Advance Journal of Food Science and Technology 2(4): 191-195, 2010
ISSN: 2042-4876

Submitted Date: May 05, 2010 Accepted Date: May 21, 2010 Published Date: July 30, 2010

Chemical and Nutrient Analysis of Gingerbread Plum (*Neocarya macrophylla*) Seeds

Tidjani Amza, Issoufou Amadou, Mohamed T. Kamara, Kexue Zhu and Huiming Zhou
State Key Laboratory of Food Science and Technology, Jiangnan University,
No. 1800 Lihu Road, Wuxi, 214122 Jiangsu, P. R. China

Abstract: The proximate composition of gingerbread plum (*Neocarya macrophylla*) seeds, mineral, fatty acid and amino acid compositions were evaluated. The proximate analysis revealed the following composition: moisture 10.57 and 10%, ash 4.43 and 6.43%, fat 47.28 and 2.14%, crude protein 20.37 and 61.71%, carbohydrates 8.64 and 12.10% and crude fiber 8.70 and 7.37% for Gingerbread Plum Seed Flour (GPSF) and Defatted Gingerbread Plum Seed Flour (DGPSF) respectively. Oleic, linoleic and arachidonic acids were the major unsaturated fatty acids with 47.15, 19.10 and 17.64% respectively. Saturated fatty acids accounted for 14.72% of total fatty acids. The main saturated fatty acids were palmitic and stearic, with minute amounts of arachidic. Magnesium, potassium and calcium were the predominant elements present in the seeds. Copper, iron and manganese were also detected in appreciable amounts. Essential amino acids were above the recommended amount by Food Agricultural Organization/World Health Organization (FAO/WHO) for humans. The results of the present investigation showed that gingerbread plum seeds are a rich source of many important nutrients that appear to have a very positive effect on human health.

Key words: Amino acids, fatty acids, gingerbread plum, minerals, proximate composition, seeds

INTRODUCTION

People in the western Sahel consume wild and cultivated edible plants to satisfy their nutritional requirements. In many parts of the Sahel, farmers in rural areas produce insufficient yields of millet the staple grain (Kamara *et al*., 2009) . During periods of grain shortage, people increase their reliance on wild plant foods to supplement their diets (Glew *et al*., 2005). Several studies (Taehee *et al*., 1997, Freiberger *et al*., 1998) have shown that these wild products are an alternative source of oil and protein for human and animal feeding. Examples of such products are Boscia senegalensis seeds (Taehee *et al*., 1997), and Adansonia digitata seeds (Yazzie *et al*., 1994).

Gingerbread plum trees are indigenous to these regions. Gingerbread plum, a purely West African species (formerly Parinari macrophylla Sabine; now Neocarya macrophylla (Sabine) Prance) belongs to chrysobalanaceae family. The plant family has 17 genera and 350 species. Pharmacologically, the decoction of the bark and leaves are used as mouth wash, internal troubles and for inflamed eye (Frederick, 1961). The leaves may also be chewed or applied topically for the same end. The fruits are used in a variety of ways. Many are eaten fresh or are boiled with cereal. Pounded with water, they create a colorful red counterpart to lemonades or orange crushes. And often this refreshing liquid is thickened with flour (from maize or cassava) and boiled into a widely enjoyed and tangy tasting gruel. The kernels inside the seeds are eaten too. The gingerbread nuts are usually roasted and enjoyed like cashews or almonds. Some are consumed as snacks, others mixed into cooked dishes, and a few are pressed to yield cooking oil (National Research Council, 2008).

Previous studies have reported on the nutritional and functional contents of the flesh of gingerbread plum fruit (Frederick, 1961; Cook *et al*., 1998; Cook *et al*., 2000; Audu *et al*., 2005). However, detailed analysis of the nutrient content of the seed has yet to be reported. Therefore, the main objective of this study is to determine the proximate composition, amino acid, minerals of gingerbread plum seed, and to evaluate the seed oil fatty acid profile.

