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Proximate Composition and Microbial Level Estimation of some Selected Roasted/Fried Food Items Sold Along Nigeria Roadsides

Nworu J.S.,* Chime E.C., Edafiokena A., Amitaye A.N., Ovili V.U., Anyichie I.K. and Amuka J.O.

School of Basic Science (Chemistry), Nigeria Maritime University, Okerenkoko, Delta State, Nigeria.

*Corresponding author E-mail address: jerome.nworu@nmu.edu.ng (Nworu J.S.)

Abstract: The objective of this study was to determine the proximate and microbiological compositions of some food samples obtained at three different locations within Ibadan Metropolis, Nigeria from different local food vendors. The highest mean carbohydrate, crude protein, fat, moisture, total ash and crude fibre are 88.10 ± 0.79% (Roasted Yam), 17.76 ± 2.29% (Roasted Fish), 20.54 ± 4.0% (Suya Meat), 20.27 ± 11.43% (Roasted Plantain), 4.57 ± 0.10% (as in Suya Meat) and 5.07±0.69% (Roasted Plantain) respectively while the lowest mean carbohydrate, crude protein, fat, moisture, total ash and crude fibre are 49.14 ± 1.37% (as in Fried Bean Cake), 0.08 ± 0.01% (Roasted Yam), 0.47 ± 0.05% (Roasted Yam), 1.81 ± 0.33% (Roasted Fish), 1.37 ± 0.12% (Doughnut) and 0.16 ± 0.06% (Fried Bean Cake) for all the samples estimated. The highest mean heterotrophic bacteria and fungi counts are $6.19×10^3$ cfu/ml (Roasted Yam) and $3.30×10^3$ cfu/ml (Fried Bean Cake) respectively while the lowest mean heterotrophic bacteria and fungi counts are $1.64×10^3$ cfu/ml (Doughnut) and $1.08×10^3$ cfu/ml (Roasted Plantain) respectively. These food samples were shown to contain certain level of proximate parameters but these are not sufficient for nutritional requirements in human diet. Increasing the shelf-life of foods is one of the major purposes in food processing. Processes which precede food processing causes loss of essential vitamins and minerals. Also, roasted foods sold along Nigerian road-sides are exposed to dust accumulation and wastes from automobile exhaust.

Keywords: Proximate; Moisture; Ash content; Crude fibre; Crude Protein; Microbial

1. Introduction

Consumer trends and demands, national and international regulations, and the food industry's need to manage product quality dictate the need for analysis of food items. Food is one of the basic needs of life. It is essential for perfect health, productivity and mental development. Astronomical increase in population of developing countries has resulted in increase in food prices as well as shortage of fertile land which has resulted in hunger and malnutrition.[1-2] The importance of food in human existence cannot be over emphasize. This is the reason why an issue of food and nutrition has been a major topical issue across the world especially in developing countries. It was estimated that 204 million people principally in sub-Saharan Africa were severely malnourished between 1990 and 1992 as reported by the Food and Agricultural Organization (FAO) of the World Health Organization (WHO).[3] This is mainly due to insufficient protein intake among the populace which has posed a major health concern especially in little children.[4] However, this malnutrition cannot be said to be principally caused by insufficient food intake but also of inadequate nutritional quality of the food available to the populace[4-6] This might be due to the method of food processing which could contribute to nutritional loss.

Food processing which include sorting, grading, packaging, re-shaping and value addition is aimed at increasing the shelf-life of food. However, washing, peeling and blanching steps which precede food processing are responsible for loss of essential vitamins and minerals.[7] Processes that exposed foods to high levels of oxygen, light and heat such as frying, roasting, washing and drying causes great nutritional loss.[5,8] It is instructive to note that the commonest food processing methods employed by locals in West Africa including Nigeria are boiling, frying, roasting, smoking and drying. Boiling is a method of cooking that involves water and allowing the water to boil vigorously while roasting is a method of using uncovered pan in the absence of water to produce brownish exterior and moist-cooked interior. These processing methods are aimed at increasing the nutritional quality of food and decreasing anti-nutritional substances present in them.[9,10] However, nutritional qualities are also loss in the process. It was reported that extrusion cooking affected the nutrients especially the proximate composition of pigeon pea and unripe plantain blends[4] while boiling and drying of seeds of African bread-fruit resulted in percentage decrease in nutrients and vitamin A.[3] Alike, there are several reports available in the literature related to the proximate and microbiological compositions of food samples.[11-42]

