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Comparative chemical analysis of Cucumeropsis edulis and Adenopus breviflorus as affected by heat treatment

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Target Audience: *Researchers, Farmers, Animal nutritionists*

Abstract

Adenopus breviflorus is a perennial climber; it has the potentials to serve a dual purpose of being used as a protein supplement. This research was undertaken to compare the chemical composition of the raw and cooked Cucumeropsis edulis (edible) and Adenopus breviflorus (wild). The results of the proximate composition for the raw and cooked samples of Cucumeropsis edulis were crude protein (10.2 3±0.03% and 6.92 ± 0.08%), ether extract (2.43 ± 0.03% and 2.13 ± 0.09%), crude fibre (11.80 ± 0.16% and 31.8 ± 0.15%) and ash 8.23± 0.14% and 9.60 ± 0.20%) while those for A. breviflorus were crude protein (17.29 ± 0.15% and 9.89 ± 0.13%), ether extract 2.53 ± 0.15% and 1.40 ± 0.06%), crude fibre (29.95 ± 0.52% and 21.8 ± 0.12%) respectively. Sodium, Potassium and Magnesium content were higher in the raw C. edulis and Adenopus breviflorus samples. The levels of anti-nutrient substances (hydrocyanic acid, oxalate, phytic acid were higher in the raw than in the cooked samples of both cucurbits. Cooking brought about a reduction of 41.9% in phytic acid content in the pulp of A. breviflorus, while hydrocyanic acid had the least percentage decrease of 12.6% in the pulp of A. breviflorus.

Key words: *Cucumeropsis edulis, Adenopus breviflorus, Anti-nutrient, Chemical analysis*

Description of Problem

Plant proteins play an important role in both human and animal nutrition. Developing countries are saddled with the problem of low protein intake among its populace. This low protein intake has led to the constant search for lesser known unconventional legumes as new sources for use both as functional food/feed ingredients and nutritional supplement (1). Most vegetables and cereals which are of plant origin contain protein, though some of the proteins are of low quality or may be low in one or two essential amino acids.

Over the years the use of plant protein isolate like soya bean has been on the increase thus causing a hike in the total cost of the product. When compared to other vegetables which are less used, the Cucurbitaceae is among the more important plant families that supply man with edible product and useful fibre. Their importance varies with respect to agroecological, socio-economical characteristics and feeding habit of each region. They are generally cultivated for their fruits and oily seeds most times. curbitaceae family includes some of the world's most important vegetables, (2) which also make up the largest group of summer vegetable crops. Their fruits are very useful in terms of human health. i. e, purification of blood, relief of constipation, good for digestion and release of energy (3). Several studies have revealed that the fruit of cucurbits plants contain B-carotene which is very essential in the treatment of vitamin A deficiency (4).

Adenopus breveflorus Benth has the

potentials to serve a dual purpose as a protein supplement and also as an organic folk medicine (5). The medicinal importance of this plant lies in its phytochemical components mostly alkaloids, tannin, flavonoid and phenolic compounds which produce definite physiological actions on the human or animal body (6) and for wood protection (7).

The plant is found in the temperate climate and can also thrive in the Tropical zones, different tribes in Nigeria identify the plant Adenopus breveflorus as “Ogbenwa” in Igbo, “Tagiri” in Yoruba and “Ndiseekpo in Ibibio. It is a perennial climber ascending to the forest canopy (8). The leaves are extremely scabrid and sandpapery while the fruits are dark green with creamy blotches and are ovoid and about 9cm long. The seeds and the fruits have been long used in traditional medicine as herbal remedy for the treatment of measles, digestive disorders and antiseptics for wound in man, and also very valuable to livestock farmers for the treatment of Coccidiosis and Newcastle disease in various animal species especially in poultry (9).

Cucumeropsis edulis (Squash) is one of the oldest known cultivated species, indigenous to Mexico (10). Neel et al (11) described C. edulis as an annual creeping or climbing plant with – angled stems up to 15m long, the leaves are cordate at the based lobed. The fruit is gigantic with an average weight of 100g -1200g depending on the size of the fruit. It grows as a large annual vine, which is cultivated for human consumption; it supplies the body with carbohydrates, soluble fibre, pro-vitamin A and protein. The vine and fruit are used as fodder.