MATERIALS AND METHODS

This study was held in the State Key Laboratory of Food Science and Technology, Jiangnan University, Wuxi, Jiangsu province, People's Republic of China.

Materials: Gingerbread plum seeds collected in July 2009 in Birni N'Gaouré, southern region of Republic of Niger were provided by Alimentation Générale SARA,

Corresponding Author: Tidjani Amza, State Key Laboratory of Food Science and Technology, Jiangnan University, No. 1800 Lihu Road, Wuxi, 214122 Jiangsu, P. R. China

Niamey, Niger. The seeds were milled using a laboratory scale hammer miller and the resulting flour was sieved through a 60 mesh screen. The Gingerbread Plum Seed Flour (GPSF) was dispersed in hexane at flour to hexane ratio of 1:5 (w/v) and stirred for 4 h at room temperature. The experiment was repeated twice as described above. The hexane was decanted and the defatted gingerbread plum seed flour (DGPSF) was air dry for 24 h under a vacuum drier and stored at 5±1ºC in sealed glass jars until use.

Methods:

Proximate analysis: The proximate composition of GPSF and DGPSF was determined according to Ceirwyn (1995). The moisture content was determined by drying in an oven at 105±1ºC until a constant weight was obtained. Ash was determined by weighing the incinerated residue obtained at 525±1ºC after 4 h. Crude fat was extracted by the Soxhlet method with petroleum ether. The crude protein was determined by the micro-Kjeldahl method and a Conversion factor of 6.25 was used to quantify the crude protein content (Tkachuk, 1969) and crude fibre was determined by AOAC (1995). The carbohydrate content was estimated by subtracting the sum of percentage of moisture, crude fat, crude protein, fibre and ash contents from 100%. Triplicate samples were analyzed for each sample.

Amino acid analysis: The dried samples were digested with HCl (6 M) at 110ºC for 24 h under nitrogen atmosphere. Reversed phase high performance liquid chromatography (RP-HPLC) analysis was carried out in an Agilent 1100 (Agilent Technologies, Palo Alto, CA, USA) assembly system after precolumn derivatization with O-phthaldialdehyde (OPA). Each sample (1 µL) was injected on a Zorbax 80 A C18 column (i.d., 4.6×180 mm, Agilent Technologies, Palo Alto, CA, USA) at 40ºC with detection at 338 nm. Mobile phase A was 7.35 mM/L sodium acetate/ triethylamine/ tetrahydrofuran (500:0.12: 2.5, v/v/v), adjusted to pH 7.2 with acetic acid, while mobile phase B (pH 7.2) was 7.35 mM/L sodium acetate/methanol/acetonitrile (1:2:2, v/v/v). The amino acid composition was expressed as g of amino acid per 100 g of protein.

Fatty acid analysis: Fatty acid for the GPSF was determined according to the method of Ceirwyn (1995). Fat was extracted with methyl ether that was prepared directly with the treatment of the fat with sodium methoxide. Gas chromatography/mass spectra (GC/MS) system was used to identify and quantify the fatty acids of the product developed on a FINNIGAN TRACE MS gas chromatograph/mass spectra equipped with a 30 m x 0.25 mm Ov-1701 column. Column flow rate was 0.8 mL/min with helium as the carrier gas, split was 64 mL/min and the source temperature was 270ºC. The fatty acid methyl esters were identified by comparison with the retention times of NU CHECK Inc. standards (Elysian, 1L) and quantified by internal normalization.

Table 1: Proximate chemical composition of gingerbread plum seed flour (GPSF) and defatted gingerbread plum seed flour (DGPSF) (g/100 g, dry matter basis)

Chemical composition (%)	GPSF	DGPSF
Moisture	10.57±0.98	10.00±1.00
Crude protein	20.37±1.36	61.71±0.89
Crude lipid	47.28±1.36	2.14±1.01
Ash	4.43±0.82	6.43±0.73
Carbohydrates	8.64±0.29	12.10±0.70
Crude fiber	8.70±1.01	7.37±0.93

Values are means ±standard deviation of three determinations.