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Table 1. Proximate analysis of various fast food items collected at different locations

Proximate Analysis	Location	RP (%)	RF (%)	RY (%)	SM (%)	FP (%)	RC (%)	FBC (%)	DT (%)
Carbohydrate		79.76	74.05	88.99	50.51	59.11	79.58	50.21	64.61
Crude Protein		3.65	15.89	0.085	8.50	10.03	7.12	12.03	8.02
Fat	Agbowo	0.49	5.17	1.48	24.55	13.94	2.02	18.92	8.93
Moisture		7.23	2.09	7.25	5.78	14.39	7.02	16.02	16.75
Total Ash		3.31	1.70	1.45	4.45	2.02	2.05	2.60	1.27
Crude Fiber		5.66	1.31	0.75	6.20	0.51	2.21	0.22	0.42
Carbohydrate		63.57	70.95	87.45	54.33	60.13	79.76	47.60	65.14
Crude Protein		3.51	17.08	0.081	9.50	9.88	7.05	11.57	8.10
Fat	Dugbe	0.40	6.78	2.48	20.51	12.51	1.54	22.09	9.91
Moisture		25.03	1.90	7.90	4.81	15.05	7.43	15.98	14.83
Total Ash		3.17	1.89	1.41	4.65	1.97	2.12	2.59	1.51
Crude Fiber		4.32	1.40	0.68	6.20	0.46	2.10	0.17	0.51
Carbohydrate		59.27	70.03	87.85	57.64	60.53	79.79	49.62	65.0
Crude Protein		3.40	20.31	0.078	8.5	10.01	6.98	12.31	7.87
Fat	Eleyele	0.51	5.65	1.77	16.55	13.02	1.71	20.51	10.06
Moisture		28.56	1.45	8.11	5.86	13.98	7.34	14.99	15.10
Total Ash		3.02	1.15	1.50	4.60	2.08	2.11	2.47	1.34
Crude Fiber		5.24	1.41	0.69	6.85	0.38	2.07	0.10	0.63

Proximate analysis is of key commercial concern as food-manufacturing companies need to ensure that their products meet the appropriate laws and legal declaration requirements as well as the safety aspects of the end products when released to the end consumer. To meet the industry-desired standards and be competitive on the market, food-manufacturing companies need to find and utilize in their workflow reliable analytics techniques to analyse the production alongside with the ongoing manufacturing process.

Many urban dwellers obtain a significant portion of their diet from street foods which increase the street food demand in major cities.[34] The preparation and sale of street foods is an age-old activity and has reached new dimensions as a result of rapid urbanization.[35] The safety and shelf life of these street foods, some ready-to-eat, depend upon the interaction of chemical, physical and microbial factors.[36] Street foods are foods and beverages that are sold by street vendors or hawkers and the foods and beverages could be raw or cooked.[37] They include starchy samples of maize, cassava, rice, plantain and yam; legumes like cowpea and groundnut, vegetables like tomatoes, onions, pepper, carrots, pumpkin etc and animal protein like goat meat, beef and various types of fishes.[38] Street foods displayed can be contaminated easily by dust, exhaust, smoke, insects, hands of intending buyers and climatic elements.[35] Street food vending is a large source of employment in many cities of developing countries,[40] contributing significantly to household incomes.[39] Street vendors are often poorly educated, unlicensed, untrained in food hygiene practices and they work under unsanitary conditions with little or no knowledge about the causes of food borne diseases.[41] Most of the foods are not protected from flies which may carry food borne pathogens like Bacillus sp, Staphylococcus sp, E. coli, Clostridium sp, Vibrio sp, Campylobacter sp, Listeria sp and Salmonella sp.[41,42]

