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COMPOSITION, MINERAL SAFETY INDEX, CALCIUM, ZINC AND PHYTATE INTERRELATIONSHIPS IN FOUR FAST-FOODS CONSUMED IN NIGERIA

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ABSTRACT. The proximate, mineral and amino acid contents and calculated values of calcium/phytate Ca/Phy, Zn/Phy, [Ca][Phy]/[Zn], Ca/P, Na/K, Ca/Mg, [K/(Ca+Mg)], mineral safety index (MSI) for Na, Mg, P, Ca, Fe and Zn, and the amino acid scores were determined in four fast-foods consumed in Nigeria. The fast-foods were meat pie, doughnut, *moin-moin* (steamed bean pudding) and cake. In the proximate: protein ranged 156-327 g/kg, carbohydrate ranged 467-664 g/kg and energy ranged 14-16 mega Joules (14-16 MJ/kg). In minerals: Zn ranged 323-1071 mg/kg and 119-327 mg/kg in Fe while Cu and Co were not detected. The highest phytate level (2554 mg/kg) was observed in *moin-moin*. [Ca][Phy]/[Zn] ranged 0.04-0.06 showing Zn availability for body biochemical use. The essential amino acids were on the high side with range of 243-317 mg/g crude protein. The limiting amino acids varied. The best MSI was observed for Ca while the worst was observed for Zn showing that Zn might have some deleterious effects. Two independent experiments were conducted.

KEY WORDS: Fast-foods, Minerals, Amino acids, Mineral Safety Index

INTRODUCTION

Trends in food consumption have been accompanied by changes in eating patterns. Traditional family meals have been replaced, in part, by between-meal snacks and by meals eaten away from the home [1]. These trends are expected to continue for several reasons [2]. These include increasing employment among women, decrease in family size, increase in per capital income, change from traditional life-styles and a general desire and demand for convenience [2].

Good nutrition requires that people learn to eat in a rational way, whether snacking, eating at home, or eating away from home. Eating nutritiously on the road is becoming easier with the increase in variety of healthful foods offered at both fast-food restaurants and supermarkets.

Fast food restaurants now corner state capitals and some major cities in Nigeria. Major concerns about fast-foods include their tendency to be high in sodium, fat and calories while being low in vitamins A and C and in dietary fibre [2]. However, not all fast foods may be having these traits. In Nigeria, we have the Association of Fast Food and Confectionary Operators of Nigeria (AFFCON). No report is available on the nutritional qualities of fast-foods in Nigeria. However, available reports are found on the bacteriological examination of some ready-to-eat or fast-foods [3-5].

The purpose of this paper is to document and provide data on the chemical composition (and other related calculated values) in order to characterize fast-foods consumed in Nigeria: highlight the health implications of the foods composition, as is deemed appropriate.

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EXPERIMENTAL

Collection of samples

Fast-food samples were collected from Mr Big's (a fast-food restaurant) in Ado-Ekiti, Nigeria. This is the most patronized fast-food restaurant in Ado Ekiti, Nigeria. The samples were collected when hot. The samples were meat pie, doughnut, *moin-moin* (steamed bean pudding) and cake. These samples were the mostly consumed fast-foods in the restaurant. The samples of the products were collected five times leading to five independent experiments.

Sample treatment

Ingredients. The ingredients for the preparation of meat pie were: meat, Irish potatoes, wheat flour, baking powder, butter, tap water, table salt, pepper, onions, seasonings and sausage meat. For doughnut, ingredients were: wheat flour, baking powder, baking yeast, granulated sugar, hot tap water and butter. Ingredients for the preparation of *moin-moin* (steamed bean pudding) were: beans, pepper, onions, vegetable oil, cray fish/egg/meat and table salt. For preparation of cake, ingredients were: wheat flour, baking powder, eggs, butter, flavouring agents, table salt, preservatives, granulated sugar and particularly nutmeg.

