

Proximate Composition and Fatty Acid Profile of Okpa Produced from Bambara Groundnut Flour in Bayelsa State, Nigeria

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Abstract

The nutritional value of traditional food (TFO) called 'Okpa' obtained by processing Bambara groundnut (*Vigna subterranean L.*) was investigated. Proximate composition of Okpa showed that it contained high moisture content (70.21%), crude protein (8.31%), carbohydrate (11.35%), lipid (6.17%), low in ash (2.26%) and crude fibre (1.71%) and average energy yield was 151.51 kcal/100g calories. Fatty acid profile of Okpa contained highest total amount of saturated fatty acids (64.63%) being dominated by stearic acid (46.50%), palmitic acid (16.68%) and trace amount of myristic acid (0.33%). The total monounsaturated fatty acid was 32.57%, comprised of oleic acid (21.46%), palmitoleic acid (11.07%) and myristoleic acid (0.04%). Total polyunsaturation was lowest (2.84%), comprised of trace amounts of linoleic acid (0.62%), linolenic acid (2.15%), eicosatrienoic acid (0.05%) and arachidonic acid (0.02%). Quality of fats in Okpa was poor due to low Ps value of 0.044, not beneficial to health of consumers with heart-related diseases.

Keywords: Nutritional value, traditional Okpa, and fat

1.0 Introduction

"Okpa" is a traditionally processed food from Bambara groundnut (*Vigna subterranean, L. Verdc.*) which originated from Africa that is grown for survival during famine and disaster (Olaleye *et al.*, 2013). It is highly cherished by the Igbos in the Eastern part of Nigeria. It is an indigenous leguminous plant grown by subsistence farmers in drier regions of sub-Saharan Africa (Temegne, 2011, Temegne *et al.*, 2018). Thus, Bambara nut serves as an important source of protein in the diets of a large populace who cannot afford expensive animal protein (Bamishaiye *et al.*, 2011). In most of the South-Eastern states of Nigeria, Okpa is considered as second to bread because it is eaten in all households at any time of the day to obtain energy and provide essential nutrients in the body (Bamishaiye *et al.*, 2011). The bambara seeds are also known to have different names in different ethnic groups in Nigeria, which is the largest producer of 0.1 million tons, followed by Burkina Faso which produces 44,712 tons annually (Hillocks *et al.* 2012). The Igbos call it Okpa; the Hausas call it "fuojoya", while the Yorubas call it "erivour". The Bambara seed is very rich source of protein, carbohydrate and minerals (Azman *et al.*, 2018); hence it is consumed as food in different part of the world. The young fresh seeds can be boiled and eaten as snack, similar to boiled peanuts. Okpa literally means beans porridge, is usually produced from bambara groundnut by molding the flour, mixing with hot water and adding some condiments to form paste which is wrapped with banana leaves and put into tins or plastic containers before steaming it to produce the local meal called Okpa (Enwere and Hung, 1996).

Although, Okpa is a small-holder business among the females in most indigenous Ibo communities in Eastern Nigeria, middle-belt and spread to southern Nigeria; it is rare to have a standardized “Okpa” in the market because, like other traditionally prepared foods such as akara, moi-moi and chin-chin; the method of preparation and the quantities of the ingredients used depends on the cultural values of the different ethnic groups; thus there are differences in the quality of Okpa in different locations in Nigeria (Adebowale *et al*, 2011 and Adegunwa *et al*, 2014). In spite of its popularity in local menu, there is paucity of information on the quality of fats of Bambara nut, especially when it is processed as Okpa. Davidson *et al* (2019) confirmed that lack of reliable data on the nutritional value of many traditional foods (inclusive of Okpa) had restrained the rate of acceptability and utilization of cultural foods in modern society. Furthermore, Okeke *et al*, (2008) asserted that most traditional foods are becoming obscure in recent times due to non-availability of nutritional composition which guides consumers on the health implications of such lesser known locally processed food products. Therefore, this study was undertaken with the aim of evaluating the nutritional value and to ascertain whether the quality of fats of a locally processed Okpa is beneficial to the health of consumers in Bayelsa State and other parts of the society in general.