Roasting and frying of foods (such as yam, potato, plantain, corn, fish and meat) are common delicacies among the people of Nigeria. It is common to find these delicacies at every nooks and crannies of the country. Locals patronize these delicacies almost on a daily basis. Yam tubers (*Dioscorea sagittifolia*), maize (*Zea mays*), plantain (*Musa paradisiaca*) and potato (*Solanum tuberosum*) are very good source of carbohydrates and are used as staple food while fish and meat are good source of protein. Effect of various cooking techniques have been observed on the proximate properties and/or chemical compositions of asparagus beans,[11] Sorghum,[21] Bambara Groundnut,[20] Pigeon Pea,[19] Common Bean (*Phaseolus Vulgaris* L.),[18] Frozen Leguminous Vegetables,[17] Moin-moin,[14,16] Moin-moin and Akara from nucuna prurient,[15] Wheat and Sesame seed flower blends,[13] Wheat flour,[12] Peanut and Sesame seed.[10]

A critical search of the literature shows that there is no information on the level of proximate composition and microbial loads of roasted plantain, roasted fish, roasted yam, suya meat, fried potato, roasted corn, fried bean cake and doughnut even though these food samples are consumed by most Nigerians. The present study is therefore aimed at examining the nutritional qualities (proximate composition) and the microbial loads these street foods samples.

2. Materials and Methods

2.1. Sample collection

Eight (8) different samples; Roasted plantain, Roasted Fish, Roasted Yam, Suya Meat, Fried potato, Roasted Corn, Fried beans cake and Doughnut were collected from three (3) different locations; Agbowo, Dugbe and Eleyele within Ibadan Metropolis, Nigeria (Table 1) from different local food vendors and stored in different sample bottles.
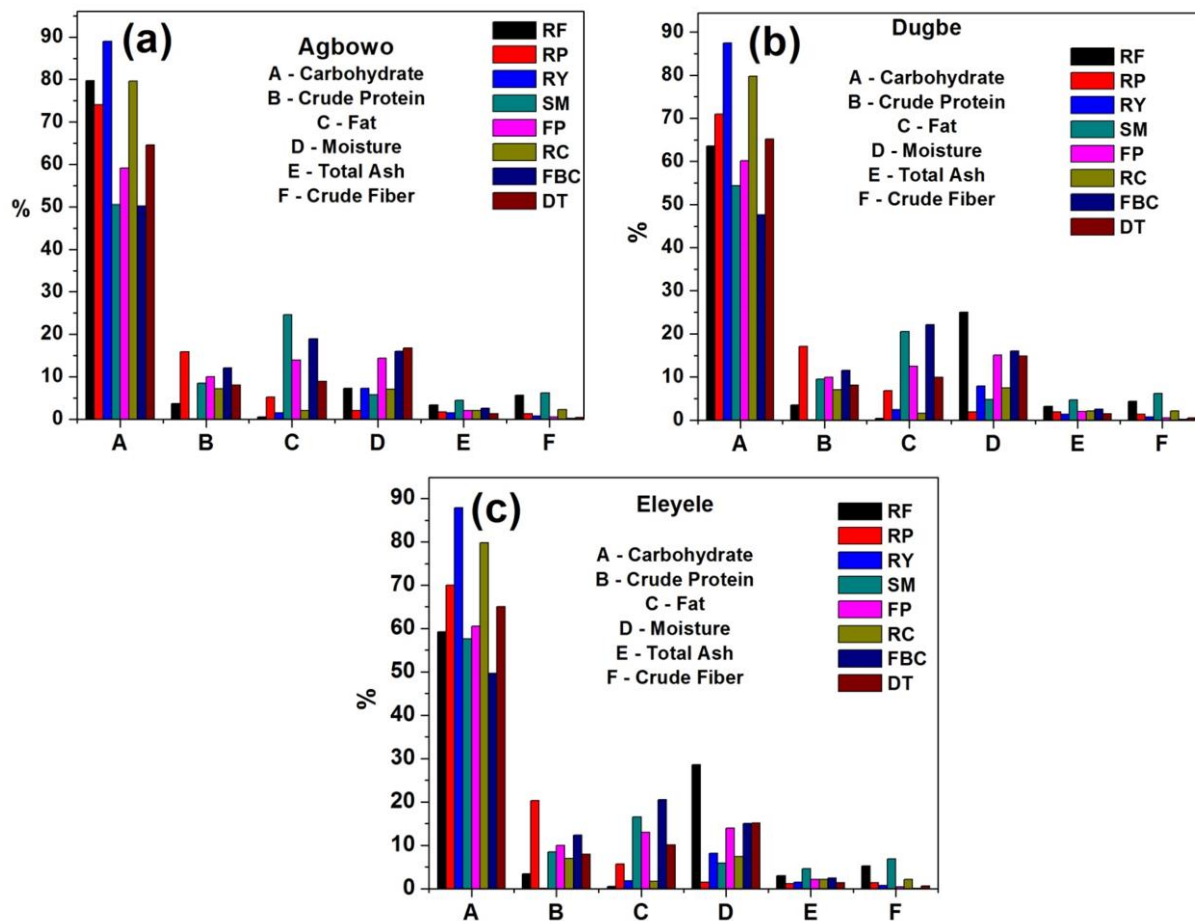
2.2. Proximate Analysis