The samples were first oven dried at a temperature of 100 ^{o}C for 1 h. After drying, the samples were milled into fine powder with a Kenwood major blender, Model Titanium KM020 (Kenwood Chef Major, Giovanni, UK). The samples were sieved with 200 mm mesh, stored in dry plastic bottles and then kept in a laboratory refrigerator for preservation pending analyses. Known weights of samples were taken, dry ashed at a temperature of 540 ^{o}C in the Carbolite furnace (all types of electric heated chamber 30–1800 ^{o}C) (Carbolite, Derbyshire, UK) to constant weight. The ashed samples were each transferred into a 50 mL beaker, crucible was washed with 25 mL of 20% (v/v) nitric acid into corresponding beaker and the beaker was heated to boiling to break the ash. The solution was carefully filtered and transferred into 50 mL standard flask and made up to the mark with distilled-deionized water.

About 2.0 g of homogenized sample each was defatted with chloroform/methanol mixture. Between 30-35 mg of defatted sample was put in glass ampoule, 7 mL of 6 M HCl was added and oxygen expelled. The sealed ampoule was put in oven at 105±5 ^{o}C for 22 h and later allowed to cool before the content was filtered. The filtrate was evaporated to dryness at 40 ^{o}C under vacuum. Residue was dissolved with 5 mL acetate buffer (pH = 2).

Proximate analysis

Moisture, total ash, fibre and ether extract of the samples were determined by the methods of the AOAC [6]. Nitrogen was determined by a micro-Kjeldahl method [7] and the crude protein content was calculated as N x 6.25. Carbohydrate was determined by difference. All the proximate results were reported as g/kg dry weight. The energy values were calculated by adding up the values obtained for carbohydrates (x 17 kJ), crude protein (x 17 kJ) and crude fat (x 37 kJ) for each of the samples. Determinations were in duplicate.

Mineral analysis

The mineral elements were determined in the solutions obtained as above – Na and K by flame photometry, Model 405 (Corning, Halstead Essex, UK) using NaCl and KCl to prepare standards. Minerals were analysed using the solutions obtained by dry ashing the samples at 550 ^{o}C and dissolving it in 10% HCl (25 mL) and 5% lanthanum chloride (2 mL), boiling, filtering and making up to standard volume with deionized water. P was determined colorimetrically

using a Spectronic 20 (Gallenkamp, London, UK) instrument, with KH_2PO_4 as a standard. All other elements (Co, Fe, Cu, Ca, Mg, Zn, Cr and Mn) were determined by atomic absorption spectrophotometry, Model 403 (Perkin-Elmer, Norwalk, Connecticut, USA). All determinations were made in duplicate. All chemicals used were of analytical grade, and were obtained from British Drug Houses (BDH, London, UK).

The detection limits for the metals in aqueous solution had been determined just before our mineral analyses using the methods of Varian Techtron [8], giving the following values in µg/mL: Co (0.01), Fe (0.01), Cu (0.002), Na (0.002), K (0.005), Ca (0.04), Mg (0.002), Zn (0.005), Mn (0.01) and Cr (0.02). The optimal analytical range was 0.1 to 0.5 absorbance units with coefficients of variation from 0.9-2.2%.

Determination of phytate

Phytate was quantified using the method described by Harland and Oberleas [9]. The blank was also prepared by Harland and Oberleas [9] method. The colorimeter used was a Spectronic 20 (Gallenkamp, UK). The amount of phytate in the sample was calculated as hexaphosphate equivalent using the formula:
Phytate, mg/g sample = mean K x A x 20 / (0.282 x 1000) where A = absorbance; mean K= std P (µg)/A/n (stds); phytate = 28.2% P.

Determination of amino acid

The method of amino acid analysis was by ion-exchange chromatography (IEC) [10] using the Technicon Sequential Multisample Amino Acid Analyzer (TSM) Model TSM (Technicon Instruments Corporation, New York, USA). Samples (2.0 g) of each group were defatted with chloroform/methanol (2:1) mixture. Between 30-35 mg of the defatted sample was put in a glass test tube, 7 mL of HCl was added and oxygen expelled by flushing with nitrogen gas. The sealed test tube as put in an oven at 105±5 ^{o}C for 22 h and later allowed to cool before the content was filtered. The filtrate was evaporated to dryness at 40 ^{o}C under vacuum. The residue was dissolved with 5 mL acetate buffer (pH 2.0). Determinations were in duplicate. The period of an analysis lasted for 76 min for each sample. The column flow rate was 0.50 mL/min at 60 ^{o}C with reproducibility within ± 3 %.

