

Nutrient Composition of selected Snacks in South-West Nigeria

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Abstract. The consumption of ready to eat snacks as meals is rampant in Nigeria and this has made fast foods outlets to multiply at a fast rate across all states. This study was conducted to determine the proximate and nutrient composition of snacks obtained from the south-west states in Nigeria. Ten FFF (five non-meat-based and five meat-based) were selected from ten fast food outlets from South-west Nigeria using systematic random sampling. The FF were analyzed for proximate and mineral compositions using standard laboratory procedures. The gross energy, protein, carbohydrate and total fat of FFF ranged from 205.06 to 402.92 kcal/100g, 3.49 to 12.52%, 8.10 to 71.68% and 4.39 to 23.24% respectively. Sodium content ranged from 0.64 mg to 588.57 mg/100g while potassium content was from 24.91 mg/100g to 216.13 mg/100g. Calcium:phosphorus ratio was 0.02 to 2.8 and sodium:potassium 0.03 to 3.03. Non-meat based samples had higher calcium content when compared to the meat based group $P<0.05$. Fat content of the samples is inversely correlated with ash and dietary fiber content $P<0.01$; and total carbohydrate at $P<0.05$. There was significant difference $P<0.05$ in ash within groups of fast foods, with popcorn having the highest value. Fat content of the samples is inversely correlated with ash and dietary fiber content $P<0.01$; and total carbohydrate at $P<0.05$ within the doughnut samples. This study has shown that these snacks are poor sources of dietary fiber, zinc and potassium; and have abnormally high sodium and potassium ratio which might induce the incidence of high blood pressure in regular consumers of these snacks.

Keywords: Proximate Analysis, Mineral Content, Fast Foods, Monosodium Glutamate.

1. Introduction

Dietary pattern is a major determinant of health status, either positively or otherwise. The consumption of ready to eat snacks has been on the increase in Nigeria because of increased population of urban areas as a result of technology explosion and westernization, where there has been a significant shift from the consumption of normal traditional diets to “on the go foods” or pre-cooked foods such as pies, rolls, doughnuts etc.; these foods or snacks have been associated with the pathogenesis of diet related non-communicable diseases such as chronic heart diseases, high blood pressure, diabetes that are directly associated with obesity (Drewnowski, 2000; Callabero, 2001; Ledikwe et al., 2006). These foods are known to have a higher than normal content of simple sugars, saturated fats, trans fats and flavor enhancing substances some of which are obesogenic in nature. A good example of the flavor enhancer is monosodium glutamate which occurs naturally in proteinous foods as an amino acid called glutamate, but only free glutamate; in salt form with sodium or potassium is effective in enhancing the flavor off foods (Andarwulan et al., 2011; Otemuyiwa and Adewusi, 2013). Most snacks consumers are oblivious to the nutrient contents of these foods, hence, the reason for this study which is to determine the nutrient composition of some selected snacks obtainable in population dense south-west Nigeria so as to provide informed choice for selection of snacks by consumers.

2. Materials and Methods

2.1 Study Area

Nigeria is made up of six geo-political zones with a total of 36 states and the Federal Capital Territory.

The south west zone comprises of six states (Lagos, Ekiti, Ondo, Oyo, Ogun and Osun) with an estimated population of 28 million people (NPC, 2009). The study areas are Ikeja the capital of Lagos State, Abeokuta the capital of Ogun State and Ibadan the capital of Oyo State.

2.2 Sampling Procedures

The fast foods centers were registered with the states ministries of commerce and industries and also the states ministries of tourism. There were 34 registered franchised fast food centers in Lagos, 27 in Ibadan and 13 in Abeokuta. 10 franchised fast food centers were selected in ratio 5:3:2 in the state capital respectively. 1 pastry based franchised fast food was selected by balloting from each fast food centre.

The fast foods centers were registered with the states ministries of commerce and industries and also the states ministries of tourism. The formula for selection from each state was:

Total number of fast foods outlet in each state capital
x sample size

Total number of fast food outlet in the 3 state capitals

2.3 Study Design

Franchised Fast Foods (FFF) were purchased from the selected outlets as consumed and kept in food warmers at 65⁰C till analysis.

