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Nutrient composition of five varieties of commonly consumed Nigerian groundnut (*Arachis hypogaea* L.)

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RESUMEN

Composición en nutrientes de cinco variedades de maní (*Arachis hypogaea* L.) de consumo habitual en Nigeria

Se ha investigado la composición en nutrientes de las cinco principales variedades de maní (*Arachis hypogaea* L.) de consumo habitual en la parte sur-occidental de Nigeria. A las muestras crudas con cáscara y secas se les analizó su composición proximal (humedad, ceniza, proteína, grasa, fibra e hidratos de carbono), vitaminas (β-caroteno, tiamina, niacina y tocoferol) y minerales (Na, K, Ca, P, Mg, Fe, Mn, Zn, Cu, Se, Co, Al, As, Cd y Pb). Los resultados mostraron que el maní tenía entre 4.12 - 9.26% de humedad, 2.77- 3.31% de cenizas, 24.26 - 26.35% de proteína, 45.41 - 48.14% de materia grasa, 2.51 - 2.94% de fibra y 15.90 -17.75% de carbohidratos. Todas las variedades analizadas contenían β-caroteno (63.32-65.35mg/100g), tiamina (0.73-0.98mg/100g), niacina (14.00-16.03mg/100g) y tocoferoles (18.62-21.07mg/100g), siendo la variedad "*Boro rojo*" la que contiene las cantidades significativamente más altas (P <0.05), de casi todo. Los metales pesados como, Co, As, Cd y Pb no fueron detectados en ninguna de las muestras y los demás minerales varían en la mayoría de las variedades de la siguiente manera: K> P> Mg> Ca> Mn> Cu> Na> Zn> Fe> Al> Se. La variedad "*Boro rojo*" también tuvo el mayor contenido elemental en la mayoría de los minerales analizados. Por lo tanto, estos cacahuetes *de la variedad "Boro rojo*" es la más recomendable y pueden ser considerados unos productos alimenticios útiles para minimizar la malnutrición proteico-energética (MPE) y las deficiencias de micronutrientes en Nigeria. El resultado de esta investigación puede suponer una significativa contribución a la tabla de composición de alimentos.

PALABRAS CLAVE: Arachis hypogaea L. – Maní – Minerales – Nigeria – Nutrientes – Vitaminas.

SUMMARY

Nutrient composition of five varieties of commonly consumed Nigerian groundnut (*Arachis hypogaea* L.)

The nutrient composition of the five major varieties of groundnut (*Arachis hypogaea* L.) commonly consumed in the south-western part of Nigeria was investigated. Raw dry-shelled samples were analyzed for proximate (moisture, ash, protein, fat, fiber and carbohydrate), 'vitamins' (β-carotene, thiamine, niacin and tocopherol) and minerals (Na, K, Ca, P, Mg, Fe, Mn, Zn, Cu, Se, Co, Al, As, Cd and Pb). Results showed that the groundnuts had 4.12-9.26% moisture, 2.77-3.31% ash, 24.26-26.35% protein, 45.41-48.14% fat, 2.51-2.94% fiber and 15.90-17.75% carbohydrate. All the varieties analyzed showed β-carotene (63.32-65.35mg/100g), thiamin (0.73-0.98mg/100g), niacin (14.00-16.03mg/100g) and tocopherol (18.62-21.07mg/100g) activities; with boro red having significantly (P <0.05) higher values in all but β-carotene. Heavy metals like Co, As, Cd and Pb were not detected in any of the samples and the other minerals vary with K>P>Mg>Ca>Mn>Cu>Na>Zn>Fe>Al>Se in most of the varieties. Boro red also had the highest elemental contents in most of the minerals analyzed. Thus, these groundnuts can be considered useful foodstuffs in minimizing protein-energy malnutrition (PEM) and micronutrient deficiencies in Nigeria. However, the boro red variety is most recommended. The outcome of this research is a contribution to the food composition table.

KEY-WORDS: Arachis hypogaea L. – Groundnut – Minerals – Nigeria – Nutrient – Vitamins.

