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Chemical, *In-vitro* Protein Digestibility, Minerals and Amino Acids Composition of Edible Peanut Seeds (*Arachis hypogaea* L.)

M.A.Y. Abdualrahman
Department of Food Technology, Nyala Technological College, Nyala, Southern Darfur State, Sudan

ABSTRACT

Peanut (*Arachis hypogaea* L.) is the third important oil seed crop of the world in production after soybean and cotton. This study aimed to evaluate the nutritional value of edible peanut seeds grown under rainfed area of Darfur region. For this, peanut was carried out in term of chemical, *in-vitro* protein digestibility, minerals and amino acids. The proximate analysis of raw peanut was moisture (5.9±0.01%), protein (28.97±0.03%), ash (3.64±0.01%), fat (47.94±0.01%), crude fiber (3.17±0.02%), total carbohydrates (10.38±0.01%) and *in-vitro* protein digestibility (92.65±0.02%). On the other hand, sodium, calcium, phosphorus, iron and zinc contents were (2.10±0.03, 59±0.01, 254.5±0.01, 2.3±0.03 and 3.7±0.02 mg 100 g^{-1}), respectively. The amino acids results indicated that peanut was superior with respect to phenylalanine, leucine, isoleucine and valine when comparable to those of FAO reference pattern.

Key words: Peanut, chemical, *in-vitro* protein digestibility, minerals, amino acids

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INTRODUCTION

Peanut (*Arachis hypogaea* L.) is the third important oil seed crop of the world in production after soybean and cotton. In Sudan, the crop is cultivated in the traditional rainfed and under irrigation with an average total production of about 543.9 thousand metric tons. In the seventies, peanut was one of the most exported crops in the Sudan and during that period; Sudan was the second exporting country of peanut after the United States of America. It was exporting about 22% of the total world export and the annual revenue exceeded one hundred million dollars. Since the beginning of the eighties, the export of peanuts started to decline to less than one million dollars. Many factors were behind the deterioration and instability in the peanut export; among them, a reduction in peanut production and increasing of local consumption[1]. Peanuts are a rich source of protein, prior to 1990 the protein efficiency ratio method of protein evaluation considered peanut protein along with soy protein as an incomplete protein, containing relatively low amounts of essential amino acids, cystine and methionine but high in lysine and it was advised to be sure that a diet with peanuts as a stable also include complementary food such as whole grains like corn and wheat, which are adequate in methionine but limited by lysine[2]. Amino acid profile of peanut is in many respects inferior to the profile of soybean. Comparatively, the protein content of peanut is only about 70% of that of soybean. Peanuts are a reasonable source of dietary minerals especially potassium, phosphorus and magnesium. However, they are poor source of fat soluble vitamins like A, D and K[2]. Peanut oil is an excellent source of mono-and polyunsaturated fatty acids, exceeding the levels of these fatty acids in soybean and corn oil, but significantly lowers than in sunflower and safflower oil[2]. This study aimed to investigate the chemical, *in-vitro* protein digestibility, minerals and amino acids composition of edible peanut seeds grown under rainfed area of Darfur region.

Corresponding Author: M.A.Y. Abdualrahman, Department of Food Technology, Nyala Technological College, Nyala, Southern Darfur State, Sudan

MATERIALS AND METHODS

Material: The raw peanut seeds were obtained from Grieda, the most important rainfed area for oil seed crop production in Southern Darfur State, Sudan, during 2011/2012 season. The raw peanut seeds were cleaned and kept at room temperature (32°C) for further analysis.

Proximate analysis: The proximate analysis of raw peanut in term of moisture, ash and crude fat were determined in triplicate according to the AOAC[3] method. Crude protein was calculated as N%×6.25 according to the AOAC[4]. Crude fiber was conducted by using acid/alkali digestion method according to the AOCS[5]. Total carbohydrates content was calculated by subtracting the previous components from 100.

***In-vitro* protein digestibility:** *In-vitro* protein digestibility of raw peanut was determined according to the three-enzyme method as described by Hsu *et al.*

and satterlee *et al.* [6,7] in which a multi-enzyme solution of (1.6 mg trypsin, 3.1 mg chymotrypsin and 1.3 mg peptidase per milliliter) was used in the determination.

Mineral contents: The minerals were determined by the dry-ashing method as described by Pearson[8]. Half a gram of raw peanut was weighed into a crucible and ashed in a muffle furnace at 600°C for 4 h. the ash was cooled and dissolved in dilute HCl (HCl: distilled water 1:3, v/v) and a few drops of concentrated nitric acid was added. The crucible was kept on a hot sand bath and boiled. The content was allowed to cool and transferred to 50 mL volumetric flask and the volume made up to the 50 mL mark with distilled water. Zinc and Ferrous were determined using a GBC 908 Atomic Absorption Spectrophotometer. Phosphorus was determined by the ammonium molybdate-ammonium vandate method. Calcium was determined by the titration Chapman and Pratt[9]. Sodium was determined using a Corning 410 flame photometer.