Estimation of quality of dietary protein

The quality of dietary protein can be measured in various ways [11] but basically it is the ratio of available amino acids in the food or diet compared with needs expressed as a ratio [12-14].

Statistical analyses

The Phy:Zn, Ca:Phy and [Ca][Phy]:[Zn] values were calculated according to the method of Wyatt and Triana-Tejas [15]. The coefficients of variation percent were calculated [16]. Ca/P, Na/K, Ca/Mg and the milliequivalent ratio of [K/(Ca + Mg)] [17]; the mineral safety index (MSI) [17] of Na, Mg, P, Ca, Fe and Zn were also calculated. The differences between the standard MSI and the MSI of the samples were also calculated. The chi-square was compared with (Chi^2 T) setting the level of confidence at $\alpha < 0.05$ [16].

RESULTS AND DISCUSSION

Proximate composition

Table 1 shows the proximate composition of the fast-food samples. Protein was generally high with values ranging from 156 g/kg (cake) to 327 g/kg (meat pie). The constituents of the various fast-foods could have resulted into these results. Carbohydrate was also high with value range of 467 g/kg (*moin-moin*) to 663 g/kg (doughnut); *moin-moi*n was made from bean pudding, hence its lowest level of carbohydrate. The values of ether extract, ash and fibre were generally low. While the low ether extract was an advantage, the low level of fibre could be deleterious [18]. The energy values were high with a range of 13733 kJ/kg (cake) to 16395 kJ/kg (doughnut) showing them to be good sources of concentrated energy; however these values were lower than in cereals [19]. The crude protein values of 156 to 327 g/kg was a reflection of the composition of the samples; meat pie had the highest value (327 g/kg) because meat was part of the ingredients whilst *moin-moin* was second (313 g/kg) because it's major ingredient were bean seeds which is a major source of protein; however, cake had the least value (156 g/kg) because it's major ingredient was wheat flour. Fibre content was highest (7.2 g/kg) in the doughnut sample likely because of its high content of wheat flour in the ingredient.

Table 1. Proximate composition (g/kg) of fast-food samples.

Parameter	Fast-food samples				CV %[b]
	Meat pie	Doughnut	*Moin-moin*	Cake	
Moisture	91.1 ± 0.07	80.4 ± 0.07	87.6 ± 0.14	83.8 ± 0.07	5.4
Crude protein	327 ± 1.41	164 ± 0.07	313 ± 1.41	156 ± 2.12	38.7
Ether extract	53.4 ± 0.21	63.1 ± 0.28	49.1 ± 0.07	55.0 ± 2.12	10.6
Ash	30.6 ± 0.07	22.4 ± 0.04	77.4 ± 0.04	170 ± 0.07	90.1
Fibre	6.3 ± 0.21	7.2 ± 0.07	6.1 ± 0.21	3.5 ± 0.21	27.4
Carbohydrate	492 ± 2.83	664 ± 2.12	467 ± 2.12	533 ± 0.07	16.2
Energy (kJ/kg)	15895 ± 82.7	16395 ± 69.7	15075 ± 58.7	13733 ± 113	7.6
$Chi^2 C^c$				30.2	
$Chi^2 T^d$				28.9	
Remark				*	

[a]*Moin-moin* = steamed bean pudding; [b]CV % = coefficient of variation; [c]Chi^2 C = chi – square calculated; [d]Chi – square Table; * = significant at $\alpha = 0.05$; Figures after ± are standard deviation values.

The statistical observation in the proximate composition showed that most of the values were close on parameter basis with the exception of ash whose CV % was 90.1; the CV % in moisure was just 5.4. On the whole the Chi^2 C > Chi^2 T at α <0.05, although the significant difference between the samples was positively low.

Mineral composition

The mineral composition is shown in Table 2. Both Co and Cu were not detected. Among the major elements, cake had the highest level of Na, K, Ca, Mg and P and also occupied the prime place in the minor element Zn (1071 mg/kg). Mn was very low with values ranging from 1.0 mg/kg (doughnut) to 2.9 mg/kg (*moin-moin*). Generally the CV % values were close with values ranging from 40.4-67.0. The Chi^2 C > Chi^2 T at $\alpha < 0.05$, although the significant difference was low.

