food Product Using African Breadfruit Seeds (*Terculia africana*)

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ABSTRACT: Breadfruit tempeh was prepared by fermenting African breadfruit seeds with *Rhizopus oligosporus* (NRRL 2710) and later used as filler to formulate breadfruit pie. Sensory evalution was carried out on this food product. During the fermentation process, physicochemical changes and proximate analysis of breadfruit tempeh were monitored at 12 hour interval until 60 hour. Crude fiber content decreased from 14% to 1.07% and carbohydrate content from 28.57% to 24.57%. The protein content increased from 7.86% to 10.94%, nitrogen content from 1.26% to 1.75%, ash content from 0.7% to 0.9%, lipid content from 5.60% to 8.60% and moisture content from 48.60% to 55.70% which later reduced to 53.80%. Reducing sugar was not detected. P^H decreased from 6.55 to 5.71 while temperature increased from 29^{o}C to 45^{o}C and later declined to 39^{o}C. The fermenting breadfruit tempeh was harvested at 36hr and a portion of it was deep- fried, some oven dried and the remaining portion were steam- boiled and they were used as fillers in different combinations to formulate breadfruit pie. Oven-dried breadfruit tempeh plus meat pie fillers had the highest protein content of 28.88% while meat pie fillers had the least protein content of 13.42%. Deep-fried breadfruit tempeh mixed meat pie fillers was the preferred among all the filler used to formulate breadfruit pie.

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1. INTRODUCTION

African breadfruit (*Treculia africana*) is a tropical forest tree that produces highly protenious seeds (Aminigo and Obot, 2004). Among people of southern Nigeria the seeds are usually eaten after boiling, roasting or frying. It can also been used to make breadfruit flour and vegetable milk like soy milk from soybean (Onwezulo and Nwakalor, 2009). Proximate composition of raw breadfruit seeds reveals that it contains 73% carbohydrate, 12% proteins, 8% moisture, 1.62% crude fiber, 2.2% ash and 4.23% lipids (Osabor *et al.,* 2009). Soybean and African breadfruit seeds are legumes.

Tempeh is produced by species from *Rhizopus* fermenting cooked, dehulled together by dense non-sporulated mycelium by *Rhizopus* sp. It has clean yeasty odour with meat-like flavor devoid of beany flavor in whole soybean which is disliked by so many people. Apart from soybean, other substrates such as melon seeds, bambara groundnut, barley and African yam bean has been used to produce tempeh (Feng, 2006; Amadi *et al.,* one third of total food consumption by human beings worldwide (Kanwar *et al.,* 2007).

The consumption of tempeh is still unpopular in Nigeria despite the abundance of soybean (Aderigbe and Osegboun, 2006). Tempeh contains vitamin B_{12} and its consumption is linked to decreased risk of heart diseases, strokes, osteoporosis, cancer, digestive disorders (Kenth and Bisping, 1994; Babu *et al.,* 2009). Tempeh can serve as meat foe vegeterians (Nouts and Kiers, 2005; Liem et al., 1997). The objective of this study is to determine the suitability or otherwise of African breadfruit seeds as an alternative tempeh.

2. MATERIALS AND METHODS

Freshly dehulled African breadfruit seeds were obtained from Mlie 3 market Port Harcourt, Nigeria using polythene bags and were immediately taken to the laboratory. *Rhizopus oligosporus* strain (NRRL 2710) was gotten from the Department of Biological Science University of Agriculture Abeokuta, Nigeria.

2.1. PREPARATION OF BREADFRUIT TEMPEH

A method similar to the used for the production of tempeh using melon seeds were adopted (Amadi *et al.,* 2003). Two hundred gram (200g) of dehulled breadfruit in seeds were soaked in tap water (1 at: 6 breadfruit seeds to water w/w) for 24 hours 30^{O}C. The soak water was drained and fresh water added to the seed which were cooked for 1 hour which was the cooking time predetermined using the method adopted by Njoku *et al.* (1989) and Nwabueze and Nwokenna (2006). The seeds were allowed to

cool to room temperature (25-30^{o}C) and were later inoculated with 2ml spore suspension of a 7 day old to culture of *Rhizopus oligosporus* grown on potatoe dextrose agar which contains 1.8 x 10^{6} cfu/ml. It was homogenously mixed and tightly packed asceptically in a perforated plastic container and kept at room temperature. After 36-48hrs, the fermenting breadfruit tempeh was harvested. A portion of it was sliced and sprinkled with little salt, curry, and maggi before it was deep- fried ion groundnut oil for 3-5 minutes using Kenwood Electric Deep fryer set at 160^{o}C. Another portion of the freshly harvested breadfruit tempeh was oven-dried in hot air oven at 160^{o}C for 7-10 minutes while the remaining portion was steam-boiled for 10-15 minutes.

