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Fruit characteristics and nutrient composition of three Nigerian landrace morphotypes of snake tomato (*Trichosanthes cucumerina* L., Cucurbitaceae)

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Abstract. Fruit characteristics and nutrient composition of three morphotypes of *Trichosanthes cucumerina* L. (Cucurbitaceae) were studied. Results showed that average fruit weight ranged from 438.1 to 651.4 g, average fresh pulp weight from 20.4 to 37.6 g, seed weight per fruit from 21.8 to 39.5 g, number of seeds per fruit from 54 to 70, and 100-seed weight from 39.2 to 64.1 g. Nutrient composition analyses showed that the seeds of the three morphotypes of *T. cucumerina* are good sources of crude protein (26.2-26.6 g/100 g), fat (44.6-57.2 g/100 g), phosphorus (78.0-81.5 mg/100 g) and calcium (41.0-46.7 mg/100 g). The pulp is a good source of ascorbic acid (23.1-23.3 mg/100 g). The anti-nutritional oxalate content is low (1.20-2.62 g/100 g) suggesting that mineral nutrients are not held in unavailable form. The variations observed in the fruit characteristics and nutrient compositions are suspected to be due to genotype. Genetic improvement and further studies on the agronomy of this plant are recommended so as to encourage its cultivation.

Riassunto. Sono state studiate le caratteristiche dei frutti e la composizione in nutrienti di tre morfotipi di *Trichosanthes cucumerina* L. (Cucurbitaceae). E' risultato che il peso medio dei frutti varia tra 438.1 e 651.4 g, il peso medio della polpa tra 20.4 e 37.6 g, il peso dei semi per frutto tra 21.8 e 39.5 g, il numero dei semi per frutto tra 54 e 70 ed il peso di 100 semi tra 39.2 e 64.1 g. L'analisi della composizione in nutrienti ha mostrato che i semi dei tre morfotipi sono buone fonti di proteine (26.2-26.6 g/100 g), di grassi (44.6-57.2 g/100 g), di fosforo (78.0-81.5 mg/100 g), di calcio (41.0-46.7 mg/100 g) e la polpa di acido ascorbico (23.1-23.3 mg/100 g). Il contenuto dell'anti-nutrizionale ossalato è basso (1.20-2.62 g/100 g), suggerendo che i nutrienti minerali non sono presenti in una forma non disponibile. Le variazioni osservate nelle caratteristiche dei frutti e nella composizione dei nutrienti sembrano avere una base genetica. Il miglioramento genetico e studi di tipo agronomico su questa pianta sono raccomandabili e la sua coltivazione è da incoraggiare.

Key words: Cucurbitaceae, Fruit, Nutrients, Snake tomato, *Trichosanthes cucumerina*

Introduction

The snake tomato, *Trichosanthes cucumerina* L., is a member of the family Cucurbitaceae. The plant grows in the tropics and is similar to *T. dioca*, which is widely cultivated in India (Datta 1988). In modern Chinese commerce, species of *Trichosanthes* constitute one of the most important medicinal cucurbits (Yang & Walters 1992). The common name "snake tomato" is derived from the snake-like shape of the fruit. *T. cucumerina* is locally grown as a vegetable in home gardens in Africa (Soladoye & Adebisi 2004). In southwest Nigeria, it is found growing in protected environments in backyards. A survey carried out in southwest Nigeria showed that less than 2% of the farmers sampled knew about the cultivation of *T. cucumerina* while 15% of the farmers sampled used the pulp of *T. cucumerina* as an outright substitute for the regular tomato (*Lycopersicon esculentum* (L.) Mil) especially during the period of regular tomato scarcity and its attendant exorbitant prices (Onagoruwa 2002).

The survey by Onagoruwa (2002) also identified three landrace morphotypes of *T. cucumerina* distinguished by the fruit colour

and size when at the unripe stage. The first morphotype has long fruit with deep green background and white stripes when unripe; the second morphotype has short fruit with light green background and white stripes when unripe, while the third morphotype has light green long fruit when unripe. The fruit, irrespective of the colour at unripe stage, turn red when ripe. There is no information in the literature on the fruit characteristics and food value of these three identified landrace morphotypes. Farmers in southwest Nigeria claimed that the paste-like red pulp of *T. cucumerina* is sweeter, thicker and does not go sour as fast as that of the regular tomato (Onagoruwa 2002). *T. cucumerina* exhibits prolonged vegetative growth even after commencement of fruiting, along with multiple fruiting peaks (Okelana & Okeleye 1994). This is a great advantage because harvesting can continue for a longer period compared to the regular tomato.