Table 2. Mineral composition (mg/kg) of the fast-food samples.

Parameter	Fast-food samples				CV %[b]
	Meat pie	Doughnut	*Moin-moin*	Cake	
Sodium	328 ± 1.41	263 ± 0.71	331 ± 0.35	611 ± 0.71	40.4
Potassium	443 ± 1.41	361 ± 1.41	491 ± 0.71	953 ± 0.71	47.4
Calcium	346 ± 2.12	263 ± 0.71	460 ± 0.71	863 ± 0.71	55
Magnesium	424 ± 0.71	358 ± 0.35	334 ± 0.71	778 ± 0.71	43.6
Zinc	401 ± 0.35	323 ± 0.71	525 ± 0.71	1071 ± 0.71	58.2
Copper	ND	ND	ND	ND	-
Iron	122 ± 0.35	119 ± 0.71	327 ±0.71	219 ± 0.71	50
Cobalt	ND	ND	ND	ND	-
Manganese	1.9 ± 0.04	1.0 ± 0.00	2.9 ±0.01	2.8 ± 0.01	40.9
Chromium	ND	ND	ND	ND	-
Phosphorus	347 ± 0.71	483 ± 0.71	583 ±0.35	1391 ± 0.35	67
Chi^2C^c				28.9	
Chi^2T^d				28.9	
Remark				*	

a-d and *See Table 1; e = not determined; ND = not detected.

It is well known that minerals are necessary for life. Co, Cu and Cr were not detected in any of the samples. Co(II) is a component of vitamin B_{12} (cyanocobalamin) which is essential for the prevention of anaemia; Cu and Fe are present in the enzyme cytochrome oxidase involved in energy metabolism. Since Co, Cu and Cr are needed in the diet, the present samples would need to be supplemented in these minerals when they serve as the only food sources. Iron was high in all the samples but highest in *moin-moin* (327 mg/kg) which is becoming a weaning food in Nigeria. About 1-10% of Fe from plant sources is normally absorbed by the body [14] although this value can be improved upon when plants are consumed with meat. For example, the addition of meat to legume or cereal diet can double the amount of Fe absorbed and so contribute significantly to the prevention of anaemia, which is so widespread in developing countries like Nigeria [14].

Zinc is present in all the samples at high levels. Zinc is present in all tissues of the body and is a component of more than 50 enzymes [14]. The minimum Zn allowance (about 15-20 mg) per day would be met by all the samples. The concentration of Mn was low in all the samples. This observation agrees to what obtains in meat [20, 21]. 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 [21].

Calcium concentration was high in all the samples. Calcium is an important constituent of body fluids. It is a coordinator among inorganic elements particularly K, Mg or Na where calcium is capable of assuming a corrective role when such metals are in excessive amount in the body [21]. Ca, P and vitamin D combine together to avoid rickets in children and osteomalacia (the adult rickets) as well as osteoporosis (bone thinning) among older people [22]. A dietary regime of adequate dietary Ca over the years should be a deterrent to this condition. All the phosphorus in the samples was high in value. 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 [23]. Phosphorus is an essential component in nucleic acids and the nucleoproteins responsible for cell division, reproduction and the transmission of hereditary traits [23].

The samples are good sources of K, Mg and Na. Magnesium is an activator of many enzyme systems and maintains the electrical potential in nerves [23]. Potassium is primarily an

intercellular cation, in large part this cation is bound to protein and with Na influences osmotic pressure and contributes to normal pH equilibrium [22].

Mineral ratios

Table 3 depicts the various mineral ratios that were calculated. The entire CV % was low (7.2-29.1). The Ca/P was generally greater than 0.5 which is the minimum ratio required for favourable Ca absorption in the intestine for bone formation [24]. These levels of Ca/P ratio would enhance strong bone development since absorption under this condition would be high. The Ca/P ratio is reported to have some effect on Ca in the blood of many animals [25]. All the Na/K values were greater than 0.60. This is the ratio that favours none enhancement of high blood pressure disease [24] in man. To bring this ratio low, foods rich in potassium should be more consumed. The Ca/Mg values ranged between 0.74 and 1.38 whereas the recommended value is 1.0. Both Ca and Mg would need adjustment for good health. The milliequivalent ratios of [K/(Ca + Mg)] were all less than 2.2. This meant our sample would not promote hypomagnesaemia in man [26].

