International Journal of Biotechnology and Food Science
Vol. 2(4), pp. 82-87, May 2014
ISSN: 2384-7344
Research Paper

Proximate and functional properties of raw and fermented bottle gourd seed (*Lagenaria siceraria*)

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Accepted 13th April 2014

Abstract. The proximate and functional characteristics of fermented bottle gourd seed used as food condiment were studied. The seeds were fermented at an ambient temperature of 28 ± 2°C for 96 h. The result of the proximate composition shows that moisture, protein and fat content increased from 9.07 to 10.50 g, 6.43 to 7.11 g and 50.56 to 60.64 g for raw and fermented bottle gourd seeds respectively. Significant difference ($P < 0.05$) existed in their proximate composition, except for ash which had no significant difference. The result of the functional properties for the fermented sample showed an increase in the foam capacity, emulsion capacity and foam stability, but opposite effect was observed in the case of wettability, swelling index, gelation and pH. There was a significant difference ($P < 0.05$) in the functional properties of the samples, but shows no significant difference pH of the fermented sample. The result from this study is an indication that a good manipulation can improve the fermented seeds so that they can be more desirable for use as an alternative food condiment in the future.

Keywords: Bottle gourd, seeds, fermentation, proximate.

INTRODUCTION

The bottle ground belongs to the cucurbitceae family, botanically it is called *lagenaria*. It is also referred to as the water jug seed, the calabash gourd, the white flowered gourd, the bottle squash by U.S.A, the doodhi by the Chinese, Lauki and Ghia by the Indian, Labu by the Indonesian's, Hyotan an Yugao by the Japanese, UPO by the Philippians and Ban by the Vietnam (Landsberg, 2010). The cucurbitacea family has about 800 species noted mainly for their usefulness more than a vegetable.

It is a commonly cultivated plant in tropical and subtropical areas of the world, not believed by some to have spread or originated from wild populations in southern Africa. Bottle gourd is a vine grown for its fruits which can either be harvested young or used as a vegetable or harvested when mature, dried and used as a bottle utensil or pipe (Morimoto et al., 2005). The fresh fruit has a light green smooth skin and a white flesh. Round varieties are called calabash gourds. They come in varieties of shapes, sizes, colour and weight. They have moderately hard rind with a thick edible flesh below and central cavity (John and Catheine, 2009). There are numerous seeds in the fruit and they are consumed directly as snack foods in many cultures throughout the world. They are excellent sources of both protein and oil (Christian, 2006; Murkovic and pfannhauser, 2000). It is rich in essential fatty acids, anti-oxidants, vitamins and omega-which is known to promote energy levels, brain functions and overall human vitality (Morimoto et al., 2005). The seeds are highly rich in minerals and protein (Egbekun et al., 1998).

Although fermented foods condiments have constituted a significant proportion of the diet of many people, Nigerians have exhibited an ambivalent attitude in terms of consumers taste and preference for such foods (Achi, 2005). The introduction of foreign high technology product especially processed ones has changed the Nigerian food culture into mixed foods of both foreign and local dishes (Badifu and Ogunsua, 1991). The traditional condiments have not attained commercial status due to their very short shelf life, objectionable packaging materials and characteristic putrid odour (Nwokolo and

Sim, 1999) both suggested that if their condiments could be extended as a food ingredient and fabricated into foods, it will increase their versatility and utility (Egbekun et al., 1998).

Global food security is becoming shaky with increasing dependence on a few major staple crops. This has resulted in an alarming reduction not only in crop diversity but also in the variability within crops. Many indigenous leguminous crops including the bottle gourd *(Lagenaia siceraria)* are under-utilized and are almost going extinct. This is due to preference to other melon varieties, modernity and ignorance. It therefore becomes necessary to discover other ways of utilizing this nutritious food other than using the rind for decoration or bird houses

The research was therefore aimed at improving the usefulness of bottle gourd seed by evaluating the functional, proximate and microbial characteristics of the fermented bottle gourd seeds when used as a food condiment, and also orienting people to know about its desirable quality so as to avoid the seed from going into extinction.

MATERIALS AND METHODS

Bottle gourd seeds (*L. siceraria*) were purchased from a local market at Ose, Onitsha, Anambra State. The seeds were cooked for 8 h at the temperature of 100°C; the seeds were drained and wrapped with tender banana leaves, boiled for another 2 h and allowed to ferment for four days. The seeds were milled and tied with a native leaf called Ofoala" and left for another two days for secondary fermentation during which the flavour develops. The fermentation during which the flavor develops, the fermented samples were then subjected to proximate and functional analysis in comparison with the raw bottle gourd.

