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Article *in* Pakistan Journal of Biological Sciences · October 2010
DOI: 10.3923/pjbs.2010.1011.1015 · Source: PubMed

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http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 13 (20): 1011-1015, 2010
ISSN 1028-8880

Nutrient Changes and Antinutrient Contents of Beniseed and Beniseed Soup during Cooking using a Nigerian Traditional Method

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Abstract: Evaluations of the effect of prolong cooking on the nutrient and antinutrient composition of beniseed and beniseed soup were carried out in this study. Proximate, mineral, vitamin A and C and antinutrient compositions of raw beniseed (BS-R), beniseed boiled (BSB) for 15, 30, 45 and 60 min and beniseed soup (BSS) cooked for the same intervals of time were assessed. Results of the proximate composition analyses showed that raw and boiled beniseed had lower moisture content (5.39-5.51%) than beniseed soups (10.06-15.20%). Nitrogen-free extract (total carbohydrates), fats and phosphorus contents were improved in both the boiled beniseed and beniseed soup while calcium and potassium were increased in the boiled seeds and soup samples respectively. Moisture (in the raw and boiled beniseed), ash, magnesium, zinc, iron contents in both the seed and soup were unchanged in all the samples. Vitamins A and C levels of both boiled beniseed and beniseed soup samples were reduced with increase in cooking time. Beniseed soup had higher protein contents than both the raw and boiled beniseed which decreased with increase in cooking time. Beniseed samples provided good sources of energy (572.97-666.05 kcal/100 g). Except for phytate, the levels of antinutrients tested were lower in the raw and boiled beniseed than in the soup samples which decreased with increase in cooking time. The results are discussed with reference to the effect of prolonged cooking on the nutrient requirements of consumers.

Key words: Protein, hydrocyanate, phytate, oxalate, minerals, vitamin C

INTRODUCTION

Beniseed, also known as sesame (*Sesame indicum*), is an oilseed cultivated worldwide for its seeds which contain approximately 50% oil of very high quality (47% oleic acid and 39% linoleic acid) and 25% protein especially rich in methionine and tryptophan (Bedigian *et al*., 1985; Ashri, 1989). Biswas *et al.* (2001) reported a value of 47% oil for the seeds. The seeds have been valued throughout history for their contributions to diet (in snacks and as soup ingredient), medicine, industry and household uses (Morris, 2002; Simon *et al*., 1984; Aukland, 1970; Abe *et al*., 2001; Johnson *et al*., 2001). Beniseed is a cherished soup condiment in some parts of Nigeria-Northern States, Middle Belt and parts of Cross River State of Nigeria. The soup is eaten with carbohydrate foods such as pounded yam, garri and other flours made into foofoo. In some of these areas (particularly Obudu Local Government Area of Cross River State) men insist on having the beniseed soup properly cooked for a long time before consumption, else they complain of experiencing painful urination after consumption. Cooking is one of the domestic food processing methods that involve using heat to prepare food for consumption. Soup making involves the application of moist heat method of cooking which employ relatively low temperatures (Fox and Cameron, 1984). Cooking, apart from making food palatable and safe, inactivates practically all the antinutritional factors that are heat labile and improves digestibility and may result in the reduction of available nutrients (Umoh and Bassir, 1981). The nutritional value of a soup varies depending on the ingredients used and nutrient losses recorded during the cooking process. Nutrient losses depend to a large extent on the way by which the cooking is carried out and also on the physical state of the food. For instance, the treatment that the food receives before it is cooked, the time of cooking, the amount of liquid used, the extent to which air is excluded and the time for which food is kept hot before it is consumed, all affect the extent to which nutrients are lost (Fox and Cameron, 1984; Wardlaw, 1999; Potter and Hotchkiss, 2006).

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This study, therefore, aimed at finding out the effects of various cooking times on the nutrient contents of beniseed soup and boiled beniseed. The outcome would contribute to enlightening consumers on the associated public health problems.