Table 3. Computed mineral ratios of the fast-food samples.

Mineral ratio	Fast-food samples				CV %	Standard
	Meat pie	Doughnut	*Moin-moin*	Cake		
Ca/P	0.997	0.546	0.79	0.62	27.1	≥0.5
Na/K	0.741	0.729	0.674	0.641	7.2	0.60
Ca/Mg	0.817	0.735	1.38	1.11	29.1	1.0
[K/(Ca +Mg)][a]	1.15	1.39	1.24	1.16	8.9	<2.2

[a]The milliequivalent ratio.

Mineral safety index

The mineral safety index (MSI) values of the samples are shown in Table 4. The standard MSI for the elements are Na (4.8), Mg (15), P (10), Ca (10), Fe (6.7) and Zn (33). For Na, the MSI values ranged from 2.5 (doughnut)-5.9 (cake); only cake had negative difference (-1.1) between the standard and calculated MSI values. This meant that only the cake might be overloading the body with sodium leading to secondary hypertension. For MSI of Mg, meat pie was above the USRDA [17] by 0.9 and cake by 14.2 times. For P, Fe and Zn, the odd samples out, respectively were cake (-1.5); meat pie (-47.5), doughnut (-46.4), *moin-moin* (-130.3) and cake (-91.0); meat pie (-849.6), doughnut (-676.7), *moin-moin* (-448.1) and cake (-2323), respectively. The implication of the above is that abnormally high level of P was present in cake; Fe and Zn were abnormally present in all the samples. Calcium was normal in all the samples. All the samples could cause the reduction of zinc absorption in the small intestine [27] and iron poisoning particularly in children [28]. All the Zn MSI values were greater than 33. This meant that all the samples have Zn values far above the recommended adult intake. The minimum toxic dose is 500 mg, or 33 times the RDA [17]. High doses of Zn can be harmful. Zinc supplements can decrease the amount of high density lipoprotein (HDL) circulating in the blood, increasing risk of heart disease [29]. Excess Zn interacts with other minerals, such as Cu and Fe, decreasing their absorption. In animals, Zn supplements decrease the absorption of Fe so much that anaemia is produced [30]. When patients are given 150 mg of Zn per day, Cu deficiency results. Intakes of Zn only 3.5 mg/day above the RDA decrease Cu absorption [24]. In animals, Cu deficiency causes scarring of the heart muscle tissue and low levels of Ca in the bone [29]. Excess Zn also decreases the functioning of the immune system. From the foregoing, all the

samples would lead to excess Zn consumption with its deleterious effects. It is interesting to note that the current results in the MSI followed the trend observed in different animal samples [31].

Table 4. Mineral safety index of Na, Mg, P, Ca, Fe and Zn for the various fast-food samples.

Mineral Index Safety																		
Sample	Na			Mg			P			Ca			Fe			Zn		
	TV[a]	CV[b]	D[c]	TV	CV	D	TV	CV	D	TV	CV	D	TV	CV	D	TV	CV	D
Meat pie	4.8	3.2	1.6	15	15.9	-0.9	10	2.9	7.1	10	2.9	7.1	6.7	54.6	-47.5	33	882.6	-849.6
Dough nut	4.8	2.5	2.3	15	13.4	1.6	10	4.0	6.0	10	2.2	7.8	6.7	53.1	-46.4	33	709.7	-676.7
Moin-moin	4.8	3.2	1.6	15	12.5	2.5	10	4.8	5.2	10	3.8	6.2	6.7	146.0	-130.3	33	481.1	-448.1
Cake	4.8	5.9	-1.1	15	29.2	-14.2	10	11.5	-1.5	10	7.2	2.8	6.7	97.7	-91.0	33	2356	-2323
Mean	-d	3.7	1.1	-	17.8	-2.8	-	5.8	4.2	-	4.0	6.0	-	87.9	-81.1	-	1107.4	-1074
SD	-	1.5	1.5	-	7.8	7.8	-	3.9	3.9	-	2.2	2.2	-	43.9	44	-	848.5	849
CV %	-	40.6	136.4	-	43.6	-279	-	66.9	92.4	-	55.0	37.1	-	50.0	-54.3	-	76.6	-79.0

[a]TV = table value; [d]- = not determined; [b]CV =calculated value; [c]D = difference.