Proximate analysis

The standard AOAC (2000) methods were used to determine proximate composition of the samples.

Determination of crude fibre

Using the digestion methods, sample (2 g) of each treatment was digested in a conical flask with 200 ml of 1.25% H_2SO_4 solution under reflux for 30 min boiling. The digest was allowed to cool before filtration, using Buchner funnel equipped with muslin cloth, secured with elastic band thrice. Then residue was washed thrice with hot distilled water, scooped into a conical flask and digested with 200 ml of 1.25% NaOH solution under digest, it was filtered and with the help of distilled water it was washed thrice. Finally the residue was transferred into a clean dry, weighed porcelain dish and dried in the oven at 85°C to constant weight. This immediately was placed in muffle furnace at 550°C for 4 h, withdrawn, cooled in desiccators and weighed. The difference in weight was calculated and reported as crude fiber.

Determination of moisture content

The oven method: Two grams (2 g) of the sample was weighed into a dried metallic crucible of known mass. They were placed into the oven at 105°C for 3 h to dry, withdrawn and placed in a desiccators to cool and were weighed. They were again reheated/ dried cooled, reweighed and reheated. This process was repeated until relatively constant mass realized. The difference in the masses before and after drying was recorded as moisture content.

Determination of ash content

After moisture determination, dried samples were transferred into a muffle furnace for 4 h at 55°C. After which it was cooled in a desiccators, weighed and recorded. The weight of mane rate calculated as ash content.

Determination of crude fat

Each test sample (2 g) was wrapped in a filter paper, weighed and noted. Gradually it was lowered into the thimble, fitted to a flask containing a solvent (hexane). The round bottom flask in the soxhlet extraction unit was slowly heated for 3 h. The filter paper with spent (de-fatted) sample was removed from the extractor and the reflected solvent distilled oil was recovered. The filter paper and spent sample were dried at 85°C and weighed. The difference in mass was calculated as crude fat.

Determination of crude protein

Test samples (0.1 g) each, was weighed into a dried 50 ml digestion flask. A pinch of $CaSO_4$ and Na_2SO_4 mixed in the ratio 1:10 respectively was added and 20 ml of concentrated H_2SO_4 also added for digestion. The flask was placed in a kjeldahl heating digestion stated at about 45% and digested for 30 min or until the black aqueous solution turns light green.

It was cooled to room temperature and transferred quantitatively to a 100 ml volumetric flask. The digestion flask was then rinsed into the digester and its volume made up to 100 ml mark with distilled water. The same procedure was carried out for a blank in the absence of

test sample. The diluted digest (10 ml) was pipette into a distillation flask. Then 10 ml of 2% Boric acid received in a 50 ml beaker and two drops of mixed indicator added to give a brown coloration. The tip of the delivery tube was sure to extend above the surface of the boric acid solution. Then 10ml of 40% NaOH was poured into the distillation flask and distillation unit switched on. Distillation continued until the boric acid solution color changed from brown to blue. The resultant solution was titrated over 0:1 N until an observable color change from blue to pale pink/ peach was noticed. Titre value was noted and recorded then the protein content calculated as:

$$\% \text{ protein} = \frac{(T\text{-}B) \times NHCL \times 0.00014 \times \text{mode volume} \times 100 \times 6.25}{\text{Aliquot} \times \text{weight of sample used}}$$

Where, T = Titre value of the sample, B = Black title value, NHCL= Normality of HCL used.

$$\text{Aliquot} = \frac{\text{Volume of diluted digest used}}{\text{Volume it was made up to 100 = 0.1}} \times 100$$

The same procedure was carried out for each sample.

Analysis of the functional properties

Determination of water absorption capacity

The method of Sosulski (1962) was described by Abbey and Ibeh (1988) and it was adopted. One gram (1 g) of each sample was weighed out into a dry, clean centrifugal tube and both weight noted. 10 ml of distilled water was poured into the tube and properly mixed with the sample to make a suspension. It was then centrifuged at speed of 3500 rpm for 15 mm. After which supernatant was discarded then the tube and its content re-weighed and noted. The gain in weight is the water absorption capacity of the test sample.

Determination of oil absorption capacity

The method of Sosulski (1962) as described by Abbey and Ibeh (1988) was adopted. One gram of each sample was weighed into a dry, clean centrifugal tube and both weight noted. 10 ml of refined vegetable oil was poured into the tube and properly mixed with the flour. The suspension was centrifuged at 3500 rpm speed for 15 min, then the supernatant was discarded, the tube with its content re-weighed. The gain in mass is the oil absorption capacity of the sample.