MATERIALS AND METHODS

Beniseed were purchased from Obudu main market in Obudu Local Government Area of Cross River State, Nigeria in 2007. It was cleaned of stones, sand and other particles, washed and sun-dried. The seeds were divided into five batches, beniseed raw (BS-R), beniseed boiled (BSB-15, BSB-30, BSB-45 and BSB-60) of 160 g each. Batches BSB-15, BSB-30, BSB-45 and BSB-60 were boiled for 15, 30, 45 and 60 min, respectively using a cooking stove. The boiled samples were dried in a hot air circulating oven (Astell-Hearson) at 70°C for 12 h and then milled in a manual grinder (Corona model) into fine paste. These were stored in the refrigerator for analysis. Also, 640 g each of cleaned, sun-dried seeds were separately ground into paste and used to cook soups using the same recipe for 15, 30, 45 and 60 min, respectively yielding another four batches of cooked beniseed soups.

The beniseed soup was prepared according to the traditional cooking method of the Bette people of Obudu Local Government Area of Cross River State, Nigeria, at various cooking time intervals as previously reported (Agiang *et al*., 2008). The soups were differently homogenized in an electric blender (Kenwood), dried at 70°C in a hot air circulating oven for 24 h and ground into powder. It was then stored in air-tight containers in a freezer (-4°C) until required for analysis. All analyses were carried out within two weeks of sample preparation.

Nutrient and antinutrient analysis: Nutrient compositions were determined in triplicates using the standard methods of AOAC (1993) for proximate, minerals and ascorbate. Determination of vitamin A was adopted from the method of Bessey *et al.* (1946). Hydrocyanate was determined using the AOAC (1993) method, oxalate by the method of Dye (1956) and phytate by the method of MacCance and Widdowson (1935).

Statistical analysis: Data were presented as Mean±SD and the significance of the differences among means was measured by one-way ANOVA and post hoc tests (LSD) of the SPSS Inc. (1995) using the Microsoft (MS) Excel programme at $p<0.05$.

RESULTS

Results of the proximate analyses of raw beniseed, boiled beniseed and beniseed soup are shown in Table 1. Cooking resulted in the reduction of moisture in the soup samples (from 15.20 to 10.06%), protein in both the boiled seeds (from 18.38 to 8.22%) and the soup samples (from 22.75 to 19.40%) with increase in cooking time. There were increases in crude fat contents of both the seed (from 46.10 to 52.01%) and the soup (from 51.30 to 58.30%) with increase in cooking time. The fibre and ash contents of the soup samples were higher ($p<0.05$) than in both the raw and boiled seeds. All the samples had high energy values ranging from 552.78 to 666.05 kcal/100 g. Results of mineral analyses on Table 2 show that calcium was higher in boiled beniseed (929.71-984.58 mg/100 g) than the raw beniseed (750.11 mg/100 g) and beniseed soup samples (665.76-755.10 mg/100 g). These decreases were observed to occur, in the soup samples, with increase in cooking time. All the samples had lower Na ($p<0.05$) compared to the raw beniseed (BS-R) while the soup samples had higher potassium than the raw beniseed and boiled beniseed. Vitamin A was higher ($p<0.05$) in the soup samples (4.17-4.83 mcg/0.3 g) than in the raw beniseed (1.66 mcg/0.3 g) and the boiled beniseed samples (0.54-1.22 mcg/0.3 g) while vitamin C was higher in the raw sample (10.07 mg/100 g) and the boiled seeds (4.56-7.29 mg/100 g) than the soup samples

Table 1: Proximate composition of raw beniseed, boiled beniseed and beniseed soup (% Dry Matter)