2.0 Materials and Method

2.1 Source of Materials

Three (3) wraps of locally prepared Okpa which weighed about 350g were randomly bought at the rate of = ₦750 from female hawkers at different sections of swali market in Yenagoa municipal city of Bayelsa State, Nigeria. It was immediately covered with foils and put into clean plastic container and taken to food science laboratory in River State University, Nkpolu, Port Harcourt, Nigeria for chemical analyses.

2.2 Nutritional Evaluation

The proximate composition which consisted of moisture, crude fibre, crude fat and ash content was determined by standard methods (AOAC, 2012). The Kjeldahl method was used to determine the crude protein content and carbohydrate was determined by calculating the difference (100-% moisture+% crude fat+% crude fibre+% ash content). The average total energy yield of Okpa was calculated using the Atwater factors to multiply as follows: 4.0 was multiplied by carbohydrate and crude fibre; 4.1 was multiplied by the protein value and 9.0 was multiplied by the fat value and the total was summed up (Fox and Cameron, 1989). The mean and mean deviation was calculated for all the values obtained on the proximate composition.

2.3 Fatty Acid Profile Analysis

The fatty acid profile of the Okpa was determined according to AOAC (2012) standard methods. The fats from Okpa was extracted using petroleum ether by Soxhlet method and subjected to GC-MS analysis (Model 7890A Agilent Series, USA), with flame ionization detector (FID). 10 grams of the fats in Okpa sample was extracted with petroleum ether using the Soxhlet methods and the extract was esterified with 2ml potassium hydroxide (0.5N) in methanol to obtain fatty acid methyl ester (FAME). An aliquot of the esterified sample was injected into the gas chromatography analysis where the individual fatty acids were identified based on comparison of retention times and profiles shown on the chromatogram of the standard oils which was expressed as a percentage of the total content of all acids present in the sample.

3.0 Results and Discussion

The proximate composition (Table 1) showed that the locally processed Okpa was a complementary source of crude protein (8.31%), fat (6.17%) and ash (2.26%). It was a moderate source of carbohydrate (11.35%) and crude fibre (1.71%) on wet weight basis. The values of proximate composition of Okpa in this study was consistent with other scientists who reported at NSUKKA in Enugu State of Nigeria (Davidson *et al.*, 2019), that a standardized Okpa contained high moisture content of 60.45%, carbohydrate content of 11.6%, crude protein content of 10.5% and lipid was 8.1%, but there was great difference in the crude fibre which was reported to be 9.2%; whereas, the samples of Okpa was found to have low crude fibre of 1.72% in Bayelsa State, Nigeria. This may be attributed to the addition of local spices such as uziza and other ingredients been used by traditional Igbo cultures at Enugu State; (Davidson *et al.*, 2019).

Table 1: Proximate composition of Okpa

Sample	Moisture (%)	Ash (%)	CHO (%)	Crude protein (%)	Crude fibre (%)	Lipid (%)	Total energy (kcal/100gm)
A	70.21	2.40	11.51	8.42	1.72	6.03	
A ₁	70.19	2.25	11.35	8.30	1.70	6.15	
A ₂	70.24	2.14	11.20	8.21	1.71	6.23	
Mean + MD	70.21±0.02	2.26±0.09	11.35±0.10	8.31 ± 0.07	1.71±0.54	6.17±0.07	151.51

Fatty Acid Composition of Okpa

The results (Table 2a) showed that a locally processed Okpa which is consumed by large population of Igbos in Eastern Nigeria and some ethnic tribes in middle belt and southern Nigeria, contained higher proportion of saturate fatty acids (SFA) (46.50%) dominated by stearic acid (46.50%), followed by palmitic acid (16.68%), plus low amount of myristic acid (0.33%), eicosanoic acid (0.85%) and lechenic acid (0.27%) which combined to have total saturation of 64.63%. The Okpa also contained high amount of monounsaturated fatty acids (MUFA), mainly comprised of oleic acid (21.46%), palmistoleic acid (11.07%) and trace amount of myristolic acid (0.04%) which combined to have total monounsaturation of 32.57%. It also contained low amount of polyunsaturated fatty acids (PUFA), namely; linoleic acid (0.62%), linolenic acid (2.15%), eicosatrienoic acid (0.05%) and arachidonic acid (0.02%) which combined to have low total polyunsaturation of 2.84%.