Mineral bioavailability

The phytate (Phy), Ca:Phy, Phy:Zn and [Ca][Phy]/[Zn] of the samples are shown in Table 5. Phytate was highest (2554 mg/kg) in *moin-moin* among the samples. The Ca:Phy was the most varied with CV % of 92.2. The Chi^2 C < Chi^2 T at $\alpha < 0.05$ and the differences among the samples were not significant. Oberleas and Harland [32] showed that foods with a molar ratio of Phy:Zn less than 10 showed adequate availability of Zn and problems were encountered when the values were greater than 15. In Table 5, all the Phy:Zn values were below 1.0 showing that Zn would be available under this model. Wise [33] suggested that the solubility of the phytate and the proportion of Zn bound in a mineral complex in the intestines depend on the levels of calcium. In this model, phytate precipitation is not complete until dietary Ca:Phy molar ratio attains a value of approximately 6:1. At Ca:Phy molar ratios lower than 6:1, phytate precipitation is incomplete, so that some of the dietary zinc remains in solution. The proportion remaining in solution increases with decreasing Ca:Phy molar ratios [33]. In our results only cake result (11.5) was above the critical molar ratio of 6:1. Hence, the calcium content of the other fast-foods might be sufficient to promote phytate-induced decreases in zinc bioavailability [34]. Ferguson *et al*. [35] showed that the molar ratio varies with different foods and recommended that this value be used in conjunction with other data to explain the availability of Zn using the Ca:Phy ratio. Our results for [Ca][Phy]/[Zn], that is (Ca x Phy:Zn) are also in Table 5. Ellis *et al*. [36] and Davies and Warrington [37] indicated that the ratio of Ca x Phy:Zn is a better predictor of Zn availability and said that, if the value were greater than 0.50 mol/kg there would be interferences with the availability of Zn. In our results, Ca x Phy:Zn values were all lower than 0.50 mol/kg, that is to say using this indicator, Zn would be available in all the samples. The results here are in total agreement with the results in 35 food samples of major consumption in Nigeria [38].

Table 5. Phytate (Phy), Ca:Phy, Phy:Zn and [Ca][Phy]/[Zn] of the fast-food samples.

Parameter	Fast-food samples				CV %
	Meat pie	Doughnut	*Moin-moin*	Cake	
Phytate (mg/kg)	2183	1936	2554	1236	28.1
Ca/Phy	2.61	2.24	2.97	11.49	92.2
Phy/Zn	0.54	0.59	0.48	0.11	50.7
[Ca][Phy]/[Zn]	0.047	0.039	0.056	0.046	14.8
Chi^2C^c				10.8	
Chi^2T^d				12.6	
Remark				NS	

a-d = see Table 1; NS = not significant at α = 0.05; Ca/Phy = mg of Ca/AW of Ca: mg of PHY/AW of Phy, Phy/Zn = mg of Phy/AW of Phy: mg of Zn/AW of Zn; [Ca][Phy]/[Zn] = (mol/kgCa) (mol/kgZn).

Amino acids composition

The amino acids compositions of the fast-foods are shown in Table 6. The least varied amino acid in the samples was alanine with CV % of 1.3 while cystine was the most varied with CV % of 37.9. The most concentrated amino acid in all the samples was glutamic acid which ranged from 80.5 mg/g (doughnut) -115 mg/g crude protein (*moin-moin*). This is also the most concentrated amino acid in coconut endosperm [39]. Statistical differences were significant among the samples (Table 6).

Table 6. Amino acid composition (mg/g crude protein) of the fast-food samples.