Determination of swelling index

A portion (3 g) of each flour sample was weighed into a clean, dry, graduated (50 ml) cylinder. The sample gently levelled in the cylinder and the volume noted. 30 ml of distilled water was added to each sample. The swirled cylinder was allowed to stand for 60 min, while the change in volume was recorded every 15 min. The swelling power index of each sample was calculated as a multiple of the original volume (Sosulski, 1962).

Determination of wettability

This as described by Onwuka (2005) was adopted. One gram of each sample was placed in a clean, dry, measuring cylinder (10 ml). Placing a finger over the open end, the cylinder was inverted and clamped at a height of 10 cm from the surface of a 500 ml beaker containing 500 ml of distilled water. The sample in the cylinder was gradually spread on the surface of the water on moderate speed. The time taken for each sample to be completely wet is noted as wet ability.

Determination of gelling and boiling points

The method of Narayana-Rao (1982) was adopted. The sample (10 g) was dispersed in distilled water, in a 250 ml beaker and made up to 100 ml. A thermometer was clamped on a retort stand with its build submerged in the suspension. With a magnetic stirrer the suspension was continuously stirred and heated. This continued until the suspension began to gel and the corresponding temperature recorded. The temperature as soon as boiling commence was also noted and recorded.

Determination of foam capacity

The method as described by Onwuka (2005) was adopted in the determination of foam capacity. Test sample in 100 ml distilled water and its volume noted. The suspension was blended with a warming blender 1600rpm for 5min. It was then poured into a 250 ml measuring cylinder, its volume noted and recorded.

Using Abbey and Ibeh (1988) formula, foam capacity expressed percentage increase in volume is as follows:

$$\text{Foam capacity} = \frac{\text{Volume after whipping - volume before whipping}}{\text{Volume before whipping}} \times 100\%$$

Determination of emulsion capacity

The procedure of Beuchat et al. (2000) as described by Eke (2002) was adopted. The sample (2 g) and 75 ml of distilled water were blended for 30 s using a magnetic stirrer.After complete dispersion, refined vegetable oil was added continuously through a burette until emulsion break point, separation into two layers was reached. The

Table 1. Proximate composition of raw and fermented bottle gourd seeds (*Lagenria siceraria*).

Parameters	Raw seed (%)	Fermented seed (%)
Moisture	9.07 ± 0.15^{a}	27.35 ± 0.20^{b}
Ash	3.90 ± 0.10^{a}	3.78 ± 0.17^{a}
Fat	40.56 ± 0.21^{a}	42.88 ± 0.99^{b}
Protein	25.24 ± 0.22^{a}	26.81 ± 0.50^{b}
Fibre	2.86 ± 0.12^{a}	2.29 ± 4.37^{b}
NFE	15.89 ± 4.37^{a}	13.45 ± 0.95^{b}

Table 2. Mineral composition of raw and fermented bottle gourd seed (mg /100 g dry matter).

Parameters	Raw seeds	Fermented seeds
Calcium	48.26^{a}	48.42^{a}
Potassium	118.22^{a}	113.12^{b}
Sodium	52.04^{a}	51.24^{a}
Magnesium	56.74^{a}	56.80^{a}
Manganese	15.08^{a}	13.02^{b}
Iron	12.88^{a}	11.76^{a}
Copper	5.12^{a}	4.82^{a}
Lead	1.22^{a}	0.89^{b}
Zinc	19.43^{a}	20.02^{a}
Phosphorus	94.24^{a}	94.20^{a}

emulsion capacity was expressed as ml of oil emulsified per gram of sample.

RESULT AND DISCUSSION

The result show that the crude protein of the fermented samples was higher (26.81 ± 0.50%) than that of the raw sample (25.24 ± 0.22%) and significant difference existed between the two samples at $P < 0.05$. A net synthesis of enzymic protein during fermentation may possibly account for the reported protein increase (Kylen and McGeady, 1995; Fordhan et al., 1995; Enujiugha, 2003; Odibo, et al., 1990). The values of the crude protein in raw seed flour samples were in agreement with the findings of Fokou et al. (2004), and compare well with 28.66% obtained for *C. sativas* (Achu et al., 2005), cashew nut (22.8%), cotton seed (21.9%), sesame (18.7%) (FAO, 1982). Therefore, the seeds can be used as alternative sources of protein in diets (Chinyere et al., 2009). The fat content increased significantly from (40.56 ± 0.21%) in raw sample to (42.88 ± 0.99%) in fermented sample at $p < 0.05$. The fat content of the raw bottle gourd seeds can be compared to that of groundnut (47.5%) (Uddo, 1980), and fluted pumpkin seed (47.5%) (Asiegbu, 1981).