Because of the good qualities of the pulp of this plant as claimed by the farmers, its long bearing period and the need to widen the food and genetic base of food plants with the aim of improving the well-being of the people and prevent genetic erosion, this study has been designed to investigate the fruit characteristics and nutrient composition of three landrace morphotypes of *T. cucumerina* identified in Southwest Nigeria.

Materials and Methods

During a survey that was conducted (Onagoruwa 2002), mature fruits of three identifiable landrace morphotypes of *T. cucumerina* distinguished on the basis of the fruit size and colour when unripe were collected, as follows:

Morphotype I: long fruit with deep green background and white stripes;

Morphotype II: short fruit with light green background and white stripes;

Morphotype III: light green coloured long fruit.

The seeds of the three morphotypes were extracted separately in the laboratory at the Department of Plant Science, Faculty of Agriculture, Obafemi Awolowo University, Ile-Ife, Nigeria. The seeds were washed using deionized water and then air-dried for 24 hours. The seeds were later dried in the oven at 60 °C for 5 hours to reduce the moisture content to 12%. The seeds were cooled on the table and then treated with Apron Plus fungicide before planting on to the field. The first field experiment was conducted during the rainy season (April-August) of 2003 and then repeated in the rainy season (April-August) of 2004.

Each morphotype was planted on a plot of 5 m x 5 m replicated four times in randomized complete block design (RCBD) according to the methods of Steele & Torrie (1995). The spacing used was 1 m x 1 m at two seeds per stand. At eight weeks after emergence, flowering started and at 14 weeks the fruits started ripening.

At full ripening, fifty fruits of each morphotype were harvested separately from the four middle rows in each plot. The fruits were taken to the laboratory and weighed. Thereafter, the fruits were split open; the seeds were extracted and then depulped. The pulp and seed were then weighed separately. Thereafter, the percentage pulp weight and seed weight were computed. The seeds were then dried to 12% moisture content. After drying, the seeds of each morphotype were weighed in batches of 100 seeds three times independently. The average of the three measurements gave the 100-seed weight. The pulp and seed for each morphotype were dried in a Gallenkamp oven at 80 °C for 48 hours.

The dried pulp and seed samples were ground into powder separately using a Wiley micro hammer stainless mill. The pulp and seed were subjected to chemical analyses separately. To ensure quality control, the ground samples were stored separately in screw-capped bottles and stored in a refrigerator at -5 °C until they were needed for analyses. The pulp and seed were subjected to chemical analyses separately. For the analyses of pulp and seed of each morphotype, a total of 12 samples made up of four field replications and triplicate laboratory analyses were used. In all, a total of 36 samples were analyzed made up of four field replications, three sample analyses and three morphotypes.

All the chemical analyses described below

were carried out using the routine chemical analytical methods of Association of Official Agricultural Chemists (AOAC 1995). The ether extract content was determined by the Soxhlet extraction method using petroleum ether while crude protein content was determined by first determining nitrogen content by Kjeldahl method and then multiply the nitrogen value by factor 6.25. The moisture content was determined by drying 10.0 g of the samples in the oven at 80 °C for 48 hours. The proportional difference in weight converted to percentage was expressed as percent moisture content. The ash contents of the samples were obtained by digesting 5 g ground samples in a muffle furnace at 550 °C for one hour. The proportional difference in weight converted to percentage is expressed as percent ash content. For crude fiber determination, ground samples were passed through 1 mm sieve and 1 g of the sample was weighed into a weighed crucible. About 50 ml of tetra-oxo-sulphate (IV) acid (1.25%) was added. The mixture was boiled for 1 hr, filtered and the residue was washed. Added to the residue was sodium hydroxide (1.25%) and boiled for 1 hr, filtered, washed and rinsed with acetone. The sample was dried and the dry residue weight was recorded. The dry residue was ashed and weighed. The fibre content was calculated by difference, after subtracting the residue weight found for the blank crucible.