Materials and Methods

Collection of samples

The Adenopus breviflorus (Benth.) fruits used for this study were picked in the bushes around Ediba community in the Calabar Municipal Local Government Area of Cross River state Nigeria. The Cucumeropsis edulis used were bought from two popular local markets in Calabar, and both samples were taken to the crop science laboratory of the University of Calabar, Calabar for proximate analysis.

Treatment of sample

The fruits of the wild melon Adenopus breviflorus (Benth.) and Cucumeropsis edulis were washed with clean water and mechanically cut into tiny pieces, part of the Adenopus breviflorus and Cucumeropsis edulis were boiled separately using electric stove for 40 minutes, each part of the cooked and uncooked Adenopus breviflorus and C. edulis were dried separately in an air circulating oven and later ground with a blender and stored in an air tight container from where required amount was taken for proximate and phytochemical analysis.

Proximate analysis

The different samples were subjected to proximate chemical analysis by the standard method laid down by the Association of Official Analytical Chemist A.O.A.C. (12). Moisture was determined by drying the fresh samples to constant weight at 80^0C in air circulating oven.

Ash was determined by incinerating the sample in a muffle furnace at 500 – 600^0C. Ether extract was estimated by the exhaustive extraction of the dry samples with petroleum ether 40 – 60^0C using Soxhlet apparatus. Crude fibre was obtained from the loss in weight on ignition of dried residue remaining after digesting of fat-free sample with 1.25% H_2 SO_4 and 1.25% NaOH solution under specific conditions.

Estimation of mineral elements

The mineral elements were estimated in

the Central laboratory of the University of Uyo. The determination of calcium, zinc, magnesium was carried out using atomic absorption spectrophotometer (PYE UNICAM, 20900). Sodium and potassium were determined using the flame photometer A.O.A.C. (12). Phosphorus was determined colorimetrically by the use of the ammonium vanadate.

Estimation of hydrocyanic acid

Determination of hydrocyanic acid in Cucumeropsis edulis and A. breviflorus. The cyanide content of both samples was determined by the amount of HCN released on hydrolysis. Extract of both samples of Cucurbita edulisand A. breviflorus obtained by homogenizing 30g of each of the samples in 259ml of 0.1M orthophospuric acid for 5 minutes. The homogenate was centrifuged at 2,500 rpm for 20 minutes and clear supernatant was obtained. An alliquot of the supernatant was taken for determination of hydrogen cyanide using an auto analyzer Technicon AAII, according the method of Roa and Hahan (13).

Determination of phytic acid

Phytic acid composition was analyzed according to Wheeler and Ferrel (14) by using 2.0g of dehydrated sample each. A standard curve was constructed and expressed the results as Fe $(NO_3)_3$equivalent. The amount of phytate phosphorus content was calculated from the standard curve by assuming the 4:6 iron to phosphorus molar ratio.

Determination of oxalate

To determine oxalate in each of C. edulis and A. breviflorus, the samples were separated into two fractions using the following procedure: 2g of finely ground samples of Cucumeropsis edulis and A. breviflorus each were extracted with 100 ml of boiling distilled water for 30 minutes, each was filtered and adjusted to 200ml The content of oxalate in the two fractions were analyzed based on the method of AOAC (12) with 10 ml of potassium permanganate for titration. All the analyses were carried out in triplicates and the result calculated and expressed on dry weight basis.

Results and Discussion

Proximate Composition of A. breviflorus and C. edulis

Results of the proximate composition of the experimental edible and wild melon are presented in Table 1.