Fermentation increased the moisture content of the sample from (9.07^{a} ± 0.15%) in raw sample to (27.35^{b} ± 0.2%) in fermented sample. The moisture content of the fermented sample agrees with Odunfa (1981a) who reported that 'ogiri' is an oily paste produced mainly from melon seeds. Ash content was reduced from 3.90% in raw seed to 3.78% after fermentation, and there was no significant difference ($P < 0.05$) between the samples. Crude fibre of the sample reduced from 2.86 to 2.29% for raw and fermented bottle gourd seed respectively and significant difference existed between them ($P < 0.05$).These values were similar to those obtained by Silou et al. (1999) for melon from Nigeria (2 to 5%) and peanuts (2.78%). Loukou et al. (2007) also reported crude fibre of 2.30 to 2.94% for melon species. Crude fibre contains indigestible material which enhances easy movement in the large intestine, prevents constipation and stimulates peristalsis of bottle gourd (*Lagenaria siceraria)* seeds.

Table 2 shows the mineral composition mg/100 g of both the raw and fermented samples. Potassium was found to be the most abundant mineral element (198.5 mg/100 g) in the seed flour sample followed by phosphorus, magnesium and calcium. Similar observation was reported for two varieties of *L. siceraria* seed flours (Ogunbusola, 2008). The highest value of potassium agreed with the observation that potassium was the most predominant mineral in Nigerian agricultural products (Olaofe et al., 1988). Copper, manganese, were generally low in the seed flour. The Na/K ratios in both raw and fermented samples (0.44 and 0.45) respectively is less than 1. The seed flour would probably reduce high

Table 3. Results for the functional properties of the raw and fermented bottle gourd seeds (*Lageneria siceraria*).

Parameters	Raw seeds	Fermented seeds
Foam capacity (%)	2.17 ± 0.29[a]	6.17 ± 0.29[b]
Foam stability (%)	115.00 ± 1.00[a]	132.67 ± 0.58[b]
Emulsion capacity (%)	40.00 ± 0.50[a]	53.11 ± 1.52[b]
Wettability (sec)	5.00 ± 1.00[a]	3.00 ± 0.00[b]
Swelling index (ml)	15.00 ± 0.50[a]	4.17 ± 0.29[b]
Gelation (°C)	58.17 ± 0.29[a]	22.17 ± 0.29[b]
pH	6.60 ± 0.10[a]	7.04 ± 0.00[a]

blood pressure. The Ca/Mg weight ratio obtained in the raw and fermented seed flours (0.85 and 0.87 respectively) is low compared with the recommended ratio of 2.2 (NRC, 1989). This may be due to the low calcium content of both the raw and fermented seed flours. Supplementation with calcium may be necessary if the seed is to be used for diet formulation particularly as weaning food.

Functional properties

Table 3 shows the results of the functional properties of the bottle gourd seed, and it was observed that fermentation increased the emulsion capacity of the seed from 40.00 to 55.33% for raw and fermented samples respectively. Emulsion capacity of the raw bottle gourd seed can be compared to the loofah bottle gourd seed (41.20 g/100 g).

Fermentation decreased the gelation point for the first and second boiling (58.17 to 22.12%) and (80 to 35%) respectively. The values obtained suggest that raw flour of the seeds can be useful in food system such as sausage emulsion and soup thickening. There was a decrease in swelling index from 15 ml in the raw seeds to 4.17 ml in the fermented seeds. This could be attributed to the fact that the raw seeds have more of inter molecular starch bound which allowed it to absorb water and swell (Ampe et al., 1992), as the statistical analysis showed there was significant difference between the two samples at $P < 0.05$. The foaming capacity of the sample flour increased from 2.17 to 6.175% after fermentation. Their pH increased from 6.60 ± 0.10 to 7.04 ± 0.00 for raw and fermented samples respectively while wettability decreased from 5 to 3 s.

CONCLUSION

The findings of this study revealed that bottle gourd seeds can be utilized for ‘ogiri’ production while the rind used decoration. The effects of fermentation on the proximate and functional properties of this lesser known bottle gourd seed also gave an indication that the potentials of the seeds are yet to be harnessed; therefore, cultivation and exploitation of the seeds should be encouraged as an alternative source of food for the future.

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