Amino acid analysis: Amino acids contents of raw peanut were measured on hydrolysates using amino acid analyzer (Sykam-S7130) based on high performance liquid chromatography technique. The peanut hydrolysates were prepared as described by Moor and Stein[10]. Two hundred milligrams of peanut were taken in hydrolysis tube. Then 5 mL 6N HCl were added to peanut into the tube, evacuated, tightly closed and incubated for 24 h at 110°C. After incubation period, the solution was filtered and 200 mL of the filtrate were evaporated to dryness at 140°C for an hour. The dried hydrolysate was diluted with one milliliter of 0.12 N, pH 2.2 citrate buffers, the same as the amino acid standards (amino acid standards H; Pierce Inc., Rockford; IL, USA). Aliquot of 150 µL of sample hydrolysate was injected in a cation separation column at 130°C. Ninhydrin solution and an eluent buffer (the buffer system contained solvent A, pH 3.45 and solvent B, pH 10.85) were delivered simultaneously into a high temperature reactor coil (16 m length) at a flow rate of 0.7 mL min^{-1}. The buffer/ninhydrin mixture was heated in the reactor at 130°C for 2 min to accelerate chemical reaction of amino acids with ninhydrine. The products of the reaction mixture were detected at wavelengths of 570 and 440 nm on a dual channel photometer. The amino acids composition was calculated from the areas of standards obtained from the integrator and expressed as percentages.

RESULTS AND DISCUSSIN

As shown in Table 1, moisture content of raw peanut was (5.9±0.01%). The result is agreement with the (5.8, 5.7 and 6.0±0.16%) reported by Atasie *et al.* Boutros and Abdualrahman[11,12,13], respectively. The content of crude protein (28.97±0.03%) is within the range of (20-50%) reported by Nwokolo[2] and higher than (26.7%) and (27.93±0.03%) determined by Boutros and Abdualrahman[12,13], respectively. Ash content of peanut was (3.64±0.01%). This data is slightly lower than (3.8%) determined by Atasie *et al.*[11] and higher than (2.3%) and (2.66±0.04%) reported by Boutros and Abdualrahman[12,13], respectively. On the other hand, fat content of raw peanut (47.94±0.01%) is higher than (47.0%) and (47.34±0.11%) reported by Atasie *et al.* and Abdualrahman[11,13] and lower than (49.2%) stated by Boutros[12]. The crude fiber content (3.17±0.02%) is higher than (2.12±0.07%) determined by Abdualrahman[13] and lower than (3.70%) reported by Atasie *et al.*[11]. Total carbohydrate content of raw peanut was (10.38±0.01%). This result is much higher than (1.81%) determined by Atasie *et al.*[11] and lower than (14.6%) and (19.95±0.18%) found by Boutros and Abdualrahman[12,13], respectively. On the other hand, the *in-vitro* protein digestibility was (92.65±0.02%). This value is higher than (91.61±0.02%) reported by Abdualrahman[13]. However, [14] reported a value of 93.06±0.042% for peanut *in-vitro* protein digestibility.

Table 2 showed that, sodium content of raw peanut was (2.10±0.03 mg 100 g^{-1}). It can be indicated that, this result is close agreement with the (2.0 mg 100 g^{-1}) reported by Woodroof[15] and lower than the range of (19-48 mg 100 g^{-1}) reported by Yaw *et al.*[16]. The calcium content was (59±0.01 mg 100 g^{-1}). This result is agreement with range of (44-134 mg 100 g^{-1}) found by Yaw *et al.*[16], higher than (57 mg 100 g^{-1}) reported by Boutros[12] and lower than (60.0 mg 100 g^{-1}) indicated by Woodroof[15]. Phosphorus content of raw peanut was (254.5±0.01 mg 100 g^{-1}). This result is exceeded the value of (216 mg 100 g^{-1}) determined by Boutros[12] and lower than (430 mg 100 g^{-1}) found by Woodroof[15]. The iron content was (2.3±0.03 mg 100 g^{-1}). This result is agreement with range of

Table 1: Chemical composition and *in-vitro* protein digestibility of raw peanut (on DM basis)

	Components (%)						
Raw peanut	Moisture	Protein	Ash	Fat	Fiber	Carbohydrates	IVPD
	5.9±0.01	28.97±0.03	3.64±0.01	47.94±0.01	3.17±0.02	10.38±0.01	92.65±0.02

IVPD: Means *in-vitro* protein digestibility, All results are means of triplicate analysis, ±Standard deviation (n = 3)

Table 2: The minerals content of raw peanut

Samples treatment	Sodium	Calcium	Phosphorus	Iron	Zinc
	----------mg 100 g^{-1}----------				
Raw peanut	2.10±0.03	59±0.01	254.5±0.01	2.3±0.03	3.7±0.02

All results are means of triplicate analysis, ±Standard deviation (n = 3)