Table 1: Proximate composition of the pulp of Cucumeropsis edulis and A. breviflorus (Benth)* (sample in %percentage dry weight)

Parameters	C. edulis (raw)	C. edulis (cooked)	A. breviflorus (raw)	A. breviflorus (cooked)
Moisture %	94.39 ± 0.07	*b	93.86 ± 0.04	*b
Ash %	8.25 ± 0.14	9.60 ± 0.20	8.33 ± 0.67	7.60 ± 0.10
Ether Extract %	2.43 ± 0.16	2.132 ± 6.93	2.53 ± 0.15	1.40± 0.60
Crude Protein %	10.23 ± 0.16	6.92 ± 0.08	17.29 ± 0.15	9.89 ± 0.13
Crude Fibre	11.80 ± 0.16	31.8 ± 0.15	29.95 ± 0.52	21.8 ± 0.12

*a Mean and standard error of three determinations
*b Moisture content was not determined for the cooked C. edulis and A. breviflorus

The moisture contents on fresh weight basis for the pulp of raw C. edulis and A. breviflorus were 94.39±0.07?mg/100g and 93.86±0.04 mg/100g respectively. The values obtained for the pulp agree with the report of (15) that most fleshy fruits have high moisture content which aids in digestion and acts as a solvent in chemical reactions in the body system. The high moisture concentration corroborates the reports of 96.4 and 97.8% by (16) and (17) respectively for Cucumis sativus (cucumber), which also belongs to the Cucurbitaceae family. Moisture content has an effect on the stability and quality of foods. The ash contents of the raw and cooked C. edulis were 8.25 ± 0.020% and 9.60 ± 0.020% respectively, while that obtained for the raw and cooked A. breviflorus were 8.33 ± 0.67% and 7.60 ± 0.10% respective. The values reported are higher than values of 2.00% and 1.00% reported for raw and fermented samples of A. breviflorus respectively (18). Cooking increased the ash content slightly in the C. edulis, while it brought about a slight reduction in the amount of ash content in A. breviflorus. The ash content is a reflection of mineral portion analyzed which in turn varies with the locality or soil type. The ether extract contents of the raw and cooked C. edulis were 2.43± 0.03% and 2.13± 0.9% respectively, while that obtained for raw and cooked A. breviflorus were 2.53% and 1.40 ± 0.06% respectively. These results are comparable with those obtained (18) which were 3.75± 0.03% and 2.88± 0.02% for raw and fermented A. breviflorus respectively. Cooking did not increase the amount of ether extract in C. edulis but there was a slight decrease from 2.53± 0.15% to 1.40± 0.06% for the cooked sample of A. breviflorus. The crude protein content of the raw and cooked C. edulis were 10.230 ± 0.15 and 6.92 ± 0.08% respectively, while A. breviflorus had 17.2 ± 0.15% and 9.89 ± 0.13% respectively. The result in this study for raw Adenopus breviflorus corroborates that of 18) (17.60±0.20 %) but lower than 30.44% reported by (19). Cooking resulted in a substantial reduction in the amount of protein from 10.23 ± 0.16%g in the raw to 6.92 ± 0.08% in the cooked C. edulis and17.29 ± 015% in the raw to 9.89 ± 0.13% in the cooked A. breviflorus. The decrease in protein content for the cooked A. breviflorus in this study contradicts increase in protein content documented by (18) for fermented A. breviflorus. This decrease in the protein content of the cooked samples could be as a result of leaching of the nitrogenous compounds into the water that was used in cooking, excessive heating may reduce the nutritive value of protein. The crude fibre content of raw and cooked C. edulis were 11.80 ± 0.16% and 31.8± 0.15% respectively while A. breviflorus has values of 29.95 ± 0.52% and 21.8 ± 0.12% respectively. This report is in the same range with 24.50% ± 0.05% and 21.50± 0.03% for raw and fermented A. breviflorus respectively (18). The biological and hence nutritional significance of the crude fibre is not clear and not precise. The physiological role of fibre is to maintain an internal distention for normal peristaltic movement of the intestinal tract, higher amount of fibre in a feed shows readiness for water absorption, a better appetite and a more rapid rate of passage. A diet lower in fibre may cause constipation (20).

Mineral element composition

The mineral composition of C. edulis and A. breviflorus (Benth) is presented in Table 2. The raw and cooked forms of C. edulis contain considerable amounts of minerals (sodium, potassium, magnesium, calcium, phosphorous and zinc).