Table 2a: Fatty acid Profile of Okpa

S/NO	FATTY ACID	CARBON-BOND	%	CHARACTERIZATION
1.	Myristic acid	(C14:0)	0.33	SFA
2.	Myristoleic acid	(C14:1)	0.04	MUFA
3.	Palmitic acid	(C16:0)	16.68	SFA
4.	Palmitoleic acid	(C16:1)	11.07	MUFA
5.	Stearic acid	(C18:0)	46.50	SFA
6.	Oleic acid	(C18:1)	21.46	MUFA
7.	Linoleic acid	(C18:2)	0.62	PUFA (omega-6)
8.	Linolenic acid	(C18:3)	2.15	PUFA (omega-3)

9.	Eicosanoic acid	(20:0)	0.85	SFA
10.	Eicosatrienoic acid	(C20:3)	0.05	PUFA (omega-3)
11.	Arachidonic acid	(C20:4)	0.02	PUFA (omega-3)
12.	Lechenic acid	(C22:0)	0.27	SFA

Table 2b: Degree of unsaturation of Fats in Traditional Okpa

Components	Composition (%)
Total SFA	64.63
Total MUFA	32.57
Total PUFA	2.84
Ps Value	0.044

The results (Table 2b) further showed that the interaction of the high proportion of saturated fatty acids (64.63%) with average amount of monounsaturated fatty acids (32.57%) which combined with low amount of polyunsaturated fats (2.84%) resulted to low Ps value of 0.044. This implied that the quality of fats in a locally processed Okpa was lower than the quality of fat in edible palm oil and margarine which has low ps value of 0.2 (Womeni *et al*, 2009). Therefore, this study revealed that contrary to popular belief that Okpa is a healthy food (Ayogu *et al*, 2017); it is not good for the health of all consumers because it constitutes high risk to people who are having coronary diseases, due to high content of bad cholesterol (LDLs) associated with the high level of saturation (64.63%) of fats in Okpa which increases blood pressure in diabetic and hypertensive patients (Mann, 1993; Harvard, 2018). The high nutritional benefits of bambara nut agreed with earlier worker (Temegne, 2011 and 2018) who stated that bambara nut is a complete food that contained adequate amount of essential nutrients required for healthy living: such as protein (23.6%), carbohydrate (64.5%) and dietary fibre (1.4-10.3%) dry matter (Azman *et al*, 2018). The variations observed in the values of Okpa in this report and that of Temegne (2011 and 2018) could be attributed to the effects of processing and the addition of ingredients, including edible palm oil and substantial amount of table salt to make the Okpa to have sweet taste and reddish in colour to attract consumers (Davidson *et al*, 2019). Furthermore, the addition of other spices to improve the taste of the Okpa, also affected the quality and constituted greater risk to the health of consumers who are having heart-related diseases (Minka and Bruneteau, 2000, Harvard, 2018) Davidson *et al*, (2019) who corroborated these findings, stated that the consumption of standardized traditional Okpa by rural people in an experimental meal revealed that Okpa caused higher glycaemic index (GI) of 54 after the first 15 minutes; which was higher than another locally prepared meal called “Igbangwu” (made of corn-pudding) which had lower glycaemic index of 51 among Igbo people in Nsukka local government area of Enugu State in Nigeria.

Table 3: Quantitative Proportions of Essential Polyunsaturated Fatty Acids in Traditional Okpa.

