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Functional Properties of Four Cucurbits Found in Nigeria

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Abstract: The functional properties of four cucurbits grown in Nigeria namely, snake tomato *Trichosanthes cucumerina*, cucumber *Cucumis sativus*, pumpkins *Cucurbita pepo* and *Cucurbita moschata* were investigated. The effects of pH and NaCl concentrations on some of these functional properties were also determined. The highest water absorption capacity was observed in *Cucurbita pepo* (4.80 g/g) and *Trichosanthes cucumerina* as lowest (1.80 g/g). Similarly, *Cucrubita pepo* had the highest oil absorption capacity (1.10 g/g) and *Trichosanthes cucumerina* had the least (0.17 g/g). The samples had good gelation capacity. *Cucurbita pepo* gave the highest gelation at (6.67%) and *Trichosanthes cucumerina* gave the least at (12.67%). *Cucumis sativus* showed the highest emulsification capacity (6.5 g/g) and *Trichosanthes cucumerina*, the lowest at (4.2 g/g). NaCl and pH influenced the emulsification capacity. The samples did not show any remarkable percentage volume increase in the foaming capacity and pH and NaCl did not influence the foaming capacity. The sample showed that they could be utilized in the formulation of new foods.

Key words: Cucurbits, emulsification, foaming, functional properties, gelation, water absorption

INTRODUCTION

The samples, Snake tomato *Trichosanthes cucumerina*, cucumber *Cucumis sativus*, Pumpkins *Cucurbita pepo* and *Cucurbita moschata* belong to the cucurbita family. The family cucurbitaceae in Nigeria is of considerable economic importance. Certain genera such as Telfaria, Cucurbita, Citrullus are commonly cultivated in southern Nigeria since their fruits or leaves constitute important items in the local diet. Other genera are significant as oil plants, medicinal plants, sources of tanning materials, sponges and household utensils (Okoli, 1984). Most of the Nigerian species are wild but a large number are cultivated. The cucurbitaceae have perhaps more species in cultivation than any other family in Nigeria and are used for diverse purposes in different parts of the country. They occupy a special place in the life and culture of many ethnic groups (Okigbo, 1975; Dahlgren, 1980; Okoli, 1984; Gill, 1988). The gourd family, most of which are tendril climbing herbaceous annuals contains some extremely well known edible fruits such as pumpkin, squash, cucumber, musk melon and water melon. Botanically, there is no distinction between squashes and pumpkins, since both pumpkins and squashes are found in four species namely *Cucurbita pepo*, *C. Moschata*, *C. Mixta* and *C. Maxima* (Weber *et al*., 1996; Paksoy and Aydin, 2004; Milani *et al*., 2007). Cucurbitaceae seeds are relatively rich in oil and are present in large quantity in the fruits but they have considerable little importance as commercial oil seeds (Vanghan, 1970; Achu *et al*., 2005; Mariod *et al*., 2009; Chang Chew *et al*., 2010). The type of food the cucurbits are used for vary from specie to specie, some are used for salads like *Cucumis sativus* or cooked with other things and eaten as delicacy such as *Cucurbita pepo* and *Cucurbita moschata* while *Trichosanthes cucumerina* is used for thickening stew. So many of the cultivated species of cucurbits are edible and are rich in proteins, oil and minerals (Oyenuga, 1968). Since these cucurbits have shown to contain various nutrients, it is expected that they should be versatile in food formulation. However, there has been little or no information in literature of how these cucurbits have been utilized. The objective of this study is to assess the functional properties and nutritive value of these four cucurbits and their systematic utilization in the formulation of new foods for adults and babies alike.

MATERIALS AND METHODS

Cucumis sativus, *Cucurbita pepo* and *Curcurbita moschata* were purchased from Igwurita market in Ikwerre Local Government Area of Rivers State, Nigeria. The *Trichosanthes cucumerina* was obtained during field trips to Ogbogoro farms in Obio/Akpor Local Government Area of Rivers State.

Sample preparation: The cucurbits were washed and their rind discarded. The samples were then cut into slices and dried to a constant weight at 105°C for 48 hrs. The dried samples were then ground into powder and put in dried air tight containers and stored in a cool dry place.

Functional properties determination

Water and oil absorption capacity determination: The method of Beuchat (1977) was used with slight modification. 1 gm of the dried sample was mixed with 10 ml of distilled water and 10 ml of golden soya bean vegetable oil, separately for 60 sec, by hand shaking.