Table 2: Elemental composition of Cucumeropsis edulis and Adenopus breviflorus (Benth) in mg/100gm

Parameters	C. edulis (raw)	C. edulis (cooked)	A. breviflorus (raw)	A. breviflorus (cooked)
Sodium	4250	1250	1250	1500
Potassium	1800	1300	7500	6250
Magnesium	64.98	32.46	46.09	36.52
Calcium	460	430	370	375
Phosphorus	18.38	27.53	223.51	18.47
Zinc	3.59	6.33	7.75	5.50

The result showed that sodium was the most abundant mineral in the raw and cooked forms of both C. edulis and A. breviflorus. Zinc and phosphorous had low values. The value of 4250mg/100g and 1250mg/100g were obtained in this study for the raw and cooked C. edulis respectively, also the value of 1250mg/100g and 1500mg/100g were obtained respectively for the raw and cooked A. breviflorus. Cooking reduced all the mineral elements in both the raw and cooked Cocurbita edulis and A. breviflorus except for sodium and calcium in the A. breviflorus. Large quantities of sodium and potassium were present in the fruit of the raw and cooked C. edulis and A. breviflorus. These two elements are principal cations of each cellular and intracellular fluids and aids in maintaining electrolyte balance in the body (21). The potassium content of the pulp of raw and cooked C. edulis were 18.00mg/100g and 1.300mg/100g those obtained for the raw and cooked A. breviflorus were 46.09mg/100g and 36.52mg/100g. The potassium contents of the pulp of raw and cooked A. breviflorus were 7500mg/100g and 6250m/100g respectively. Potassium is essential and is required in large amount for proper growth. The Magnesium content of the raw and cooked C. edulis were 64.98mg/100 and 32.46mg/100g respectively, while those obtained for the raw and cooked A. breviflorus were 46.09mg/100g and 36.52mg/100g respectively. The values obtained were higher than those reported by (22) who reported 7.14mg% for the pulp of fluted pumpkin. Magnesium is required in plasma and extracellular fluid where it helps maintain osmotic equilibrium (23). It can also prevent some heart disorders and lower blood pressure in humans. The calcium content of the pulp of the raw and cooked C. edulis were 460mg/100g and 430mg/100g respectively and that obtained from the pulp of the raw and cooked A. breviflorus were 370mg/100g and 475mg/100g. The values obtained in his study were higher than the values reported for cucumber. Calcium is reported to be essential for blood clotting, bone and teeth formation and as cofactor in some enzyme catalysis (21). High calcium content has been reported to reduce blood pressure (24). The phosphorus content of pulp of raw and cooked C. edulis were 18.39mg/100g and 27.53mg/100g respectively and that obtained for the raw and cooked A. breviflorus were 23.51mg/100g and 18.47mg/100g respectively. The value of 7.04mg% and 4.98mg% was reported for watermelon and fluted pumpkin pulp (22). This is low when compared to the resulted reported in this study. Phosphorus maintains blood sugar levels and normal heat contraction. It is also important for normal cell growth and repair, bone growth and kidney function. It plays an important role in maintaining the body's acid – alkaline balance (25). The level of zinc content in the raw and cooked C. edulis were 3.59mg% and 6.33mg% respectively, and those for A. breviflorus were 7.75mg/100g and 5.50mg/100g. These values are comparable to those obtained for other Cucumeropsis example cucumber 5.46mg% watermelon and fluted pumpkin. The pulp of watermelon and fluted pumpkin had values of 3.86mg and 4.14mg respectively (22). Zinc is vital in protein synthesis, cellular differentiation and replication, immunity and sexual functions, teeth formation and a co-factor in some enzyme catalysis (21).

Anti-nutritional components

The result of anti-nutritional factors in raw and cooked C. edulis and A. breviflorus is shown in Table 3. Variable levels of toxicants were observed for the various samples of C. edulis and Adenopus breviflorus used. Food/feeds loaded with significant levels of anti-nutrients could pose health hazards both to man and animals alike (26). Generally, the anti-nutrient levels were higher in the raw form of C. edulis and A. breviflorus. Cooking brought about a slight reduction in the levels of anti-nutrient.