1. INTRODUCTION

Groundnut (*Arachis hypogea* L.) is among the major world oil seed crops. For some years now, China, India, the United States and Nigeria have been the major producers of the groundnut (~70% of the world production). During 2010-2011, approximately 35 million metric tons of groundnuts were harvested worldwide, where 42.81, 17.01, 5.36 and 4.39% came from China, India, the United States and Nigeria respectively (USDA-FAS, 2011). Its seeds are rich source of edible oils and provide a more valuable source of fat, protein, carbohydrate, minerals and some vitamins than any other nut, yet they are often the least expensive as well (Reddy *et al*., 2003).

Groundnut is an underexploited nut largely consumed by the western and most populations in Africa and known to a lesser extent as earthnut, monkeynut, and goobers. It is not a true nut but rather an annual legume much like the bean or a pea (Nwokolo, 1996). It has a high energy value and suitable for wide variety of agro ecological conditions (Karthikeyan *et al*., 2007). It is now grown in all tropical and subtropical countries primarily as an oil seed (Izge *et al*., 2007). It is used for different purposes: food (raw, roasted or boiled, cooking oil), animal feed (pressings, seeds, green material, straw), and industrial raw material (Onyeike and Oguike, 2003).

Regular groundnut consumption has been associated with a reduced risk in developing cardiovascular disease (Kris-Etherton *et al*., 1999), colon, prostate and breast cancer (Awad *et al*., 2000) as well as Type II diabetes (Jiang *et al*., 2002). It also seems to reduce osteoporosis and deficiencies in protein intake (Messina, 1999). Recently, it has been associated with metabolic benefits in the context of counteracting metabolic dysfunction associated with the increasing prevalence of obesity and metabolic syndrome (Coates and Howe, 2007).

Several studies have been carried out on groundnuts globally; some of which are highlighted subsequently. The chemical composition of groundnut from Argentina and Turkey had been determined by Grosso *et al*. (2000) and Ozcan & Seven (2003) respectively. Campos-Mondragon *et al*. (2009) reported the nutritional composition of six new peanut cultivars grown in Mexico. Asibuo *et al*. (2008) also reported the chemical composition of 20 groundnut varieties from Ghana and, Aslam Shad *et al*. (2009) reported the biochemical and phytochemical composition of some groundnut varieties from Pakistan. The fatty acid profile of some Nigerian groundnut oils had been analyzed (Anyasor *et al*., 2009). Furthermore, the chemical composition of groundnuts from Nigeria was also evaluated by Atasie *et al*. (2009) and Musa *et al*. (2010). However, in most of these studies, the varieties analyzed are not the commonly consumed ones (rather, they are mostly improved varieties from research institutes) and when they are commonly consumed, few varieties are considered.

Therefore, this study aimed at determining the nutrient composition of the five major varieties of groundnut commonly consumed in the southwestern part of Nigeria. We reported the proximate, vitamins and minerals found in these five varieties.

2. MATERIALS AND METHODS

2.1. Materials

Seeds of five varieties of *Arachis hypogaea* L. were purchased, each from 3-5 stores, in Mile 12 market, Lagos, Nigeria (*Ela*, *Campala*, *Boro light* and *Boro red*) and Oje market, Ibadan, Nigeria (*Mokwa*) in February 2009. Lagos and Ibadan are located in southwestern Nigeria. The seeds were stored in a polythene bag and transported to the laboratory for analysis. They were identified by Ogunwenmo, K.O. (PhD) (Professor, Biosystematics, Cytogenetics & Environmental Science, Chemical and Environmental Sciences Department, Babcock University). They were de-shelled and stored in sterile airtight bottles at 4°C until analysis.

2.2. Chemical Analysis

Groundnut samples were analyzed in triplicate for moisture, crude protein, crude lipid, crude fiber and ash using standard methods of analysis. The chemical composition was estimated according to the following methodology (AOAC, 2005): Moisture (AOAC 925.40); Ashes (AOAC, 950.49), Protein by Kjeldahl (AOAC, 950.48), Fat by Soxhlet (AOAC, 948.22) and Crude Fiber (AOAC, 935.53). Carbohydrate was estimated by difference.

β-carotene (determined spectrophotometrically – AOAC, 970.64), thiamine (determined flurometrically – AOAC, 957.17), niacin (determined colorimetrically – AOAC, 961.14) and tocopherol (determined colorimetrically – AOAC, 971.30) concentrations of the groundnut samples were determined according to the AOAC official method (2005).