2.2.1. Moisture Content

The amount of moisture in the food samples was determined according to AOAC.[22] Samples were dried in an air oven at 101°C for about 10 hours until constant weights were obtained, cooled in a desiccator, and reweighed. Moisture content was taken to be the differential between fresh and dry weights.

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Table 2. Proximate Composition of some selected fast foods within Ibadan Metropolis

Food items	Proximate Composition					
	Carbohydrate	Crude Protein	Fat	Moisture	Total Ash	Crude Fiber
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Roasted Plantain	67.53 ± 10.80	3.52 ± 0.13	0.47 ± 0.05	20.27 ± 11.43	3.17 ± 0.15	5.07 ± 0.69
Roasted Fish	71.68 ± 2.11	17.76 ± 2.29	5.87 ± 0.83	1.81 ± 0.33	1.58 ± 0.38	1.37 ± 0.06
Roasted Yam	88.10 ± 0.79	0.08 ± 0.01	1.91 ± 0.51	7.75 ±0.45	1.45 ± 0.05	0.71 ± 0.04
Suya Meat	54.16 ± 3.57	8.83 ± 0.58	20.54 ± 4.0	5.48 ± 0.58	4.57 ± 0.10	4.41 ± 0.38
Fried potato	59.92 ± 0.73	9.97 ± 0.08	13.16 ± 0.72	14.47 ± 0.54	2.02 ± 0.06	0.45 ± 0.07
Roasted Corn	79.71 ± 0.11	7.05 ± 0.07	1.75 ± 0.24	7.26 ± 0.22	2.09 ± 0.04	2.12 ± 0.07
Fried beans cake	49.14 ± 1.37	11.97 ± 0.37	20.51 ± 1.59	15.66 ± 0.58	2.55 ± 0.07	0.16 ± 0.06
Doughnut	64.92 ± 0.27	7.80 ± 0.12	9.63 ± 0.61	15.56 ± 1.03	1.37 ± 0.12	0.52 ± 0.10

Fig. 1. Proximate analysis of various fast food items collected at different locations, (a) Agbowo, (b) Dugbe and (c) Eleyele.

2.2.2. Ash Content

Dried samples obtained in the process of moisture content determination were heated in a muffle furnace at 550°C for several hours. The percentage of ash was calculated by subtracting the weight of ash from the initial weight.[22]

2.2.3. Crude Protein Content and Carbohydrate

Crude protein was analyzed by the Kjeldahl method.[22] The samples went through the three essential steps of digestion, distillation, and titration using a conversion factor of 6.25 to convert total nitrogen to crude protein. The percentage of protein in the samples was calculated thereafter. Subtracting the sum of fat content, protein content, ash content, and moisture from 100 gave the total carbohydrate content.[23]

2.2.4. Fat Content

Crude fat was determined by weighing 5g of each sample wrapped in a filter paper in a Soxhlet apparatus using petroleum ether. This was done each for 4 hours. The extracted materials left after the solvent had evaporated were weighed, and the fat content was calculated.