Table 3: Amino acids content (g 100 g^{-1} protein) of raw peanut seeds

Amino acids contents	Raw peanut seeds	FAO/WHO*
	----------g 100 g^{-1} protien----------	
Methionine	1.01	3.50
Tyrosine	2.93	-
Phenylalanine	6.10	6.00
Leucine	7.31	7.00
Isoleucine	4.22	4.00
Lysine	3.82	5.50
Threonine	3.17	4.00
Valine	5.17	5.00
Tryptophan	ND	1.00
Total essential amino acid	33.73	36.00
Histidine	2.35	-
Arginine	13.31	-
Cystine	1.00	-
Aspartic	10.07	-
Glutamic	19.68	-
Serine	4.63	-
Glycine	4.44	-
Alanine	4.55	-
Proline	6.24	-
Total nonessential amino acids	66.27	-

*Provisional amino acids pattern recommended by FAO/WHO[17], ND: Not determined

(0.20-3.70 mg 100 g^{-1}) reported by Yaw *et al.*[16], close similar to (2.4 mg 100 g^{-1}) determined by Boutros[12] and lower than (2.5 mg 100 g^{-1}) conducted by Woodroof[15]. It can be observed that zinc content of raw peanut was (3.7 ±0.02). This result is agreement with the range of (0-6.5 mg 100 g^{-1}) determined by Yaw *et al.*[16] and higher than (3.5 mg 100 g^{-1}) reported by Woodroof[15].

From Table 3, it can be observed that glutamic acid and aspartic acid were the major amino acids (19.68 and 10.07 g 100 g^{-1} protein), respectively in raw peanut. These results are slightly lower than (19.88 and 10.10 g 100 g^{-1} protein), respectively reported by Abdualrahman[13] and higher than (9.19 and 9.50 g 100 g^{-1} protein), respectively found by Yagoub and Ahmed[18] for peanut seed cake. Methionine content of raw peanut was (1.01 g 100 g^{-1} protein). This result is higher than (0.91 g 100 g^{-1} protein) reported by Abdualrahman[13] and (0.60 g 100 g^{-1} protein) reported by Yagoub and Ahmed[18] for peanut seed cake. The content of cystine was (1.00 g 100 g^{-1} protein) is higher than (0.96 g 100 g^{-1} protein) determined by Abdualrahman[13]. From Table 3, it can be observed that glycine, alanine and valine contents of peanut were (4.44, 4.55 and 5.17 g 100 g^{-1} protein), respectively. These results are lower than (4.79, 5.89 and 6.29 g 100 g^{-1} protein), respectively reported by Yagoub and Ahmed[18] for peanut seeds cake. Threonine and lysine (3.17 and 3.82 g 100 g^{-1} protein), respectively are the limiting essential amino acid in raw peanut. Theronine content (3.17 g 100 g^{-1} protein) is higher than (3.03 g 100 g^{-1} protein) stated by Abdualrahman[13] and (2.94 g 100 g^{-1} protein) reported by Yagoub and Ahmed[18] for peanut seed cake. Lysine content of raw peanut was (3.82 g 100 g^{-1} protein). This result is close agreement with the (3.85 g 100 g^{-1} protein) found by Yagoub and Ahmed[18] for peanut seed cake. However,[13] reported that lysine content of raw peanut was (3.79 g 100 g^{-1} protein). Phenylalanine and leucine contents of peanut (6.10 and 7.31 g 100 g^{-1} protein) are slightly higher than (6.07 and 7.27 g 100 g^{-1} protein) reported by Abdualrahman[13]. However,[18] reported that phenylalanine and tyrosine and leucine contents of peanut seed cake were (11.81 and 8.63 g 100 g^{-1} protein), respectively. In addition to that, isoleucine content of raw peanut (4.22 g 100 g^{-1} protein) is agreement with the (4.23 g 100 g^{-1} protein) reported by Abdualrahman[13] and lower than (5.12 g 100 g^{-1} protein) determined by Yagoub and Ahmed[18] for peanut seed cake. From Table 3, the amino acids results revealed that peanut was superior with respect to phenylalanine, leucine, isoleucine and valine when comparable to those of FAO reference pattern[17]. On the other hand, arginine content of peanut (13.31 g 100 g^{-1} protein) is similar to (13.31 g 100 g^{-1} protein) determined by Abdualrahman[13] and lower than (15.09 g 100 g^{-1} protein) reported by Yagoub and Ahmed[18] for peanut seed cake. However,[19] reported that, women consuming the arginine plus vitamins combination had a significantly reduced risk (12.7%) of developing pre-eclampsia compared to the vitamin-only group (22.5%) and the placebo group (30.1%). Total essential amino acid of raw peanut (33.73 g 100 g^{-1} protein) is lower than (36.00 g 100 g^{-1} protein) recommended by FAO/WHO[17].

CONCLUSION

From the previous results it can be revealed that, Grieda's peanut had good nutritive values in term of crude protein, fat, *in-vitro* protein digestibility, calcium, phosphorus, iron and zinc. The amino acids analysis revealed that peanut was superior with respect to phenylalanine, leucine, isoleucine and valine when comparable to those of FAO reference pattern.

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