	Samples								
Parameters	BS-R	BSB-15	BSB-30	BSB-45	BSB-60	BSS-15	BSS-30	BSS-45	BSS-60
Moisture	5.39±0.11a	5.46±0.07a	5.51±0.11a	5.47±0.07a	5.44±0.12a	15.20±0.50b	14.17±0.29b	12.00±0.50bc	10.06±0.00c
Crude fat	46.1±0.29a	50.75±0.46ab	51.09±0.09ab	51.93±0.09ab	52.01±0.10ab	51.30±3.33ab	52.50±5.63bc	55.80±2.46bc	58.30±0.50c
Crude protein	18.38±0.63ad	16.21±0.07ab	14.35±0.03b	12.94±0.06b	8.22±0.04c	22.75±0.25d	20.42±0.25d	19.84±0.25d	19.40±0.25d
Crude fibre	3.95±0.05a	3.75±0.04a	3.18±0.08ab	2.96±0.08ab	2.62±0.13b	1.11±1.00c	1.05±0.32c	1.05±0.32c	0.91±0.34
Ash	5.13±0.06a	5.02±0.02a	4.99±0.03a	4.97±0.03a	4.97±0.03a	9.83±0.29b	10.19±0.29b	10.67±0.29b	10.33±0.29
NFE	20.98±0.20ab	18.81±0.04a	20.88±0.22ab	21.73±0.57ac	26.74±0.24b	0.02±0.01d	1.69±0.12c	0.64±0.03c	1.30±0.23c
Energy value (kcal/100 g)	572.97±1.10ac	596.83±6.90a	600.73±1.52a	666.05±3.40b	607.93±2.02a	552.78±5.01c	578.44±3.51ac	584.12±2.03ac	604.80±1.44a

Values are Mean±SEM of triplicate determinations, a, b, c: Mean values in each row with different alphabets are significantly different ($p<0.05$), Nitrogen-free extract (NFE) by difference

Table 2: Mineral elements in raw beniseed, boiled beniseed and beniseed soup (mg/100 g)

Samples	Ca	Na	K	P	Mg	Zn	Fe
BS-R	750.11±32.97^{a}	298.77±74.30^{a}	828.43±20.60^{a}	676.39±1.39^{ab}	388.27±43.63^{a}	3.19±0.32^{a}	35.31±0.61^{a}
BSB-15	961.90±23.18^{b}	179.44±6.25^{b}	831.35±30.43^{a}	766.67±27.74^{a}	374.69±14.98^{a}	3.00±0.33^{a}	35.48±1.01^{a}
BSB-30	984.58±2.40^{b}	180.59±5.80^{b}	725.54±5.28^{b}	841.67±4.17^{a}	388.89±9.80^{a}	3.27±0.65^{a}	34.65±1.86^{a}
BSB-45	929.71±38.17^{b}	153.14±8.82^{b}	778.30±13.96^{a}	766.67±6.36^{a}	388.89±7.41^{a}	1.91±0.03^{bc}	35.15±0.52^{a}
BSB-60	946.94±34.05^{b}	186.08±12.92^{b}	664.86±4.57^{b}	785.28±4.47^{a}	395.06±10.50^{a}	2.22±0.28^{ac}	35.68±0.53^{a}
BSS-15	755.10±35.90^{a}	182.33±5.86^{b}	939.25±2.63^{c}	686.11±3.67^{ab}	281.48±3.20^{b}	2.05±0.44^{c}	34.63±0.69^{a}
BSS-30	733.79±31.20^{a}	198.22±13.91^{a}	918.14±28.54^{c}	683.33±22.95^{ab}	247.63±15.05^{b}	2.09±0.37^{ac}	35.98±0.12^{a}
BSS-45	677.55±4.08^{a}	175.97±13.01^{b}	976.18±13.96^{c}	630.55±19.30^{b}	279.61±9.49^{b}	2.48±0.50^{ac}	34.37±0.32^{a}
BSS-60	665.76±13.01^{a}	207.75±12.43^{a}	992.01±13.19^{c}	704.45±37.55^{ab}	258.64±0.18^{b}	3.71±0.18^{a}	35.68±0.12^{a}

Values are Mean±SEM of triplicate determinations, a, b, c: Mean values in each column with different alphabetical superscript are significantly different (p<0.05)

Table 3: Some antinutritional elements in raw beniseed, boiled beniseed and beniseed soup (mg g^{-1})