2.2. FORMULATION OF PIE PRODUCTS

Deep-fried, oven-fried and steam boiled breadfruit tempeh was used as fillers to formulate breadfruit pie similar to the conventional meat pie. Also, 4g of chopped beef was separately added to 4g portion of all differently prepared breadfruit tempeh and used as filler to prepare breadfruit pie. All the formulation was prepared on line by a commercial meat pie producer. The procedure involves mixing flour, margarine, egg, and baking powder together. The mixture was divided into small portions and dough was kneaded. The different fillers were each incorporated into the dough and baked in hot air oven at 150-200^{o}C for 20-30 minutes.

2.3. PHYSICAL CHARACTERISTICS

The method used by Amadi *et al.* (1999) was adopted to subjectively describe the colour, texture, flavor, surface coverage by mold mycelia, compactness and sliceability of breadfruit.

2.4. PROXIMATE AND CHEMICAL ANALYSIS

Moisture content was determined using hot air oven method (AOAC). Furnace methjod of Osborne and Voogt, (1978) was used to determine ash content, the Soxhlet extraction method as described by Fishwick and Wright, (1977) was used to determine total lipids. The Micro-Kjeldah method was used to determine nitrogen and crude protein content. The crude fiber content was determined using Osborbe and Voogt, (1978) method. The difference method as described by Onwezulo and Nwakalor, (2009) was used to determine carbohydrate content. D initrosalicyclic acid (DNSA) reagent method of Miller, (1959) was used to determine reducing sugar content.

2.5. TEMPERATURE AND pH

pH and temperature were determined as described by Aderibigbe and Osegboun (2006) and Njoku *et al.* (1990) respectively.

2.6. SENSORY EVALUATION

The method used was as described by Aderibigbe and Osegboun, (2006) and Njoku et al. (1990). A seven member panel who are unfamiliar with the product evaluated the taste, texture flavor, appearance, aroma, and overall acceptability of different breadfruit pie formulations using Nine Hedonic Scale. The descriptive terms and their rating were as follows: like extremely (9), like very much (8), like moderately (7), like slightly (6), no preference (5), dislike slightly (4), dislike moderately (3), dislike very much (2), dislike extremely (1). The judges were asked to rinse their mouth with water before tasting each sample.

2.7. STATISTICAL ANALYSIS

Analysis of variance (ANOVA) and correlation was used to analyze data obtained from the sensory evaluation of the food product. Tables and bar chart were also used to represent data obtained from proximate and chemical analysis carried out on fermenting breadfruit tempeh and breadfruit pie.

3. RESULTS ANALYSIS

The result show that a tempeh-like food product could be obtained from African breadfruit seeds by fermenting it with *Rhizopus oligosporus*. Mycelia of the fungi began to develop after 24 hours from the start of fermentation binding the breadfruit seeds together. The seeds became softer as fermentation progressed and the characteristic smell of cooked breadfruit seed was greatly reduced and almost eliminated. This observation was similar to that of Njoku et al., (1990). Also, moisture was noticed under the cover of the plastic container containing the fermenting breadfruit tempeh. Also, the back of the plastic container was warm. After 48 hours, black spores started forming on the seeds. Table 1 shows the physicochemical changes during fermentation of african breadfruit tempen by *Rhizopus oligosporus*.

Table 1: Physicochemical Changes during Fermentation of African Breadfruit Tempen by *Rhizopus oligosporus*

	Fermentation Time (hr)					
Parameters	**0**	**12**	**24**	**36**	**48**	**60**
Carbhydrate (%)	22.726±2.64	29.31±3.62	28.57±1.76	24.76±1.27	24.09±1.67	24.69±1.32
Moisture (%)	48.60±0.91	50.40±0.85	52.40±1.94	55.70±0.78	55.60±0.72	53.80±1.44
Protein (%)	7.86±1.06	8.31±0.41	7.00±0.10	10.94±1.16	9.63±0.51	10.94±0.95
Crude fiber (%)	14.46±0.59	5.49±0.62	4.93±0.10	1.80±0.18	1.08±0.14	1.07±0.10
Ash (%)	0.70±0.01	0.70±0.11	0.80±0.04	0.90±0.04	0.90±0.10	0.90±0.06
Lipid (%)	5.60±0.01	5.80±0.14	6.30±0.03	5.90±0.08	8.70±0.18	8.60±0.40
Reducing sugar (%)	Nil	Nil	Nil	Nil	Nil	Nil
Nitrogen (%)	1.26±0.14	1.33±0.07	1.12±0.10	1.75±0.21	1.54±0.04	1.75±0.04
pH (%)	6.70±0.14	6.55±0.03	6.50±0.01	6.40±0.03	6.00±0.06	5.71±0.03
Temperature(^{0}C)	27	29	31	44	45	39