Calcium, potassium and sodium were determined using a Jenway flame photometer. Phosphorus was determined by the vanado-molybdate spectrophotometric method. Magnesium, iron, zinc, copper, manganese, aluminum, cobalt, arsenic, cadmium, lead and selenium were determined spectrophotometrically using a Buck 210 atomic absorption spectrometer (AOAC, 968.08). All mineral determinations were done after dry ashing of the samples and according to the AOAC official method (2005).

2.3. Statistical Analysis

Data were analyzed by one way ANOVA with an SPSS version 15.0 and differences were considered to be statistically significant at $P<0.05$. An LSD test was further carried out to establish the pairs that showed significant differences.

3. RESULTS AND DISCUSSION

3.1. Chemical Composition

The mean chemical compositions of five varieties of groundnut (*Arachis hypogaea* L.) are presented in Table 1. The groundnut had 4.12-9.26% moisture, 2.91-3.45% ash, 26.64-27.57% protein, 48.06-50.66% fat, 2.76-3.07% fiber and 17.03-18.51% carbohydrate. Boro red had the highest levels of ash, fiber and carbohydrate; while ela and boro light had the highest levels of protein and fat respectively. The significantly higher ($P<0.05$) moisture content (9.26%) of mokwa would likely lower its shelf life compared with other varieties.

The ash contents reported in this study are higher compared to the report of Campos-Mondragon *et al*. (2009) – 2.0-2.2%; similar to that of Aslam Shad *et al*. (2009) – 2.70-3.03% and somewhat lower when compared with that of Musa *et al*. (2010) – 3.0-7.4%. The protein levels in the groundnut studied are similar to the 17.1-31.0% reported by Oke *et al*. (1995), 19.02-27.16% reported by Asibuo *et al*. (2008), 23.5-26.6% reported by Campos-Mondragon *et al*. (2009) and 19.7-31.3% reported by Musa *et al*. (2010). However our protein levels are slightly lower than the values (30.24-32.37%) reported by Aslam Shad *et al.* (2009). The variations existing from the reports seem to reflect the difference in locations where the groundnuts were cultivated as well as differences in the cultivars/varieties evaluated in each study.

Table 1
Chemical Composition (g/100g dry weight) of Five Varieties of Groundnut (*Arachis hypogaea* L.)**

Variety	Moisture*	Ash	Protein	Fat	Fiber	Carbohydrate
Boro Light	4.97 ± 0.06^{b}	2.91 ± 0.03^{c}	26.64 ± 0.22^{b}	50.66 ± 0.68^{a}	2.76 ± 0.03^{d}	17.03 ± 0.03^{d}
Boro Red	4.12 ± 0.19^{c}	3.45 ± 0.03^{a}	26.91 ± 0.07^{b}	48.06 ± 0.13^{d}	3.07 ± 0.02^{a}	18.51 ± 0.09^{a}
Mokwa	9.26 ± 0.08^{a}	2.93 ± 0.04^{c}	26.74 ± 0.10^{b}	50.04 ± 0.04^{a}	2.77 ± 0.03^{d}	17.52 ± 0.06^{c}
Campala	4.94 ± 0.05^{b}	2.97 ± 0.03^{c}	27.49 ± 0.13^{a}	49.47 ± 0.14^{b}	2.87 ± 0.04^{c}	17.16 ± 0.18^{d}
Ela	4.42 ± 0.08^{c}	3.10 ± 0.03^{b}	27.57 ± 0.16^{a}	48.60 ± 0.09^{c}	2.98 ± 0.03^{b}	17.75 ± 0.10^{b}

** Values are expressed as mean ± Standard Deviation, n=3.
* Determination was on wet weight basis
Values with different superscript along the same column are significantly different (P<0.05).