Samples	Hydrocyante	Total oxalate	Soluble oxalate	Phytate
BS-R	0.14±0.03^{a}	1.66±0.14^{a}	0.84±0.16^{a}	1.83±0.14^{a}
BSB-15	0.14±0.03^{a}	1.53±0.13^{b}	0.79±0.14^{a}	1.79±0.09^{ab}
BSB-30	0.13±0.03^{a}	1.47±0.1^{bc}	0.71±0.10^{a}	1.73±0.04^{ab}
BSB-45	0.14±0.03^{a}	1.42±0.01^{cd}	0.57±0.08^{b}	1.69±0.04^{b}
BSB-60	0.12±0.05^{a}	1.34±0.18^{d}	0.46±0.06^{c}	1.67±0.02^{b}
BSS-15	0.97±0.11^{b}	5.60±0.07^{e}	2.40±0.01^{d}	0.48±0.01^{c}
BSS-30	0.60±0.42^{c}	5.31±0.01^{f}	1.80±0.06^{e}	0.40±0.01^{cd}
BSS-45	0.58±0.37^{cd}	5.10±0.01^{g}	1.50±0.12^{f}	0.39±0.02^{cd}
BSS-60	0.59±0.30^{ce}	4.40±0.01^{h}	1.13±0.04^{g}	0.30±0.04^{d}

Values are Mean±SEM of triplicate determinations, a, b, c: Mean values in each column with different alphabetical superscript are alphabetically different (p<0.05)

Table 4: Vitamins A and C contents of raw beniseed, boiled beniseed and beniseed soup

Samples	Vitamin A (mcg/0.3 g)	Vitamin C (mg/100 g)
BS-R	1.66±0.01^{a}	10.07±0.01^{a}
BSB-15	1.22±0.01^{b}	7.29±0.00^{b}
BSB-30	1.04±0.01^{c}	6.15±0.01^{c}
BSB-45	0.68±0.01^{d}	5.35±0.01^{d}
BSB-60	0.54±0.01^{e}	4.56±0.01^{e}
BSS-15	4.83±0.01^{f}	3.64±0.01^{f}
BSS-30	4.45±0.01^{g}	3.44±0.01^{g}
BSS-45	4.36±0.01^{h}	3.28±0.01^{h}
BSS-60	4.17±0.01^{i}	3.16±0.01^{i}

Values are mean±SEM of triplicate determinations, a, b, c: Mean values in each column with different alphabetical superscript are significant (p<0.05)

(3.16-3.64 mg/100 g), Table 3. These results were affected by increase in cooking time causing a reduction. In general, hydrocyanate was unaffected in raw (0.14 mg g^{-1}) or boiled beniseed (0.12-0.14 mg g^{-1}), but total and soluble oxalate, phytate contents in the samples decreased with increase in cooking time (Table 4).