2.4 Proximate analysis

Moisture, ash, dietary fiber of the franchised fast foods were determined using AOAC, 2016.

The Kjeldhal method of AOAC (2010) was used to determine the protein content of franchised fast foods.

Fat content of the franchised fast foods was determined using Soxhlet method.

2.5 Determination of mineral content of fast foods

The samples were burned in a muffle furnace at 550 °C for 6 hours, and the ashes were dissolved in concentrated hydrochloric acid (Merck). Iron, calcium, copper, magnesium, and zinc were determined by atomic-absorption spectrophotometer (Perkin-Elmer Model 3300). Sodium and potassium were determined by flame photometry (Micronal

B260) and phosphorus by visible spectrophotometry (Femto 600s), via the ammonium phosphovanadomolybdate. The analyses were performed according to AOAC (2016). The results were obtained after three readings of each triplicate and expressed in g/100 g.

2.6 Determination of monosodium L-Glutamate of fast foods

The Atomic absorption spectroscopy method was used to determine monosodium L-glutamate of samples. From the previously dried and weighed samples, 200mg was dissolved in 6ml of formic acid and 100ml of glacial acetic acid was added and titrated with 0.1N Perchloric acid. End point was determined potentiometrically. A blank determination was ran in the same manner and corrected for the blank. Each ml of 0.1 N Perchloric acid was equivalent to 9.356mg of C₅H₈NNaO₄.H₂O (JECFA, 1988).

2.7 Statistical analysis

All laboratory experiments were carried out in triplicates and results presented as mean and standard deviation of replicate analysis (n=3) of samples collected for each food type. ANOVA was used to assess and compare result and calculations made using SPSS 20.0 for windows and Pearson Product Moment Correlation (PPMC) was used to measure the strength of a linear association between variables.

Results

Table 1: Proximate composition of edible portion of samples (g/100g)

samples		Drymatter(g)	Ash(g)	D. fiber(g)	Protein(g)	Fat(g)	Carbohydrates(g)	Grossenergy[Kcal]
B30S	NMB	81.82 ^b ±0.28	1.48 ^c ±0.35	2.18 ^c ±0.06	5.74 ^f ±0.07	19.55 ^d ±0.4	52.85 ^c ±0.71	399.59 ^a ±8.46
C30R	NMB	78.62 ^d ±0.42	1.46 ^c ±0.23	2.32 ^d ±0.14	5.22 ^e ±0.12	19.49 ^d ±0.3	50.07 ^d ±0.54	401.96 ^a ±6.67
S30T	NMB	79.07 ^d ±0.39	1.15 ^c ±0.09	2.06 ^c ±0.05	5.26 ^e ±0.10	18.60 ^c ±0.48	51.95 ^c ±0.21	396.45 ^a ±10.13
S60T	NMB	97.89 ^a ±0.18	5.52 ^a ±0.36	13.10 ^a ±0.19	3.49 ^b ±0.36	4.39 ^j ±0.35	71.68 ^a ±0.86	402.92 ^a ±32.46
T30R	NMB	77.71 ^e ±0.50	1.46 ^c ±0.35	2.10 ^c ±0.09	5.34 ^e ±0.32	19.33 ^d ±0.4	49.19 ^{de} ±0.96	397.06 ^a ±8.78
B40S	MB	42.94 ⁱ ±0.59	1.31 ^c ±0.28	0.69 ⁱ ±0.02	12.52 ^b ±0.36	20.26 ^c ±0.80	8.10 ^j ±1.11	260.63 ^d ±10.00
T20R	MB	65.71 ^f ±0.46	1.31 ^c ±0.02	1.84 ^f ±0.02	7.84 ^c ±0.13	23.24 ^a ±0.34	31.47 ^f ±0.66	364.42 ^b ±5.44
S20T	MB	63.85 ^g ±0.29	1.20 ^c ±0.11	1.71 ^g ±0.02	7.34 ^d ±0.02	22.20 ^b ±0.3	31.39 ^g ±0.63	348.37 ^b ±4.57
C50R	MB	42.67 ⁱ ±0.51	1.34 ^c ±0.05	1.14 ^h ±0.70	6.32 ^e ±0.05	10.32 ^e ±0.4	23.54 ^g ±0.89	205.06 ^f ±8.33
T10R	MB	43.66 ^h ±0.37	1.14 ^c ±0.07	1.25 ^h ±0.06	8.05 ^c ±0.05	12.48 ^f ±0.35	20.74 ^h ±0.19	225.16 ^e ±6.20
Control	NMB	80.74 ^c ±0.01	2.48 ^b ±0.01	9.67 ^b ±0.03	2.26 ^f ±0.44	7.20 ^h ±0.22	59.19 ^b ±0.91	307.82 ^c ±0.88
Reference	MB	81.29 ^{bc} ±0.01	2.36 ^b ±0.01	8.92 ^c ±0.63	15.45 ^a ±0.05	6.16 ⁱ ±0.16	48.40 ^e ±0.99	310.84 ^c ±0.69