Mineral analysis: The minerals were analyzed from solutions obtained by first dry ashing the DGPSF at 525±1ºC to obtain the ash. The residue of the sample was dissolved in 10 mL of 50% of nitric acid solution and made up to final volume of 25 mL of distilled water. After that the minerals (Zn, Fe, Cu, Mn, Na, K, Mg, and Ca) were analyzed separately, using an Atomic Absorption Spectrophotometer of Spectra AA 220, USA Varian. Phosphorus was analyzed by the phosphovanado molybdate method of AOAC (1995). The data reported represent the average of three determinations.

RESULTS AND DISCUSSION

Proximate chemical composition: The moisture content of GPSF was similar to those of several legumes proteins (Alsmeyer *et al.*, 1974; Akubor *et al.*, 2004; Aremu *et al.*, 2006) Table 1. The protein content from the sample was significantly increased after defatting (20.37-61.71%). The quantity of crude protein was comparable with crude proteins in protein-rich foods such as soybeans, cowpeas, pigeon pea and Kersting's groundnut (Olaofe *et al.*, 1994; Aremu *et al.*, 2006). The ether extract (crude lipid) mean values were 47.28 and 2.14% for GPSF and DGPSF, respectively, Table 1. Our results were higher when compared with the values reported for two varieties of bambara groundnut 4.10 and 6.72% (Aremu *et al.*, 2006), and pear millet and quinoa (7.6 and 6.3%), Oshodi *et al.* (1999) but were comparable to *C. vulgaris* (47.7%), Meshach *et al.* (1984) and *T. occidentalis* (54.4), Olaofe *et al.* (1994). This is an indication that gingerbread plum seeds can be grouped as part of oil-rich legume seeds. The crude fibre was comparable with most legumes such as pigeon pea, cowpea, coccineus and oil seeds (Olaofe *et al.*, 1994). There is evidence that crude fibre has a number of beneficial effects related to its indigestibility in the small intestine (Aremu *et al.*, 2006).

Amino acid analysis: It is clear that the GPSF contains all the essential amino acids in good proportion as compared to the DGPSF. The results shown in Table 2,

Table 2: Amino acid patterns of gingerbread plum seed flour and defatted gingerbread plum seed flour (g/100 g protein)

Amino acid	Total amino acid (TAA)		FAO/WHO/UNU[a]	
	GPSF	DGPSF	Child	Adult
Essential amino acid (EAA)				
Histidine	2.40±0.01	2.47 ±0.03	1.9	1.6
Threonine	2.93±0.02	2.07 ±0.03	3.4	0.9
Valine	4.47±0.03	4.40 ±0.01	3.5	1.3
Methionine	1.41±0.03	1.64 ±0.04		
Met + Cys	2.83±0.08	3.24 ±0.04	2.52[b]	1.70[b]
Phenylalanine	6.42±0.01	6.97 ±0.02		
Phe + Tyr	8.53±0.04	9.36 ±0.04	6.3[c]	1.90[c]
Isoleucine	2.75±0.02	2.53 ±0.04	2.8	1.3
Leucine	6.06±0.02	6.64 ±0.02	6.6	1.9
Lysine	2.73±0.01	4.44 ±0.02	5.8	1.6
Tryptophane	1.01±0.02	1.05 ±0.02	1.1	0.5
Non Essential amino acid (nEAA)				
Aspartic acid[d]	9.47±0.08	9.46±0.04		
Glutamic acid[e]	19.67±0.03	19.40±0.01		
Serine	5.27±0.02	6.74±0.02		
Glycine	5.85±0.03	5.91±0.02		
Arginine	9.60±0.03	10.43±0.02		
Alanine	3.11±0.04	3.23±0.02		
Tyrosine	2.11±0.03	2.39±0.02		
Cysteine-s[f]	1.42±0.05	1.60±0.02		
Proline	5.91±0.04	6.43±0.06		
Hydrophobic (nonpolar)[1]	36.73±0.05	37.01±0.04		
Uncharged polar[2]	12.39±0.08	12.29±0.02		
Basic[3]	16.97±0.03	16.80±0.09		
Acidic[4]	30.14±0.11	30.86±0.03		
Sulfur-containing5	2.44 ±0.04	2.36±0.07		
Aromatic[6]	9.70 ±0.02	9.13±0.03		