The samples were then allowed to stand at 25°C for 30 min and centrifuged at 5000 rotations per minute for 30 min. The volume of the supernatant in a 10 ml graduated cylinder was noted. Density of water was assumed to be 1 g/ml and that of oil was determined to be 0.92 g/ml.

Gelation capacity determination: Gelation capacity was measured by the Least Concentration End Point (LCE). This method was described by Briskey (1970) and Coffman and Garcia (1977). Sample suspension of 2-20% (w/v) were prepared in 5 ml distilled water. The test tube containing these suspensions were then heated for 1 hr in a boiling water bath. This was followed by rapid cooling under running cold tap water. The test tubes were then further cooled for 2 hrs at 4°C. The strength of the coagulum was evaluated by investigating the test tubes. The lowest concentration of protein which formed a stable gel and which remained inverted in the tube was termed the gelation end point.

Emulsion capacity determination: Emulsions were prepared according to the method of Swift and Sulzbacher (1963) and Beuchat (1977). Sample weight of 1 g was dispersed in 50 ml of water and 2 drops of methyl orange added to the dispersion before blending for 30 sec in a Philips blender at 1600 rpm. After complete dispersion, golden soya vegetable oil was added continuously in 5 ml portions from a 50 ml burette. Blending continued until emulsion break point, a separation into two layers was reached, (the presence of the methyl orange facilitates a fast detection of the inversion point). Emulsification determinations were carried out at 25°C and the value expressed as grams of oil per gram of sample. Effects of NaCl concentration on emulsion capacity were determined on 2% (w/v) slurries at a concentration range of 0.2 to 1.0%. Effects of pH on emulsion capacity were also investigated on 2% (w/v) slurries by adjusting the pH to a desired value with 0.1M HCl or 0.1M NaOH prior to preparing emulsions.

Foaming capacity/stability determination: This was determined by the method of Coffman and Garcia (1977). 1 g of sample was whipped with 50 ml distilled water for 5 min in a Philip blender and poured into a 250 ml graduated cylinder, the total volume at time intervals of 0-36 hrs was noted.

Volume increased (%) was calculated according to the following equation:

$$\frac{\text{Volume after whipping} - \text{Volume before whipping}}{\text{Volume before whipping}} \times 100$$

Effect of concentration on foaming were evaluated by whipping 2-10% (w/v) slurries as described above. The effect of salt NaCl concentration of 0.2-2% were investigated. The effects of pH on foaming properties were studied with 2% (w/v) slurries too. The pH was adjusted to a desired value with either 0.1M HCl or 0.1M NaOH prior to whipping. All the experiments were conducted at 25°C.

Statistical analysis: Each experiment was repeated three times. The results were presented with their means and standard deviation using Microsoft Excel 2007.

RESULTS AND DISCUSSION

Foaming capacity: The samples did not show any remarkable increase in the foaming capacity. NaCl and pH did not influence the foaming capacities.

Table 1: The water and oil absorption capacities of the Cucurbita samples. (Results are expressed in gram of water and oil absorbed per gram of sample)

Sample	Water absorbed (g/g)	Oil absorbed (g/g)
Trichosanthes cucumerina	1.80±0.00	0.17±0.01
Cucumis sativus	3.20±0.01	0.74±0.01
Cucurbita pepo	4.80±0.01	1.10±0.01
Cucurbita moschata	4.30±0.05	0.87±0.01

Results are means of three determinations ± SD (standard deviation)

Table 2: The gelling capacity of the Cucurbita samples (Result on a dry weight basis)

Samples	Least gelation in percentage w/v
Trichosanthes cucumerina	12.67±0.04
Cucumis sativus	12.00±0.00
Cucurbita pepo	6.67±0.47
Cucurbita moschata	8.00±0.00

Results are means of three determinations ± SD (standard deviation)

Table 3: The emulsion capacity of the Cucurbita samples. The result is expressed in gram of oil per gram of sample

Samples	Oil emulsified g/g
Trichosanthes cucumerina	4.20±0.12
Cucumis sativus	6.50±0.05
Cucurbita pepo	4.69±0.10
Cucurbita moschata	4.63±0.05

Results are means of three determinations ± SD (standard deviation)

The results of the water and oil absorption are shown in Table 1. *Cucurbita pepo* showed the highest water and oil absorption capacities (4.80 g/g and 1.10 g/g) respectively, *Cucurbita moschata* (4.30 g/g and 0.87 g/g) respectively, *Cucumis sativus* had water and oil absorption capacity (3.20 g/g and 0.74 g/g) respectively and the least water and oil absorption capacities were observed for *Trichosanthes cucumerina* (1.80 g/g and 0.17 g/g) respectively. The water absorption capacity of the samples were higher than the oil absorption capacity. Abbey and Ibeh (1988) had similar result in their work with heat processed cowpea flour where the water absorption capacity was also higher than the oil