^{abcdeghij} Means along the serial column with different superscripts have significant difference (p<0.05)

The value represents the means ± S.D of 3 independent experiments

Table 1 shows the detailed analytical proximate composition data of the FF groups in comparison with the reference and control diets per 100 g of edible portion. Ash, fiber, carbohydrates and Gross energy [GE] were significantly higher in composition within the NMB group when compared with the NB group but only S60T [NMB] showed a higher value than control and reference. Comparatively protein content was higher in composition MB group when compared with the NMB and control groups. Fat content was significantly higher in the FF groups when compared with the reference and control groups.

Table 2a: Mineral contents of edible portion of samples (mg/100g)

samples		Sodium(mg)	Calcium(mg)	Magnesium(mg)	Phosphorus(mg)	Potassium(mg)
B30S	NMB	255.58 ^e ±0.71	41.27 ^c ±0.16	17.68 ^b ±0.27	132.29 ^a ±0.27	99.68 ^f ±0.01
C30R	NMB	231.46 ^f ±0.39	45.40 ^a ±0.51	16.4 ^l c±0.31	130.70 ^b ±0.36	97.64 ^h ±0.14
S30T	NMB	218.43 ^g ±0.49	43.52 ^b ±0.25	18.09 ^a ±0.09	128.72 ^c ±0.81	100.10 ^e ±0.05
S60T	NMB	0.64 ^j ±0.04	0.57 ^h ±0.13	10.57 ^c ±0.51	28.24 ^f ±0.08	24.91 ⁱ ±0.00
T30R	NMB	201.60 ^h ±0.44	40.28 ^d ±0.05	18.17 ^a ±0.15	130.56 ^b ±0.49	99.11 ^g ±0.01
B40S	MB	10.51 ⁱ ±0.59	2.40 ^g ±0.001	6.79 ^d ±0.17	18.80 ^g ±0.12	41.37 ⁱ ±0.02
T20R	MB	588.57 ^a ±1.20	0.08 ⁱ ±0.01	0.03 ^g ±0.01	0.11 ^h ±0.02	201.71 ^b ±0.02
S20T	MB	567.81 ^b ±0.27	0.28 ^h ±0.36	0.04 ^g ±0.01	0.10 ^h ±0.00	216.13 ^a ±0.03
C50R	MB	372.29 ^d ±0.59	27.22 ^e ±0.26	14.05 ^d ±0.03	82.26 ^d ±0.22	122.87 ^d ±0.10
T10R	MB	430.96 ^c ±0.65	15.28 ^f ±0.28	10.20 ^e ±0.12	74.12 ^e ±0.10	164.79 ^c ±0.09

^{abcdeghij} Means along the serial column with different superscripts have significant difference (p<0.05)