The fat contents of groundnuts have been reported as 33.6-54.95% (Asibuo *et al.,* 2008), 45.09-51.63% (Aslam Shad *et al*., 2009), 49.8-53.4% (Campos-Mondragon *et al*., 2009) and 32.7-53.1% (Musa *et al.,* 2010). This shows that our values (48.06-50.66%) are within the ranges found in the literature. The high fat content in groundnuts indicates high energy density that promotes fat soluble vitamin absorption without adding to the bulk of the diet (Atasie *et al*., 2009). The fiber of groundnut varieties has been reported as 6.1%, 3.7% and 3.3-4.4% by Paul and Southgate (1978), Atasie *et al*. (2009) and Campos-Mondragon *et al*. (2009) respectively. These values are somewhat higher than those reported in this study (2.76-3.07%). Asibuo *et al*. (2008) and Campos-Mondragon *et al*. (2009) also reported 19.02-27.16% and 18.9-23.4% respectively as the carbohydrate contents of groundnuts, which are higher than the one we obtained from the groundnut varieties analyzed. This trend might also be due to the fact that improved varieties from research institutes were analyzed by Asibuo *et al*. (2008) and Campos-Mondragon *et al*. (2009) as different from the local varieties we analyzed. This calls for a need to circulate more improved varieties to our local farmers for cultivation and distribution to Nigerian groundnut consumers.

3.2. Vitamin Composition

The mean concentrations of β-carotene, thiamin, niacin and tocopherol in the five varieties of groundnut (*Arachis hypogaea* L.) are summarized in Table 2. All the groundnut varieties showed activities of the β-carotene and vitamins determined. They had 63.32-65.35mg/100g of β-carotene, 0.73-0.98mg/100g of thiamin and 14.00-16.03mg/100g of niacin and 18.62-21.07mg/100g of tocopherol. All values were reported on dry weight basis. There is a paucity of information on the levels of vitamins in groundnut varieties. This result indicates the richness of these commonly consumed foodstuffs. They have the potential of supplying these micronutrients to a malnourished populace, especially in the developing world.

Nut consumption is associated with a protection effect against coronary heart disease, partly due to its high antioxidant content (Davis *et al*., 2007). The β-carotene value of the boro light variety (63.32mg/100g: 5.28mg/100g Vitamin A) for example, is higher than the vitamin A value (0.71μg/100g) of the almond nut reported by Christian and Ukhun (2006). Both vitamin A and tocopherol have important roles as antioxidants which may reduce the risk of those cancers initiated by free radicals and other strong oxidants (Willett and Stampfer, 2001; Devlin, 2006). The levels of thiamin and niacin in all the varieties, especially the boro red, indicates that individuals consuming them can derive substantial amounts of these B-vitamins, which are essential for the metabolisms of carbohydrates, proteins, and fats.

3.3. Mineral Composition

Nuts play a significant role in human nutrition especially as sources of vitamins and minerals (Wargovich, 2000). The mean concentrations of the minerals evaluated for the five groundnut varieties in this study are presented in Table 3.

Table 2
Vitamin composition (mg/100g dry weight) of five varieties of groundnut (*Arachis hypogaea* L.)

Variety	β-carotene	Thiamin	Niacin	Tocopherol
Boro Light	63.32 ± 0.08^{d}	0.81 ± 0.02^{c}	14.10 ± 1.17^{bc}	18.62 ± 0.19^{d}
Boro Red	64.54 ± 0.11^{b}	0.98 ± 0.02^{a}	16.03 ± 0.30^{a}	21.07 ± 0.91^{a}
Mokwa	65.35 ± 0.04^{a}	0.73 ± 0.02^{d}	14.00 ± 0.39^{c}	19.05 ± 0.23^{cd}
Campala	63.46 ± 0.07^{cd}	0.92 ± 0.03^{b}	14.52 ± 0.33^{c}	19.52 ± 0.38^{bc}
Ela	63.50 ± 0.07^{c}	0.97 ± 0.02^{ab}	15.27 ± 0.22^{b}	20.02 ± 0.42^{ab}

Values are expressed as mean ± Standard Deviation, n = 3.
Values with different superscript along the same column are significantly different (P<0.05).

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Table 3
Mineral Composition (mg/100g dry weight) of Five Varieties of Groundnut (Arachis hypogaea L.)