3. Results and Discussions

Eight (8) different samples; Roasted plantain, Roasted Fish, Roasted Yam, Suya Meat, Fried potato, Roasted Corn, Fried beans cake and Doughnut were collected from three (3) different locations; Agbowo, Dugbe and Eleyele within Ibadan Metropolis, Nigeria (Table 2). Fig. 1 shows the proximate analysis of various fast food items collected at

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Table 3. Proximate Composition of some selected fast foods

Food items	Proximate Composition	
	THB	THF
Roasted Plantain (RP)	1.92	1.08
Roasted Fish (RF)	6.19	2.58
Roasted Yam (RY)	2.01	1.87
Suya Meat (SM)	3.88	1.68
Fried potato (FP)	2.69	2.96
Roasted Corn (RC)	2.80	1.37
Fried beans cake (FBC)	3.22	3.30
Doughnut (DN)	1.64	2.34

THF = Total Heterotrophic Fungi, THB = Total Heterotrophic Bacteria

Table 4. Microbiological Hazard Analysis of the selected fast foods

MHA	RP	RF	RY	SM	FP	RC	FBC	DN
				Units cfu/ml (× 10^3)				
				Agbowo				
THB	1.55	5.88	2.01	4.77	3.00	2.88	4.00	1.11
THF	1.00	2.11	1.00	2.00	3.22	1.00	4.00	2.80
				Dugbe				
THB	2.00	6.70	2.11	3.88	2.50	3.21	3.55	1.82
THF	1.00	2.66	2.17	1.05	2.55	1.88	3.25	2.11
				Eleyele				
THB	2.22	6.00	1.92	3.00	2.56	2.31	2.11	1.98
THF	1.23	2.96	2.44	2.00	3.11	1.24	2.66	2.11

different locations. The moisture content ranged from 1.90 – 28.56 % w/w in all the 8 fried samples. Roasted plantain had the highest moisture content 28.56 % w/w while roasted fish had the lowest moisture content 1.45 % w/w purchased from all locations. There is no significant difference in the moisture content of all these fried samples. Moisture content which is the percentage composition of water in food samples is pertinent in human diet because it regulates the body temperature and it gives account on the shelf life of food samples, the higher the moisture contents the lower the shelf life.

The protein content ranged from 0.078 – 20.31 % w/w with roasted yam having the lowest protein content 0.078 % w/w and roasted fish having the highest protein content 20.31 % w/w. 7 of the 8 food samples are protein-rich while the remaining is carbohydrate-rich. Roasted yam is the carbohydrate-rich food sample, and it is expected to have low protein content. The result of this research prove this to be true with mean protein concentration of 0.08 ± 0.01 % w/w. Roasted fish is the richest in protein with a mean protein concentration of 17.76 ± 2.29 % w/w, this is because its major ingredient is fish, which is a good source of protein. World health Organization[24,25] estimated the average daily protein requirement for adult to be 52.5 g, however, the amount of protein derivable from these roasted food samples were estimated at 0.078 – 20.31 g/100g. The implication of this is that consumption of these fried food samples without any other protein supplements will be grossly inadequate to meet the significant role of protein in human diet. These fried food samples are not a good source of protein as a result of roasting which reduces the amount of protein content in these food samples. Protein is very important for the body growth and cell differentiation.