Table 2b: Mineral contents of edible portion of samples (mg/100g)

samples		Zinc(mg)	Chlorine(mg)	Manganese(mg)	Iron(mg)	MSG(mg)
B30S	NMB	1.07 ^a ±0.04	0.12 ^d ±0.01	0.34 ^c ±0.02	2.96 ^d ±0.00	0.93 ^e ±0.03
C30R	NMB	1.03 ^a ±0.04	0.11 ^d ±0.00	0.40 ^a ±0.01	3.77 ^{ab} ±0.1	0.89 ^e ±0.10
S30T	NMB	1.07 ^a ±0.11	0.15 ^d ±0.04	0.32 ^c ±0.01	3.22 ^c ±0.17	0.97 ^e ±0.01
S60T	NMB	0.17 ^e ±0.01	0.26 ^c ±0.01	0.09 ^h ±0.00	0.28 ^h ±0.01	0.68 ^f ±0.02
T30R	NMB	1.11 ^a ±0.10	0.12 ^d ±0.03	0.36 ^b ±0.03	3.61 ^b ±0.09	0.85 ^e ±0.08
B40S	MB	0.65 ^b ±0.06	0.29 ^c ±0.03	0.21 ^d ±0.01	3.89 ^a ±0.09	2.26 ^d ±0.10
T20R	MB	0.05 ^f ±0.00	0.58 ^a ±0.03	0.15 ^f ±0.02	2.10 ^e ±0.01	3.38 ^b ±0.02
S20T	MB	0.08 ^f ±0.00	0.43 ^b ±0.05	0.12 ^g ±0.00	1.93 ^e ±0.00	2.83 ^c ±0.13
C50R	MB	0.53 ^c ±0.03	0.61 ^a ±0.02	0.18 ^e ±0.00	1.07 ^g ±0.02	3.76 ^a ±0.21
T10R	MB	0.318 ^d ±0.00	0.59 ^a ±0.06	0.12 ^g ±0.01	1.72 ^f ±0.17	3.52 ^b ±0.06

^{abcdegh} Means along the serial column with different superscripts have significant difference (p<0.05)

Tables 2a and 2b shows the mineral and monosodium glutamate (MSG) composition of the FF with the MB group having a significantly higher composition of sodium, potassium and chlorine in comparison with the NMB group. Likewise, calcium, magnesium, phosphorus, zinc and iron composition were significantly higher in the NMB group in comparison with the NB group; though the highest significant value was observed in a MB snack. The MB group had a higher composition of MSG when compared with the NMB group.

3. Discussion

All samples in this study had high moisture content which is contrary to those obtained by Otemuyiwa and Adewusi (2014) where samples of beef roll and meat pie had about half the values obtained in this study. This could be as a result of methods and ingredients used in the preparation of these samples coupled with the fast food outlets/centers' principles on snacks composition. Moisture content is one of the determinants of rate of food spoilage due the action of microbes enhanced by water activity (Mariam, 2005), and low moisture content foods are often characterized by high energy density and nutrients per gram of food as a result of less dilution of the nutrients (Otemuyiwa and Adewusi, 2014).

The protein value of fast food samples in this study ranged from 3.4% to 19.2% of gross energy of the samples per 100g of edible portion. The average requirement for percent protein is about 7% of total/average energy intake, Western diets provide about 14% for children and half of it for adults (Bender, 2005).

Fats are highly useful in increasing density of diet because a gram of fat yields about 9 kcal thus, making it a good source of energy; though consumption of fats beyond the recommended dietary allowance over a long period of time has been directly linked with increased risk for heart disease (NCSF, 2011). Within the doughnut samples, fat content of the samples is inversely correlated with ash and dietary fiber content $P < 0.01$; and total carbohydrate at $P < 0.05$.

The ash content of a food is the inorganic residue remaining after the organic matter has been destroyed by combustion in the muffle furnace (MAFF, 1981; AOAC, 2010). There was significant difference $P < 0.05$ within groups of fast foods, with popcorn having the highest value. This could be attributed to maize (main ingredient of popcorn) being rich in mineral content (Bressani et al., 1992).