For the determination of calcium and phosphorus, 10 g of ground samples were digested in 2:1 mixture of H_2SO_4 and perchloric acid. Calcium and phosphorus contents of the digests were read directly using atomic absorption spectrophotometer model BUCK Scientific 200A. The oxalate content was determined by using the HPLC method described by WILSON *et al*. (1982).

Data collected were subjected to analyses of variance (ANOVA) using the standard method for randomized complete block design (RCBD) according to STEELE & TORRIE (1995). Means, where significantly different, were separated using the Duncan's multiple range test (DMRT) at 5% level of probability.

RESULTS AND DISCUSSION

The three morphotypes of *T. cucumerina* were significantly different ($P<0.05$) in fruit characteristics (Tab. 1). The average fruit weight ranged from 438.1 to 651.9 g, with Morphotype III having significantly higher fruit weight compared to Morphotypes I and II. Similarly, Morphotype III had significantly higher fresh pulp weight (37.6 g/fruit), seed weight (39.5 g/fruit) and 100-seed weight (64.1 g/100 seed) compared to Morphotypes I and II. Morphotype I had the least pulp weight (29.6 g), seed weight (33.4 g) and 100-seed weight (48.6 g). It is interesting to note that the trend observed for the number of seeds per fruit differed from the trend observed for seed weight, pulp weight and 100-seed weight. There were significantly more seeds in Morphotype I (70) than in Morphotypes II (54) and III (61). This result shows that the number of seeds is not perfectly dependent on the whole fruit weight in *T. cucumerina* because Morphotype III that had a higher fruit weight than Morphotype I, in contrast, had significantly smaller number of seeds compared to Morphotype I. This may be due to the differ-

Tab. 1 - Fruit characteristics of three landrace morphotypes of *T. cucumerina*.

Morphotype	Fruit weight	Fresh pulp weight	Seed weight/fruit[1]	No of seed/fruit	100-seed weight[2]
I	628.5b	29.6b	33.4b	70a	48.0b
II	438.1c	20.4c	21.8c	54c	39.2c
III	651.4a	37.6a	39.5a	61b	64.1a

Values expressed in g.
[1]Seeds dried to 12% moisture content. [2]Values are means of three independent measurements.
Means followed by different alphabets in each column are significantly different at 5% level of probability according to Duncan's Multiple Range Test (DMRT).

ence in the genotype of the three morphotypes reported in this study. A previous study by ADEBOOYE & BELLO (1998) and ADEBOOYE & PHILLIPS (2006) showed that fruit weight was not a perfect determinant of cotyledon weight in *Irvingia gabonensis* var. *dulcis* (Aubry-Lecomte. Ex. O-Rorke) Baill, and *Mucuna urens* (L.) Medikus, respectively, because some of the smaller fruits had larger cotyledons in some of the accessions studied.

Results presented in Tab. 2 showed that the seed and pulp of *T. cucumerina* differ significantly in their chemical composition. Across the morphotypes, the nitrogen, crude protein, ether extract, crude fibre, oxalate, phosphorus and calcium contents of the seed were higher than that of the pulp, while the ascorbic acid and total sugar content of the pulp were significantly higher than that of the seeds. The nitrogen and crude protein contents of the seeds of the three morphotypes did not differ significantly. The same trend was observed for the crude protein content of the pulp of the three morphotypes. The ether extract content of the seed of Morphotype III (57.2 g/100 g) was significantly higher than that of Morphotypes I (48.4 g/100 g) and II (44.6 g/100 g), while that of Morphotype I was in turn significantly higher than Morphotype II. In contrast, the ether extract content of the pulps (0.84-0.94 g/100 g) of the three morphotypes did not differ significantly. The crude fibre contents of the seed (5.40 g/100 g) and pulp (2.81 g/100 g) of Morphotype II were significantly higher than those reported for the seed and pulp of Morphotypes I and III. It is known that crude fibre has little significance in human nutrition. The acsorbic acid content of Morphotype I seed (0.14 mg/100 g) was significantly lower than the values recorded for the seed of Morphotypes II (0.30 mg/100 g) and III (0.24 mg/100 g). The ascorbic acid contents of the pulp (23.0-23.3 mg/100g) of the three morphotypes did not differ significantly. The total sugar content of Morphotype I seed (0.14 mg/100 g) and pulp (1.82 mg/100 g) were the highest while Morphotype II seed (0.04 mg/100 g) and pulp (0.79 mg/100 g) had the lowest total sugar content. The phosphorus content of the seed (78.0-81.5 mg/100 g) and pulp (10.0-15.8 mg/100 g) and the calcium content of the seed (41.0-46.7 mg/100 g) and pulp (4.0-7.5 mg/100 g) for the three morphotypes were high. The oxalate composition of the seed was significantly higher than for the pulp in all three morphotypes. The oxalate content of the seed ranged from 2.41-2.62 mg/100 g while that of the pulp ranged from 1.20 to1.44 mg/100 g for the three morphotypes studied. These values are low oxalate considering the limit of 10 mg oxalate/serving considered as high-oxalate foods (HORNER *et al*. 2004). Oxalate is one of the anti-nutritional factors known in plants and it has deleterious