Values are means and standard deviations of triplicate, [a]: FAO/WHO/UNU energy and protein requirements (2007), [b]: Requirements for methionine + cysteine, [c]: Requirements for phenylalanine + tyrosine, [d]: Aspartic acid + asparagines, [e]: Glutamic acid + glutamine, [f]: Cysteine + cystine
[1]: Glycine, Alanine, Valine, Leucine, Proline, Methionine, Phenylalanine, Tryptophanep, and Isoleucine, [2]: Serine, Threonine, Cystein, and Tyrosine, [3]: Lysine, Arginine, and Histidine, [4]: Aspartic and Glutamic, [5] Cystein and Methionine, [6] Phenylalanine, Tyrosine, and Tryptophane

indicate that the amino acid composition of the GPSF closely resembles that of DGPSF from which it was prepared while aspartic acid and glutamic acid, were found to be abundant as expected in most legumes. GPSF has a well-balanced amino acid composition. Moreover, most of the essential amino acids of the protein were at a higher level than the Food and Agriculture Organization/World Health Organization reference pattern (FAO, 2007), except threonine and tryptophan which were less than the required amount. These values are generally in accordance with previous report (Aremu *et al*., 2006; Peter *et al*., 1998; Young, 2006).

Classifications of amino acids in different groups according to chemical properties are shown in Table 2. DGPSF and GPSF contained high amount of sulfur-containing amino acids; DGPSF has the highest amount of basic amino acids. The content of uncharged polar amino acids was found to be high in DGPSF. The GPSF and DGPSF have both high total aromatic amino acids.

Fatty acid analysis: Fatty acid composition of the oil extracted from gingerbread plum seeds is given in Table 3. The oil is rich in unsaturated fatty acids. Oleic, linoleic and arachidonic acids accounted for 47.15%, 19.10 and 17.64% of the total fatty acids, respectively.

Table 3: Fatty acid composition of gingerbread plum seed oil.

	Area (%)
Fatty acids	Gingerbread plum seed
Saturated	
Palmitic acid (16:0)	9.12±0.11
Stearic acid (18:0)	5.35±0.12
Arachidic acid (20:0)	0.25±0.04
Mono-unsaturated	
Palmitoleic acid (16:1)	0.21±0.06
Oleic acid (18:1)	47.15±0.58
Eicosenoic acid (20:1)	0.37±0.01
Poly-unsaturated	
Linoleic acid (18:2)	19.10±0.06
Arachidonic acid (20:4)	17.64±0.58

Values are means±standard deviation of three determinations

Previous study showed that the oil of gingerbread plum seed contained oleic and linoleic acids at relatively high levels (Burkill, 1985). Our results are in good agreement with reported values by Burkill (1985). In this study, saturated acids accounted for 14.72% of total fatty acids. Among them the main saturated acids were palmitic and stearic, with minute amounts of arachidic. The seed lipids of the investigated samples were rich in linoleic acid, which has a beneficial effect on blood lipids, lowering blood pressure and serum cholesterol. The nutritional value of linoleic acid is due to its metabolism at tissue

Table 4: Minerals analysis of defatted gingerbread plum seed flour

Elements (µg/g)	DGPSF
Sodium (Na)	1360.03±0.30
Potassium (K)	12500.59±0.53
Zinc (Zn)	110.84±0.79
Iron (Fe)	166.06±0.06
Copper (Cu)	45.08±0.10
Manganese (Mn)	22.66±0.11
Calcium (Ca)	6669.99±0.10
Magnesium (Mg)	20999.65±0.64
Phosphorus (P)	4629.98±0.19

Values are means±standard deviation of three determinations

levels which produces the hormone-like prostaglandins (Savage, 2001; Ramadan *et al*., 2002; Odoemelam, 2003).