Table 4: The effect of salt (NaCl) concentration on emulsification capacity of the cucurbita samples (oil emulsified g/g)

	Concentration of NaCl (gm)				
Samples	0.2	0.4	0.6	0.8	1.0
Trichosanthes cucumerina	5.70±0.14	5.61±0.10	5.61±0.10	5.06±0.10	4.88±0.00
Cucumis sativus	7.45±0.10	6.44±0.00	6.62±0.14	6.44±0.00	6.50±0.03
Cucurbita pepo	5.70±0.14	6.62±0.14	2.90±0.10	2.90±0.10	2.80±0.04
Cucurbita moschata	5.61±0.10	5.52±0.00	2.76±0.00	2.90±0.10	2.90±0.10

Results are means of three determinations ± SD (standard deviation)

Table 5: Effects of pH on emulsification capacity of the cucurbita samples (oil emulsified g/g)

	pH			
Samples	4	6	8	10
Trichosanthes cucumerina	4.60±0.00	5.52±0.00	6.44±0.00	7.54±0.10
Cucumis sativus	6.44±0.00	7.36±0.00	9.29±0.00	9.70±0.00
Cucurbita pepo	7.54±0.10	8.37±0.10	9.38±0.10	11.32±0.00
Cucurbita moschata	7.42±0.05	7.45±0.10	9.26±0.10	9.48±0.00

Results are means of three determinations ± SD (standard deviation)

absorption capacity. From the results, the samples have the ability to swell thereby increasing their bulk, enhancing flavour retention and improving mouth feel. Though Del-Rosario and Flores (1981) showed that fat and water absorption capacities improved with increased protein content, which could be attributed to the increased capacity of the flour to hold the fat globules as the amount of lipophilic proteins increases. It was not exactly the case for *Cucurbita pepo* and *Cucumis sativus Cucurbita pepo* had lower protein content than *Cucumis sativus* but the former had higher oil and water absorption capacities than the latter. The alterations could be attributed to the quality of the protein in the samples (Del-Rosario and Flores, 1981; Ogunjimi *et al*., 2002). The fat binding capacity of the protein is required in ground meat formulations, doughnuts, pancakes baked goods and soups (Sosulski *et al*., 1976).

Gelation: Table 2 showed the gelation capacity of the various cucurbits. The least gelation concentration (w/v) for the cucurbits are *Trichosanthes cucumerina* 12.67% *Cucumis sativus* 12.00%, *Cucurbita moschata* 8.00% and then *Cucurbita pepo* 6.67%.

Abbey and Ibeh (1988) showed the least gelation concentration for the raw and heat processed cowpea flour to be 16% and 18% (W/V) respectively.

Gelation is an aggregation of denatured molecules. The differences in the gelling properties could arise from the relative ratio of the different constituents - proteins, carbohydrates and lipids that make up the sample. It is possible that besides protein concentration, other constituents probably starch contribute to the gelling capacity as was reported to mung bean flours by (Del-Rosario and Flores, 1981).

Foaming properties: The various cucurbit samples analyzed did not show any remarkable increase in the foaming capacity of the samples when effects of pH, sodium chloride were tested. This could be attributed to the samples containing more carbohydrate than proteins in solution reduce surface tension of the water and aid in the formation of food foams.

Lin *et al*. (1974) also correlated foam stability with the amount of native proteins present. The samples can not be used as better aerating agents in whipped toppings, frozen deserts, confection and ice creams.

From the work of Abbey and Ibeh (1987), introduction of carbohydrate to raw and heat processed brown bean flour reduced the foaming capacity of their samples.

Emulsification capacities: Table 3, 4 and 5 showed the emulsification capacities of the various cucurbits with *Cucumis sativus* having the highest emulsification capacity (6.50 g/g followed by *Cucurbita pepo* (4.69 g/g) then *Cucurbita moschata* (4.63 g/g) with *Trichosanthes cucumerina* having the least (4.20 g/g). Salt concentrations 0.2% and 0.4% increased the emulsification capacities decreased as the salt concentrations was increased from 0.6% to 1%.

Effect of pH on emulsification capacities was also determined and the emulsification capacities increased with increase in pH. These results obtained are I agreement with what has been reported for cowpea (Abbey and Ibeh, 1988).

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