Tab. 2 - Chemical composition of three landrace morphotypes of *T. cucumerina* [1] in comparison with *L. esculentum* [2]

		Nitrogen	Crude protein	Ether extract	Crude fibre	Ascorbic acid	Total sugar	Oxalate	P	Ca
		(g / 100 g)				(mg / 100 g)	(mg / 100 g)	(mg / 100 g)	(mg / 100 g)	
Morphotype I	Seed	4.26a	26.6a	48.4b	4.35b	0.14c	0.14c	2.41a	78.0a	41.0a
	Pulp	0.34b	2.14b	0.94d	1.61d	23.1a	1.82a	1.30b	10.0b	4.00b
Morphotype II	Seed	4.19a	26.2a	44.6c	5.40a	0.30b	0.04d	2.62a	80.4a	45.1a
	Pulp	0.32b	2.03b	0.93d	2.81c	22.3a	0.79b	1.20b	13.6b	6.20b
Morphotype III	Seed	4.22a	26.4a	57.2a	4.23b	0.24b	0.12c	2.53a	81.5a	46.7a
	Pulp	0.32b	2.02b	0.64d	1.55d	25.0a	1.40a	1.44b	15.8b	7.50b
L. esculentum		-	0.7	0.3	-	17.0	-	-	24.0	7.0

[1]All values are means of triplicate analyses expressed on dry matter basis.
Means followed by different alphabets in each column are significantly different at 5% level of probability according to Duncan's Multiple Range Test (DMRT).
[2] Source: HOLLAND *et al*. 1991.

effect on nutrient absorption by the body. Oxalate, depending on its form, can bind calcium and/or magnesium in food undergoing digestion and therefore can render calcium and magnesium unavailable to the body (Oke 1966; Badifu & Okeke 1992; Adebooye 1996; Ezeagu *et al.* 2003; Adebooye & Phillips 2006). These workers also reported that oxalates are leached out during the soaking, boiling and processing of the plant materials; therefore, the low oxalate content of *T. cucumerina* can easily get leached out during processing.

All the nutritive values obtained for *T. cucumerina* reported in this study compare favourably with the protein (0.7 g/100 g), fat (0.3 g/100 g), ascorbic acid (17 g/100 g), calcium (7 g/100 g) and phosphorus (24 g/100 g) reported for *Lycopersicon esculentum* by Holland *et al*. (1991). Immature fruits of *T. cucumerina* had also been shown by Holland *et al*. (1991) to contain water (92.9 g/100 g), protein (0.5 g/100 g), fat (0.3 g/100 g), fibre (1.7 g/100 g), calcium (26 g/100 g), phosphorus (20 g/100 g) and carbohydrate (4.1 g/100 g). Soladoye & Adebisi (2004) reported a dearth of data in the literature on the chemical composition of the red ripe fruit of *T. cucumerina*.

Conclusion

The results of this study show that the crude protein, fat, ascorbic acid, potassium and calcium composition of *T. cucumerina* are high enough and compare favourably with the composition of *Lycopersicon esculentum*, its close substitute. The low and safe oxalate content also suggests that the availability of calcium and magnesium in *T. cucumerina* for human use would not be threatened. Its improvement will provide alternative for the poverty stricken local Africans who are in constant need of a substitute for the regular tomato, especially during the period of regular tomato scarcity and its attendant high and unaffordable prices. Improving this plant will also help in its conservation and prevent it from the threat of extinction. It is globally acknowledged today that many plants are facing a threat because they have long been neglected in the research and development process.

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