Mineral analysis: The mineral content of defatted gingerbread plum flour (DGPSF) is shown in Table 4. DGPSF is an excellent source of potassium, calcium, magnesium and phosphorus but poor source of manganese and copper. The defatted gingerbread plum seed flour showed exceptionally high magnesium, potassium and calcium contents. The values obtained are lower than data reported for raw conoflour (Radha *et al*., 2007) but comparable to reported the values reported for African yam bean (Aremu *et al*., 2006). The high calcium content of DGPSF makes the gingerbread plum seed flour attractive as a natural source of calcium supplementation for pregnant and lactating women, as well as for children and the elderly people. Defatted gingerbread plum seed flour also provides appreciable amounts of iron from a nutritional point of view and since human populations in the western Sahel, where gingerbread plum is in abundance, are at relatively high risk for numerous infections, it is significant that due to it notable high zinc content, gingerbread plum can satisfy a substantial portion of the zinc requirement for this nutrient which is critical to the normal functioning of the immune system.

CONCLUSION

The results of the present investigation reveal that gingerbread plum seed is a valuable source of nutrition due to substantial amount of proteins with an adequate quantity of minerals, essential amino acids, fatty acid and carbohydrates. The essential amino acid pattern of gingerbread plum seed suggests the possible use as a supplementary source to most legumes and that most of the essential amino acids are above the WHO/FAO/UNU (2007) requirements for humans. Ultimately, detailed reports on the chemical composition of gingerbread plum (*Neocarya macrophylla*) seeds have not been previously reported. The results in this paper confirm that the seeds are a rich source of many important nutrients that appear to have a very positive effect on human health.

ACKNOWLEDGMENT

The authors wish to thank Mr. Oumarou Abdou (Alimentation Générale SARA Niamey, Niger) for providing gingerbread plum seeds down to Wuxi, People's Republic of China.

REFERENCES

Akubor, P.I. and G.I.O. Badifu, 2004. Chemical composition, functional properties and baking potential of African breadfruit kernel and wheat flour blends. Int. J. Food Sci. Technol., 39: 223-229.

Alsmeyer, R.H., A.E. Cunningham and M.L. Happich, 1974. Equations to predict PER from amino acid analysis. Food Technol., 28: 34-38.

AOAC, 1995. Official Methods of Analysis. 16th Edn., Association of Official Analytical Chemists. Washington DC, pp: 67-75.

Aremu, M.O., A. Olonisakin, B.O. Atolaye and C.F. Ogbu, 2006. Some nutritional and functional studies of prosopis Africana. Electron J. Env. Agric. Food Chem., 5(6): 1640-1648.

Audu, O.T., A.O. Oyewale and J.O. Amupitan, 2005. The biological activities of secondary metabolites of *Parinari macrophylla* Sabine. Chem. Class J., 2: 19-21.

Burkill, H.M., 1985. The Useful Plants of West Tropical Africa. 2nd Edn., England: Royal Botanic Gardens, Kew, pp: 636.

Ceirwyn, J.S., 1995. Analytical Chemistry of Foods. Blackie Academic and Professional, London, pp: 71-135.

Cook, J.A., D.J. VanderJagt, A. Pastuszyn, G. Mounkaila, R.S. Glew, M. Millson and R.H. Grew, 2000. Nutritional and chemical composition of 13 wild plant foods of Niger. J. Food Comp. Anal., 13(1): 83-92.