Parameter	Fast-food samples				CV %
	Meat pie	Doughnut	*Moin-moin*	Cake	
Lysine[a]	24.1 ± 0.07	35.8 ± 0.01	22.6 ± 0.01	29.7 ± 0.01	21.4
Histidine[a]	16.2 ± 0.07	24.1 ± 0.01	11.7 ± 0.01	22.4 ± 0.07	30.7
Arginine[a]	43.2 ± 0.07	39.7 ± 0.07	48.2 ± 0.01	41.5 ± 0.14	8.5
Aspartic acid	42.2 ± 0.04	43.5 ± 0.06	56.0 ± 0.14	66.9 ± 0.14	22.3
Threonine[a]	17.4 ± 0.07	20.4 ± 0.25	17.1 ± 0.01	23.0 ± 0.07	14.3
Serine	21.5 ± 0.04	30.0 ± 0.01	20.3 ± 0.07	38.8 ± 0.01	31.0
Glutamic acid	81.2 ± 0.07	80.5 ± 0.001	115 ± 1.41	82.8 ± 0.04	18.8
Proline	14.1 ± 0.04	21.3 ± 0.07	16.9 ± 0.01	21.9 ± 0.56	20.0
Glycine	29.0 ± 0.04	20.2 ± 0.01	25.2 ± 0.04	31.8 ± 0.04	18.9
Alanine	29.8 ± 0.04	30.6 ± 0.07	30.1 ± 0.04	30.6 ± 0.04	1.3
Cystine	10.6 ± 0.07	13.7 ± 0.01	20.0 ± 0.04	26.5 ± 0.01	37.9
Valine[a]	26.0 ± 0.04	33.2 ± 0.14	35.6 ± 0.01	26.4 ± 0.04	15.9
Methionine[a]	7.5 ± 0.004	12.8 ± 0.01	7.7 ± 0.001	11.0 ± 0.04	26.4
Isoleucine[a]	25.7 ± 0.04	26.4 ± 0.01	26.3 ± 0.00	31.6 ± 0.01	10.0
Leucine[a]	32.6 ± 0.001	44.3 ± 0.07	43.0 ± 0.07	41.2 ± 0.04	13.1
Tyrosine	14.4 ± 0.04	26.3 ± 0.07	23.5 ± 0.04	19.4 ± 0.01	24.8
Phenylalanin[a]	26.2 ± 0.001	25.9 ± 0.07	42.6 ± 0.01	30.5 ± 0.06	25.0
Chi^2C				68.4	
Chi^2T				67.5	
Remark				*	

[a]Essential amino acid; * = significant at α = 0.05.

Table 7 depicts the essential amino acids (EAA) in the samples. With the exception of His in *moin-moin* (11.7 mg/g) all the EAA were greater than the suggested patterns of amino acid requirements in adults. Tryptophan was not determined. The suggested patterns of total EAA

requirement from literature were (mg/g): including His: 460 (infant), 339 (pre-school child), 241 (school child) and 127 (adult) [40]; whereas our own values with His were 201 (meat pie), 263 (doughnut), 250 (*moin-moin*) and 261 (cake). The suggested patterns without His were: 434 (infant), 320 (pre-school), 222 (school child) and 111 (adult) [40]; whereas our own values without His were: 185 (meat pie), 239 (doughnut), 238 (*moin-moin*) and 238 (cake), these values were either greater or close to the required daily intake of amino acids particularly for adults and school children.

Table 7. Essential amino acid composition (mg/g crude protein) of the fast-food samples.

Parameter	Fast-food samples				CV %
	Meat pie	Doughnut	*Moin-moin*	Cake	
Lysine	24.1	35.8	22.6	29.7	21.4
Histidine	16.2	24.1	11.7	22.4	30.7
Arginine	43.2	39.7	8.2	41.5	8.5
Methionine	7.5	12.8	7.7	11.0	26.4
Threonine	17.4	20.4	17.1	23.0	14.3
Isoleucine	25.7	26.7	26.3	31.6	10.0
Valine	26.0	33.2	35.6	26.5	15.9
Leucine	32.6	44.3	43.0	41.2	13.1
Phenylalanine	26.2	25.9	42.6	30.5	25.0
X^2C				38.5	
X^2T				36.4	
Remark				*	

* = significant at $\alpha = 0.05$.