Essential PUFA	Composition	(%)	Total (%)
omega – 3 (n-3) Fatty Acid	Linolenic acid	2.15	
	Eicosatrienoic acid	0.05	2.22
	Arachidonic acid	0.02	
omega – 6 (n-6) Fatty Acid	Linoleic Acid	0.62	0.62

Ratio of $\omega - 3$ fatty acids $\omega - 6$ fatty acids		3.58:1	4:1 Approx.
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The results (Table 3) showed that the total essential polyunsaturated fatty acids which consisted of n-3 ($\omega - 3$) plus n-6 ($\omega - 6$) was 2.84%. Although, the $\omega - 3$ fatty acids comprised of linolenic acid which impacts greater health benefits on the human heart, but it was low in concentration (2.15%). There was negligible amounts of eicosatrienoic acid (0.05%) and arachidonic acid (0.02%) which were also of great health benefits. On the other hand, linoleic acid ($\omega - 6$) which was present in little quantity (0.6%) also offers great health benefit to consumers. The World Health Organization reported that the combination of $\omega - 3$ and $\omega - 6$ fatty acids should be in the ratio of 1:1 or more, to sustain optimum health benefits which includes prevention of cardiovascular diseases and control hormonal secretions that are associated with colon cancer, obesity and abatement of hypertension in humans (Tasbozan and Gokce, 2017). However, these health benefits are limited due to the low concentrations of $\omega - 3$ and $\omega - 6$ fatty acids, which combined in the ratio of 4:1, was seemingly too low to produce significant impact on the health of the consumers. The underlying cause was the low Ps value of 0.044 which was unhealthy for efficient functioning of the human heart. The American Heart Association (AHA) stated that taking 3 grams of $\omega - 3$ fatty acid through the food we eat or fish oil or by supplementation is adequate for healthy living in an adult. However, higher amount is needed by people who have heart-diseases but should be taken under medical directives (Bruce, 2019; Nivin Todd, 2021). The health benefit of taking adequate amounts of $\omega - 3$ and $\omega - 6$ fatty acids include lowering of blood pressure, slowing down the formation of plaque in the arteries, which reduces the incidence of heart attack and stroke which eventually lead to sudden death in people having coronary diseases (Nivin Todd, 2021). Therefore, there is great need to increase the concentrations of the n-3 and n-6 fatty acids to range between 10 -15% in traditional Okpa as recommended by the World Health Organization to enhance better health of consumers. Harvard (2018) also stated that for a food substance to provide optimum health benefits to consumers, it should contain not more than 10% of total saturated fatty acids and monounsaturated fats each, while the total polyunsaturated fatty acids should be within the range of 10 – 15% for an adult. In order to develop a traditional Okpa that will give maximum health benefit to consumers, the edible oil palm should be replaced with common oils that are rich sources of polyunsaturated fats such as vegetable oil or corn oil; fish oil or soya bean oil in the absence of the preferred oils above, perhaps olive oil which contains high amount of monounsaturated fatty acids should be used (Phyllis 2020)

Conclusion:

The findings of this study has confirmed that traditional Okpa is a complementary source of essential macronutrients such as crude protein (8.31%), carbohydrate (11.35%), lipids (6.17%) and ash (minerals) (2.26%), but it was low in crude fibre (1.71%) on wet weight basis. The results had also established the fact that okpa was not a healthy food for consumption by every person because it contained high saturation of 64.63%, moderate monounsaturation of 32.52% and low polyunsaturation of 2.84%, with a low Ps value of 0.045. This implied that the quality of fats in some locally processed Okpa was not good for consumption by people who are having heart-related diseases, as well as diabetic and hypertensive patients, due to the presence of high content of bad cholesterol (LDLs) that increases blood pressure which often culminates into stroke in most cases. Therefore, people who are obsessed or diabetic and hypertensive should eat locally prepared Okpa with caution. However, in order to reduce the negative impact of high amount of saturated fats in Okpa, the

quantity of red palm oil should be reduced or completely replaced with higher quality of oils that supply high amount of polyunsaturated fats (vegetable oils, corn oil, fish oil and suya oil) and perhaps olive oil which is a high source of monounsaturated fatty acid, which are better for the human heart. In a bid to salvage the large population of people who are consuming Okpa with the erroneous belief that they are eating a healthy food, there is need to established a standard way of preparing Okpa which should be disseminated to the rural populace through media awareness programmes and seminars in rural communities, churches and schools. There is also need to have a comprehensive survey to identify the different methods of preparing Okpa amongst different ethnic groups in Nigeria, to obtain reliable data on the nutrients composition of Okpa with the aim of recommending a standard method of preparing Okpa that will be healthy to consumers in general.

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