Cook, J.A., D.J. VanderJagt, A. Dasgupta, G. Mounkaila, R.S. Glew, W. Blackwell and R.H. Glew, 1998. Use of the trolox assay to estimate the antioxidant content of seventeen edible wild plants of Niger. Life Sci., 63: 105-110.

FAO, 2007. Protein and amino acid requirements in human nutrition. Report of a joint WHO/FAO/UNU expert consultation. Geneva, Switzerland. (WHO technical report series, 935).

Frederick, R.I., 1961. Woody plants of Ghana. Oxford University Press, London, pp: 868.

Freiberger, C.E., D.J. Vanderjagt, A. Pastuszyn, R.S. Glew, G. Mounkaila, M. Millson and R.H. Glew, 1998. Nutrient content of the edible leaves of seven wild plants from Niger. Plant Foods Hum. Nutr., 53: 57-69.

Glew, R.S., D.J. VanderJagt, R. Bosse, Y.S. Huang, L.T. Chuang and R.H. Glew, 2005. The nutrient content of three edible plants of the Republic of Niger. J. Food Comp. Anal., 18: 15-27.

Kamara, M.T., Z. Huiming, Z. Kexue, I. Amadou and F. Tarawalie, 2009. Comparative study of chemical composition and physicochemical properties of two varieties of defatted foxtail millet flour grown in China. Am. J. Food Technol., 4: 255-267.

Meshach, M. Ige, A.O. Ogunsua and O.L. Oke, 1984. Functional properties of the proteins of some Nigerian oilseeds: conophor seeds and three varieties of melon seeds. J. Agric. Food Chem., 32: 822-825.

National Research Council, 2008. Lost Crops of Africa. Vol: 3, Fruits. National Academies Press. pp: 262-269.

Odoemelam, S.A., 2003. Chemical composition and functional properties of conophor nut (*Tetracarpidium conophorum*) flour. Int. J. Food Sci. Technol., 38: 729-734.

Olaofe, O., F.O. Adeyemi and G.O. Adediran, 1994. Amino acid and mineral compositions and functional properties of some oilseeds. J. Agric. Food Chem., 42(4): 878-881.

Oshodi, A.A. and H.N. Ogungbenle, 1999. Chemical composition, nutritionally valuable minerals and functional properties of Benniseed, pear millet and quinoa flours. Int. J. Food Sci. Nut., 50: 325-331.

Peter, C.A., H. Kristen, W.G. Daniel and B.V. Brodbeck, 1998. Fatty acid and amino acids profiles of selected peanut and breeding lines. J. Food Comp. Anal., 11(2): 100-111.

Radha, C., P.R. Kumar and V. Prakash, 2007. Preparation and characterization of protein hydrolysates from an oilseed flour mixture. Food Chem., 106(3): 1166-1174.

Ramadan, M.F. and J.F. M sel, 2002. Neutral lipids classes of blackcumin (*Nigella sativa* L.) seed oils. Eur. Food Res. Technol., 214: 202-206.

Savage, G.P., 2001. Chemical composition of wallnuts (*Juglans regia* L.) grown in New Zealand. Plant Food Hum. Nut., 56: 75-82.

Taehee, R.K., A. Pastuszyn, D.J. Vanderjagt, R.S. Glew, M. Millson and R.H. Glew, 1997. The nutritional composition of *Boscia senegalensis* (Anza, Dilo) in the Republic of Niger. J. Food Comp. Anal., 10: 73-81.

Tkachuk, R., 1969. Nitrogen-to-protein conversion factors for cereals and oilseed meals. Cereal Chem., 46: 419-423.

Yazzie, D., D.J. Van der Jaget, A. Pastuszen, A. Okolo and R.H. Glwu, 1994. The amino acid and mineral content of baobab (*Adansoina digitata* L.) Leaves. J. Food Comp. Anal., 7: 189-193.

Young, C., 2006. Amino acid composition of three commercial peanut varieties. J. Food Sci., 45(4): 1086-1087.