Conventional fast foods are made from highly refined and processed grains hence, the low fiber content of the fast foods. The germ and bran which are known to contain high fiber have been completely removed from the refined flours such that low level of fiber can have deleterious effect on health, but could be advantageous in health conditions requiring low dietary fiber consumption (Selvendran et al., 1979). There was an inverse correlation between dietary fiber and fat contents of snacks in this study ($r = -0.801$; $P < 0.01$) as increased dietary fiber consumption may reduce the incidence of certain diseases, including diabetes, coronary heart disease, colon cancer and various digestive disorders; it also absorbs water thus producing soft and bulky stools (FAO, 1988). Dietary fiber intake has been found to increase the process of digestion and bowel movement, while inadequate intake was reported to predispose consumers to cancer of the colon, constipation, irritable bowel syndrome, overweight and obesity, coronary heart disease and diabetes (Wu et al., 2003). The high energy value of the FF may be as a result of the composition of the key ingredients in the various snacks; processed wheat flour and margarine/butter coupled with oil. This is in agreement with the findings of Bowman et al. (2004) that fast foods are energy dense food which has been reported to promote overweight and obesity among children, and increasing evidence has associated the consumption of a diet high in carbohydrates, with high prevalence of metabolic syndrome (Gerritis and Tsalikian, 1993; Mendez et al., 2013). Calories from carbohydrates ranged from 20% to as high as 71.68% in this study per 100 g of edible portion of samples.

Minerals in foods are known to play vital roles in the maintenance of human health (Uauy et al., 1998); however, bioavailability in these foods could be affected either positively or otherwise by dietary factors which could improve (presence of meat or fish or organic acids such as ascorbic acid, citric acid, lactic acid) or inhibit (phytates, oxalates, calcium, tannins, fiber) its availability as well as iron status of individual (Fairweather-Tait, 1999). All meat based samples had a relatively higher $P < 0.05$ value of mineral contents than the non-meat based in this study which was corroborated by Bender (1992), who attested that about 1-10% of Fe from plant sources is normally absorbed by the body although this value can be attenuated if plant foods are taken with animal foods; although bioavailability was not ascertained in the present study.

Zinc is present in all tissues of the body and is a component of more than 50 enzymes (Bender, 1992). The minimum Zinc allowance 15-20 mg per day

would not be met by any of the samples as none of the samples was able to meet up to 10% of RDA for any group of people. Non-meat based samples had significant difference $P < 0.05$ zinc content when compared with the meat based samples. This is contrary to values obtained by Otemuyiwa and Adewusi (2014), where the zinc content of snacks was as high as 20mg. Zinc is an important trace element that functions for growth, normal embryogenesis, fetal growth and production of colostrums during lactation. Studies in human and animals have shown that zinc is essential for normal and functional maturation of immune system and also promotes the transport of lipid from the small intestine to the blood (Sanstead, 1981; Prasad, 1983). Potassium is involved in both electrical and cellular function in the body; therefore it is classified as an electrolyte. It has various roles in the metabolism, for instance it is essential for the regulation of acid - base balance and water balance in the blood and body tissues. Total body potassium is reported to be an index of the body's cell mass (He et al., 2003). With respect to potassium content, the meat based samples showed the highest variation. This could be as a result of composition of ingredients used during preparation. It was observed that the sausage roll sample per 100g according to FNB (2000) is approximately 4.5% of RDA of potassium for adults. An adequate intake of potassium has been found to prevent high blood pressure and reduce the risk of stroke (Whelton et al., 1997; Ascherio et al., 1998). Potassium is primarily an intercellular cation, in large part this cation is bound to protein and with sodium influences osmotic pressure and contributes to normal pH equilibrium (Moldawer et al., 1965).

Calcium is essential for bone development and prevention of osteoporosis and may also reduce the absorption of dietary fat thereby lowering serum total cholesterol and low-density lipoprotein cholesterol concentration (Vaskonen, 2003). None of the samples; per 100g of edible portion met the RDA for calcium, but this does not necessarily indicate inadequacy of the mineral in the samples. Percentage of calcium in this study according to FNB (2001), was 0.016% - 9% of RDA for children 1-3 years of age. Calcium is an important constituent of body fluids; it serves as a coordinator among electrolytes where calcium is capable of assuming a corrective role when such elements are in excess in the body (Flecks, 1976).