DISCUSSION

Though beniseed soup is not a watery soup, water forms one of the major components of the soup, thus the higher moisture contents obtained in the study compared to the seed samples. The results of the moisture contents of the seeds, however, were similar to 4.1-6.5 and 4.1% moisture of dry beniseed reported by Oresanya and Koleoso (1990), Achinewhu (1998), 5.8 and 5.4% dry weight by Aukland (1970) and Weiss (1983), respectively. Similar values were reported for groundnut (*Arachis hypogea*), 4.58±0.24% (Onyeike and Oguike, 2003), melon seed, 6.7% (Achinewhu, 1998) and African oil bean seed, 6.5% DM, being oil seeds themselves. The increases obtained in the fat contents of the samples could be attributed to the disruption of the cell structures and membrane partitions of the seeds by heat during cooking causing the fat (oil) to melt and be easily released from the seeds. Also, the palm oil used in the soup preparation as well as the ground beniseed (which would have facilitated release of oil from the seeds) would have caused an increase in fat contents of the soup as observed. These values agreed with the values of 41.3-56.8%, reported by various workers (Weiss, 1983; Bedigian *et al*., 1985; Ashri, 1989; Oresanya and Koleoso, 1990; Achinewhu, 1998; Mayhew and Penny, 1988) for raw beniseed while Biswas *et al.* (2001) reported a higher value of 57%. Denaturation of protein by heat led to the decreases obtained in all the samples with increase in cooking time as earlier stated (Fox and Cameron, 1984; Wardlaw, 1999; Potter and Hotchkiss, 2006). The results showed that moderate cooking for, say, 15 to 30 min of the beniseed or beniseed soup would preserve the proteins. From the study, beniseed or beniseed soup is not a good source of fibre. There was an apparent inverse relationship existing between the levels of lipid and total carbohydrate (NFE) in the soup samples probably due to the high fat content recorded in these samples. The gradual increases obtained in both the boiled seeds and soup agreed with the report of Onyeike and Oguike (2003) on the effect of cooking on the carbohydrate content of groundnut seed, an oil seed. Cooking causes the granules to break down, soften the cellulose and make the starch more available. The energy values of the samples were similar to 563 kcals reported by Weiss (1983) for whole sesame seed and comparing with that of groundnut (605.0 kcals), soybean (452.4 kcals), water melon (576.1 kcals) among others (Oyenuga, 1968). Several authors (Weiss, 1983; Mayhew and Penny, 1988; Bown, 1995; Allardice, 1993) have reported that beniseed is a rich source of vitamin A. Vitamin A contents of beniseed (raw and boiled) and beniseed soup in this study (Table 4) showed a progressive decrease in the vitamin levels with increase in cooking time ($p<0.05$). These losses agreed with the report of Umoh and Bassir (1977a) on vitamin A changes in some traditional Nigerian foods during cooking. Palm oil used in the soup is a good source of vitamin A, hence the observable higher values obtained in the soup. There was considerable loss of vitamin C in the soup samples probably due to oxidative damage to the nutrient during grinding of the beniseed and the shredding of the vegetables used in making the soup (Potter and Hotchkiss, 2006) or prolong cooking (Fox and Cameron, 1984). Cooking resulted in some increases in Ca, P (boiled seeds) and potassium (soup samples). There were, however, some decreases in minerals observed in the boiled beniseed samples probably due to losses through the discarded cooking water used in boiling the beniseed. Beniseed soup is not a liquid soup but a thick soup which gets stuck to the bottom of the cooking pot in the cause of cooking. As observed by Umoh and Basir (1977b), in keeping with the household practice, the cooking utensils were not always rinsed when the soup was removed. It is possible that some quantities of the minerals were lost in this way. This possibly accounted for the lower values obtained for most minerals in the soup samples compared with the seed (both raw and boiled) samples. In all cases, however, the values obtained for the minerals in most of the samples meet the recommended daily requirements for both children and adults (Food and Nutrition Board, 2004).

The concentrations of antinutrients in different foodstuffs may affect their nutritive values. Oxalic and phytic acids are known to precipitate or form insoluble complexes with calcium, magnesium, zinc and iron thus interfering with their utilization. Dietary phosphorus has been shown to bind to inositol to form phytic acid, thereby being unavailable to the consumer except through the activity of phytase (Wardlaw *et al*., 2004; Onigbinde, 2005). The toxic level of soluble oxalate, which is implicated in formation of complexes, is reported to range from 2 to 5 g (Oke, 1966). The results reported here show that beniseed, raw or boiled and beniseed soup, contain low amounts of phytic acid compared with the concentrations of 101.33 and 110.00 mg/100 g DM respectively reported in maize and cowpea (Chakraborty and Eka, 1978). The concentration of hydrogen cyanide in all the samples was low compared with the lethal dose of 50-60 mg for an adult human and the 25 mg/100 g dry matter in peeled plantain and 100-500 mg/100 g dry matter in peeled cassava earlier reported (Chakraborty and Eka, 1978). High dose of HCN pose a serious inhibitory effect on the respiratory chain at cytochrone oxidase level (Onigbinde, 2005). In all, the results showed that the concentrations of the antinutrients in raw beniseed were below toxic amounts and cooking caused further reductions.

CONCLUSION

Nutrient losses depend to a large extent on the way in which the cooking is carried out and also on the physical state of the food. For instance, the treatment that the food receives before it is cooked, the time of cooking, the amount of liquid used, the extent to which air is excluded and the time for which food is kept hot before it is consumed, all affect the extent to which nutrients are lost. In this study, there was considerable loss of some nutrients with longer time of cooking especially protein and vitamin C, though cooking resulted in the reduction of the antinutrients analyzed. However, the levels of nutrients are adequate and compare well with those of other oil seeds.

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