According to Schmid,[26] fats contribute to the absorption of fat-soluble vitamins, and acts as structural elements of cell walls, in addition to its being a concentrated source of energy. High intake of fats has associated risks such as obesity, type 2 diabetes and cancer and

coronary heart disease. The fat content ranged from 0.40 – 22.09 % w/w in all the 8 food samples. In all locations, roasted plantain and roasted yam have the lowest mean fat content with values being at 0.47 ± 0.05 % w/w and 1.91 ± 0.51 % w/w respectively while suya meat and fried beans cake had the highest mean fat concentration at 20.54 ± 4.0 % w/w and 20.51 ± 1.59 % w/w respectively. Akara (fried beans cake) is popular food in Nigeria and other West African Countries[27,30,32] and form part of diet for most ethnic groups in Nigeria. Beans are about 2-3% fat and contain no cholesterol unless they are processed or prepared with other ingredients. This shows that other ingredients have been prepared with the fried beans cake resulting in its high fat contents. It is not surprising that suya meat is relatively high in fat contents as high intake of animal fats often results in obesity, cancer and coronary heart disease.

Carbohydrates are the body's main source of energy and they comprise 40-80 % of total food energy intake. The carbohydrate content ranged from 50.51 – 88.99 % w/w. Roasted yam has the highest mean carbohydrate content 88.10 ± 0.79 % w/w while suya meat had the lowest mean carbohydrate content 54.16 ± 3.57 % w/w. FAO[31] also estimated fresh raw plantain to contain high carbohydrate content which is about 32 g/ 100 g. The result above also showed roasted plantain to contain high carbohydrate content 67.53 ± 10.80 % w/w (Table 2).

The ash content of a feedstuff is the inorganic residue remaining after the organic matter has been destroyed by combustion in the muffle furnace.[5,22,29] The ash content of the fried food samples ranged from 1.37 – 3.17 % w/w with roasted plantain having the highest ash content while doughnut had the lowest mean ash content. Roasted plantain having the highest ash content is in alignment with the result of[28] who obtained mean ash content 5.15 g/100 g in roasted plantain from all locations.

Roasted plantain had the highest percentage crude fibre of 5.07 % w/w. The percentage compositions of crude fibre in the roasted food samples ranged from 0.16 % - 5.07 % with fried beans cake having the least percentage composition.

Reports[28, 33] found out that several microorganisms such as fecal coliform bacteria, Salmonella species etc. which have public health concern have been implicated in street foods sold in some African countries. These street foods include meat/ fish pies, moin-moin, and roasted food items which is the focal point of our research.

Table 3 shows the proximate composition with Total Heterotrophic Fungi (THF) and Total Heterotrophic Bacteria (THB) factors of some selected fast foods. Table 4 showed that roasted fish has the highest mean heterotrophic bacteria count 6.19 ×10^3 cfu/ml, followed by suya meat 3.88×10^3 cfu/ml while doughnut has the lowest mean heterotrophic bacteria count 1.64×10^3 cfu/ml. The table also showed that fried beans cake has the highest mean heterotrophic fungi count 3.30 ×10^3 cfu/ml, followed by fried potato 2.96×10^3 cfu/ml while roasted plantain has the lowest mean heterotrophic fungi count 1.08 ×10^3 cfu/ml. The WHO standards for Total heterotrophic bacteria (THB) count is 10-16 cfu/ml of which the microbial loads of the roasted food items were far higher than the standards. These high bacteria count could be as a result of the food items being processed with water from sources that are not treated.[28] Presence of bacteria and fungi in high amount in these roasted food items could pose health risk to the consumers. Factors

that could have contributed to the high bacteria and fungi counts are as follows; exposure of raw and roasted food items to the environment, poor hygienic practice such as inadequate washing of hands and utensils and poor food preparation handling.

4. Conclusions

These fried food samples are sources of affordable nutrients. The result indicated that roasted yam had the highest carbohydrate content while fried beans cake had the lowest carbohydrate content, while roasted fish is the richest in crude protein content roasted yam is the least in crude protein content. The result also showed that suya meat had the highest fat content with roasted corn having the least fat content, and also roasted plantain had the highest moisture content while roasted fish had the lowest moisture content. Roasted plantain had the highest ash content and crude fibre content with doughnut and fried beans having the lowest ash content and fibre content respectively. While these fried food samples contain all the nutrients, they do not provide sufficient nutrients and therefore it is recommended that they should be taken with other food items in order to adequately meet the significant role of carbohydrate, protein, fat and fibre in human diet.

Conflicts of Interest

The authors declare no conflict of interest.

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