During the fermentation process, moisture content increased from 48.60% to 53.80% which was similarly reported by sanni et al., (1991). This could be attributed to metabolism and breakdown of carbohydrate in the breadfruit seeds by the fungi. Lipid content increased slightly from 5.60% to 8.60% and nitrogen content from 1.26% to 1.75%. The increase in nitrogen also reported by Njoku *et al.,* (1990) could be attributed to proteolysis. Protein content increased from 7.86% to 10.94% which Arawande *et al.,* (2009) attributed to dehulling of breadfruit seeds. Odunfa (1985), Njoku *et al.* (1990) and Fadahunsi and Sanni (2010) also reported an increase in protein content during fermentation of food substrates.

The decrease in crude fiber content from 14.46% to 1.07% could be linked to treatment conditions such as soaking andf boiling of the seeds. A similar result was reported by Fadahunsi and Sanni (2010). The carbohydrate content decreased from 29.31% to 24.69%. Njoku *et al.* (1990) who reported a similar result attributed it to breakdown of carbohydrate by carbohydrase produced by some microorganisms into simple sugars for energy.

Reducing sugar was not detected in the fermenting breadfruit tempeh. Temperature increased from 29^{0}C and peaked at 45^{0}C and later reduced to 39^{0}C. Related research carried out by Njoku et al. (1990) Amadi et al., (1999) and Nout and Rombouts (1990) reported similar result. This could be attributed to metabolic activity of the fungi. The reduction in p^H during fermentation of breadfruit tempeh from 6.55 to 5.71 might be as a result of acidification by acetic acid fermentation of breadfruit which reduces the chance of microbial spoilage.

Sensory evaluation of the food product was carried out by 7 man panel. Based on their assessment, a correlation of the following attributes: appearance, taste, texture, aroma, and texture on the overall acceptability of breadfruit pie is 67.85%, 64.9%, 54.5% and 43.1% respectively. It could be inferred that the overall acceptability of these food product greatly depend on taste and least on texture. Table 2 shows the sensory panels mean score of breadfruit pie prepared using different combinations of filler and overall acceptability

Table 2: Sensory Panels Mean Score of Breadfruit Pie Prepared Using Different Combinations of Filler and Overall Acceptability

Sample	**Taste**	**Texture**	**Appearance**	**Aroma**	**Overall Acceptability**
Steam-boiled breadfruit tempeh	5.57^a	6.29^a	7.71^a	7.86^a	7.00^a
Deep-fried breadfruit tempeh + meat	8.00^a	7.00^a	7.86^a	7.86^a	8.57^a
Meat pie filler	7.29^b	7.57^b	6.57^b	6.57^b	7.00^b
Stem-boiled breadfruit tempeh + meat	7.00^a	7.43^a	7.86^a	6.43^a	8.00^a
Oven-dried breadfruit tempeh + meat	7.14^a	8.00^a	8.00^a	7.29^a	8.00^a
Deep-fried breadfruit tempeh	6.86^b	6.71^b	7.86^b	7.57^b	8.14^b
Oven-dried breadfruit tempeh	6.71^a	7.29^a	6.29^a	7.14^a	6.71^a

Keys: Means within each row which do not have the same superscript are significantly different (P< 0.05).Mean score were based on a nine hedonic scale: 9 = like extremely; 8 = like very much; 7 = like moderately; 6 = like slightly; 5 = neither like nor dislike; 4 = dislike slightly; 3 = dislike moderately; 2 = dislike very much; 1 = dislike extremely.

4. CONCLUSION

Based on overall acceptability, deep-fried breadfruit tempeh mixed with beef used as filler to prepare breadfruit pie was the most prteferred among the 7 man panel. This could be as a result of the seasoning such as maggi, salt, curry sprinkled on the freshly prepared breadfruit tempeh before frying. Generally, breadfruit pie prepared using breadfruit tempeh as filler is highly acceptable like the conventional meat pie.

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