Histidine is a semi-essential amino acid particularly useful for children growth. It is a precursor of histamine present in small quantities in cells. When allergens enter the tissues it is liberated in larger quantities and is responsible for nettle rash [41]. The values of isoleucine ranged from 25.7-31.6 mg/g crude protein in the samples. It is an EAA for both old and young. The isoleucine levels were all high. Male Syrup Urine Disease is an inborn error of metabolism in which brain damage and early death can be avoided by a diet low in isoleucine and two other EAA, leucine and valine [39]. While our Ile, Leu and Val were good for pre-school child and school child, they were far greater than the requirements for adults. Methionine is an EAA and ranged from 7.5-12.8 mg/g in the samples. With cystine, it ranges from 18.1-36.4 mg/g. These values would satisfy the three upper age limits. Methionine is needed for the synthesis of choline. Choline forms lecithin and other phospholipids in the body. When the diet is low in protein, for instance in alcoholism and kwashiorkor, insufficient choline may be formed; this may cause accumulation of fat in the liver [41]. Consumers of our samples would consume more than enough methionine. Phenylalanine ranged from 25.9-42.6 mg/g in the samples. In addition to tyrosine, it ranged from 40.6-66.1 mg/g. These are good for pre-school child, school child and adults [40]. Phenylalanine is the precursor of some hormones and the pigment melanin in hair, eyes and tanned skin. The Tyr values ranged between 14.4-26.3 mg/g in the samples (Table 6). Tyrosine is the precursor of some hormones (like the thyroid hormones) and the brown pigment melanin formed in hair, eyes and tanned skin. It reduces the requirement of Phe. Permanent deficiency of the enzyme-hypertyrosinaemia, a rare inborn error of metabolism can cause liver and kidney failure unless treated with a synthetic diet low in Phe + Tyr [41]. Valine was high in our samples (26.0-35.6 mg/g). Valine is restricted in the treatment of Maple Syrup Urine Disease. The Cys/Cys + Met (%) values were high in the samples: meat pie (58.6%), doughnut (51.7%), *moin-moin* (72.2%) and cake (69.8%). The percent Cys in TSAA in ripe coconut endosperm was 62.9 [39]. Information on the agronomic advantages of increasing

the concentration of sulphur-containing amino acids in staple foods shows that Cys has positive effects on mineral absorption, particularly Zn [42, 43].

Table 8 contains the EAA scores of the fast-foods. Both Lys and Thr shared the lowest level of 0.44 in meat pie. Thr was the lowest (0.51) in doughnut, Thr was the lowest (0.43) in *moin-moin* and Lys was the lowest (0.54) in cake. The first limiting amino acid is Lys, second is Met + Cys and third is Thr. Hence to correct for limiting amino acid in meat pie, 100/44 (for Lys or Thr) or 2.27 times as much of meat pie protein would have to be eaten when it is the sole protein source in the diet; in doughnut it is 100/51 or 1.96 times proteins; in *moin-moin* it is 100/43 or 2.33 times protein; in cake it is 100/54 or 1.85 times protein to correct for limiting Lys. The CV % was generally low in the EAA scores with value range of 10.0-27.3. The Chi^2 C > Chi^2 T, $\alpha < 0.05$ although the value of significant difference was not high.

Table 8. Amino acid scores of the fast-food samples.

Parameter	Scoring pattern[a]	Fast-food samples				CV %
		Meat pie	Doughnut	*Moin-moin*	Cake	
Isoleucine	40	0.64	0.66	0.66	0.79	10.0
Leucine	70	0.47	0.63	0.61	0.59	12.4
Lysine	55	0.44	0.65	0.41	0.54	21.3
Met + Cys	35	0.52	0.76	0.79	1.04	27.3
Phe +Tyr	60	0.68	0.87	1.10	0.83	20.0
Threonine	40	0.44	0.51	0.43	0.56	12.5
Tryptophan	10	-	-	-	-	-
Valine	50	0.52	0.66	0.71	0.53	15.5
X^2 C					31.4	
X^2 T					28.9	
Remark					*	

[a]Provisional amino acid scoring pattern (mg/g of protein); * = significant at $\alpha = 0.05$.

CONCLUSIONS

In summary this study indicates that the fast-foods are not just unhealthy foods as they are good sources of protein, carbohydrate, mineral and amino acids. However, the level of iron and zinc may be antagonistic to the absorption of other minerals, sodium may enhance secondary hypertension and lysine rich foods may be eaten to supplement in meat pie and cake consumption.

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