Phosphorus is always found with Ca in the body, both contributing to the supportive structures of the body. It is present in cells and in the blood as soluble phosphate ion, as well as in lipids, proteins,

carbohydrates and energy transfer enzymes (Adeyeye and Agesin, 2007). There existed a wide variation in the composition of phosphorus within the meat based group; some were as high as 11% to as low as 0.01% according to of RDA for adults. Phosphorus is an essential component in nucleic acids and the nucleoproteins responsible for cell division, reproduction and the transmission of hereditary traits (Adeyeye and Agesin, 2007).

Sodium highest value was reported for beef roll; this is contrary to the report of Otemuyiwa and Adewusi (2014) where sodium contents were as high as 1062 mg in samples but similar with sodium content of snack food reported by Tee et al. (1989) which ranged from 3 to 595 mg/100 g. High dietary sodium intake has been implicated for the development of high blood pressure and stiffening of the arterial walls and therefore, a risk factor for coronary heart disease, which is a major cause of death in Europe, edema or water retention (Anderson et al., 2015). Food processing may increase the sodium content in food products not only by adding salt (sodium chloride), but also by the addition of additives that contain this mineral in their formulation, which aims to modify properties such as texture and flavor besides prolonging their shelf-life (Assis dos Passos et al., 2013).

The value of MSG in this study was as high as 3.38 mg/100g, although the recommended value for MSG has been debated by various organizations (USDHHS, 1995; FASEB, 1995); the naturally occurring range in foods has been highlighted by Rodriguez et al. (2003), but a safe range has not yet been postulated. Stegink et al. (1988) suggested that MSG is absorbed quickly into the gastrointestinal tract and could raise plasma levels of glutamate which has been proven to damage the areas of the brain unprotected by the blood brain barrier (Stegink et al., 1985; Meldrum, 1993). Also, its level in food above certain levels have been linked with myocardial dysfunction ((Rietz and Guilbault, 1977; Belitz and Grosch, 1987; Mendoza et al., 1994).

The value of manganese in this study is relatively low which agrees with the study by Adeyeye (1996) where the value of manganese was relatively low in all fast food samples. Manganese functions as an essential constituent for bone structure, for reproduction and for normal functioning of the nervous system; it is also a part of the enzyme system (Flecks, 1976).

The standard sodium-potassium ratio that favored non-enhancement of high blood pressure disease is

given as 0.60 most of the samples exceeded this ratio except sample S30T and B40S, also calcium: magnesium ratio in some samples (occurred most in non-meat based samples) were higher than the recommended ratio of 1.0 and lower in most meat based samples. This could be as a result of the non-meat based samples having higher calcium content when compared to the meat based group $P < 0.05$. Most sample had a Na/K values greater than 0.60. This is the ratio that favours none enhancement of high blood pressure disease (Nieman et al., 1992) in man. To bring this ratio low, foods rich in potassium should be encouraged.

The Ca : P was generally less than 0.5 in non-meat based samples which is the minimum ratio required for favorable Ca absorption in the intestine for bone formation (Nieman et al., 1992). These levels of Ca/P ratio would enhance strong bone development since absorption under this condition would be high (Anderson et al., 2017). The Ca/P ratio is reported to have some effect on Ca in the blood of many animals (Adeyeye and Faleye, 2007). More calcium rich foods are encouraged to correct this deficiency. The Ca/Mg values ranged between 0.05 and 7.0 whereas the recommended value is 1.0, both Ca and Mg content of the FF would need adjustment to achieve good health if eaten regularly by consumers.

4. Conclusion

This study has shown that most snacks available in south-western Nigeria are poor sources of essential nutrients especially those required for tissues formation and regeneration, growth and metabolism; but are good sources of energy giving nutrients.

5. Recommendations

Based on the findings of this study, it is recommended that:

- Good quality snacks should be produced for supplies of necessary nutrient for human healthy growth in the study area.
- Government monitoring agency such as NAFDAC should be empowered to see to the quality of production and supply of snacks for consumption.
- There should be financial support from the government for the producers of snacks in various organizations in the southwest zone of Nigeria.
- Hygienic way and quality education on snacks production should be given to all the stakeholders.

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