Variety	Na	K	Ca	P	Fe
Boro Light	3.43 ± 0.02^{d}	575.24 ± 2.79^{d}	45.25 ± 2.11^{cd}	372.50 ± 2.06^{c}	1.34 ± 0.04^{d}
Boro Red	5.12 ± 0.04^{a}	611.21 ± 3.92^{a}	62.58 ± 1.71^{a}	402.94 ± 2.19^{a}	1.67 ± 0.04^{a}
Mokwa	3.37 ± 0.09^{d}	584.45 ± 3.65^{c}	43.71 ± 3.37^{d}	384.61 ± 1.99^{b}	1.33 ± 0.03^{d}
Campala	3.57 ± 0.05^{c}	586.63 ± 3.97^{c}	50.14 ± 3.24^{bc}	387.46 ± 3.88^{b}	1.42 ± 0.03^{c}
Ela	3.78 ± 0.03^{b}	596.69 ± 3.66^{b}	55.45 ± 2.13^{b}	398.88 ± 1.73^{a}	1.50 ± 0.02^{b}

	Mn	Mg	Zn	Cu	Se
Boro Light	25.15 ± 0.20^{d}	97.86 ± 2.07^{c}	2.91 ± 0.16^{c}	21.40 ± 1.60^{bc}	0.04 ± 0.01^{b}
Boro Red	30.91 ± 0.52^{a}	111.95 ± 2.43^{a}	4.14 ± 0.32^{a}	27.12 ± 2.07^{e}	0.11 ± 0.04^{a}
Mokwa	24.10 ± 0.45^{e}	$99.92\pm2.71b^{c}$	2.79 ± 0.28^{c}	20.20 ± 1.26^{c}	0.04 ± 0.02^{b}
Campala	26.05 ± 0.39^{c}	102.39 ± 1.21^{b}	3.47 ± 0.21^{b}	22.79 ± 1.20^{b}	0.06 ± 0.03^{ab}
Ela	27.58 ± 0.33^{b}	109.50 ± 2.61^{a}	3.80 ± 0.27^{a}	$25.46\pm1.19\ ^{a}$	0.08 ± 0.04^{ab}

	Al	Co	As	Cd	Pb
Boro Light	0.11 ± 0.03^{cd}	ND	ND	ND	ND
Boro Red	$0.17\pm0.01\ ^{a}$	ND	ND	ND	ND
Mokwa	0.09 ± 0.03^{d}	ND	ND	ND	ND
Campala	0.14 ± 0.02^{bc}	ND	ND	ND	ND
Ela	0.16 ± 0.02^{ab}	ND	ND	ND	ND

Values are expressed as mean ± Standard Deviation, n=3.
Values with different superscript along the same column are significantly different (P<0.05).
ND – Non-detectable

The result shows that Co, As, Cd and Pb were not detected in the samples. Other minerals vary with K>P>Mg>Ca>Mn>Cu>Na>Zn>Fe>Al>Se, in most varieties. In all minerals evaluated, boro red had the highest contents followed mostly by ela; while makwa normally had the least contents. This trend is clearly reflected in the ash contents of these groundnut varieties (Table 1). The data obtained in this study for K, P and Ca are similar to previous data from bamabara groundnut reported by Amarteifio *et al.* (2006). However, most of the minerals are lower compared with those reported by Asibuo *et al.* (2008) from 20 improved varieties of groundnut. This further calls for the need to invest resources in the development, production and distribution of improved groundnut varieties for Nigerians.

Minerals serve as cofactors for many physiological and metabolic functions. The presence of a substantial amount of Ca and P in all the groundnut varieties is a good indication that they are rich in minerals that play a role in bone formation, blood coagulation and muscle contraction along with other metabolic processes. It has also been hypothesized that chronic groundnut consumption would improve serum Mg concentration, thus reducing the risk of cardiovascular disease (CVD) (Alper and Mattes, 2003). Mn, Cu, Zn and Se, which are parts of the human antioxidant defence systems (Wardlaw and Hampl, 2007), were present in all the varieties analyzed, especially the boro red variety. Therefore, they can boost the antioxidant status of individuals consuming them. Consequently, they can positively minimize the effects of oxidative stress-related diseases in individuals consuming them.

4. CONCLUSION

Groundnuts can be considered as good sources of protein and fats, which make them useful for enhancing growth and supplying energy to humans and animals when added to the diet. All the groundnut varieties analyzed are potential micronutrient (vitamins and minerals) sources and thus will facilitate various metabolic processes and improve growth and development in their consumers. However, boro red is the most recommended variety due to its relative macro and micronutrient richness. The outcome of this research is a very useful contribution to the food composition table. There is a need to release the already developed improved varieties of groundnuts in Nigeria to farmers for mass production, distribution and consequent positive impact on their consumers.

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