The hydrocyanic acid content of the raw and cooked C. edulis were 1.7 ± 0.01mg/100g and 1.5 ± 0.008mg/100g respectively while A. breviflorus were 1.43 ± 0.01mg/100g and 0.09 ± 0.006mg/100g for the raw and cooked samples respectively. Cyanide content of the pulp of many fruits, roots and nut have been investigated (27;19 and 28). Hydrocyanic acid is the catabolic product of cyanogenic glucoside. The estimation of cyanide is significant because it is a known toxin, causing health conditions in man and livestock (29 and 30). Cyanide reaction in the animal tissues results in the formation of a higher metal affinity with ferric ions causing strong oxidation of this metal. This reaction lowers the ability of iron to carry electrons in the electron transport chain, thereby preventing tissue utilization of oxygen by the inhibition of the cellular respiratory enzymes (31). Phytic acid content in the raw and cooked C. edulis were 0.34±0.01mg/100g and 0.27±0.01mg/100g respectively while that of A. breviflorus were 0.25 ± 0.01mg/100g and 0.43 ± 0.01mg/100g for raw and cooked sample respectively. The presence of phytic acid in this study was low compared to 11.74 ± 0.02 and 3.43±0.20 documented by Ishaya and Oshodi (19) and Aladekeyi et. al (18) for raw and isolated flour of A. breviflorus respectively. The presence of phytic acid in diet reduces the apparent digestibility of total phosphorus (19). This hinders the absorption and utilization of certain mineral elements. This acid is not easily hydrolyed by large intestinal enzyme. Oxalate content on dry weight basis in the raw and cooked C. edulis were 16.5 ± 0.07mg/100g and 14.3 ± 0.1mg/100g while A. breviflorus had 16.60 ± 0.07mg/100g and 14.3±0.09 mg/100g for the raw and cooked samples respectively. This result is slightly lower than the 20.97mg/100g documented by (26) but significantly higher than 1.33 ± 0.01 reported by (19). Oxalate is a chelating agent which binds calcium very effectively. Plants with high oxalate content may produce acute metallic calcium deficiency (hypocalcemia) when plant product is used as main food source (32).

Table 3: Levels of some toxicants in the pulp of Cucumeropsis edulis and Adenopus breviflorus (Benth) in mg/100gm

	C. edulis (raw)	C. edulis (cooked)	A. breviflorus (raw)	A. breviflorus (cooked)	C. edulis	A. breviflorus
					% change after cooking	
Hydrocyanic acid	1.74 $\pm$ 0.01	1.52 $\pm$ 0.01	1.43 $\pm$ 0.01	1.09 $\pm$ 0.01	-23.8	-12.6
Oxalate	16.00 $\pm$ 0.07	14.3 $\pm$ 0.10	16.60 $\pm$ 0.01	14.3 $\pm$ 0.01	-13.86	-13.86
Phytic aid	0.34 $\pm$ 0.01	0.27 $\pm$ 0.01	0.43 $\pm$ 0.01	0.25 $\pm$ 0.01	-20.6	-41.9

Mean and standard error means of 3 determinations

Conclusion and Applications

1. From the chemical analyses carried out crude protein levels decreased from 10.23 $\pm$ 0.13% to 6.92 $\pm$0.08% and from 17.29 $\pm$ 0.15% to 9.89 $\pm$ 0.13 for in C. edulis and A. breveflorus after cooking respectively. Crude fibre increased after cooking in C. edulis but decreased in A. breviflorus.
2. Sodium, potassium and magnesium content were higher in the raw C. edulis (4250, 1800, 64.98) and A. breviflorus (1250, 7500, 46.09) respectively than in the cooked samples. (1250, 1300, 32.46) and (1500, 6250, 36.52) for C. edulis and A. breviflorus
3. Cooking brought about a reduction in the anti-nutrient content of A. breviflorus. 41.9% 13.86% and 12.6% for phytic acid, oxalate and hydrocyanic acid respectively.

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