

Comparative Phytochemical and Nutritional Composition of *Trichosanthes cucumerina* (L.) and Some *Solanum lycopersicum* (L.) Cultivars in Nigeria

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Abstract

The phytochemical and nutritional composition of *Trichosanthes cucumerina* L. an underutilized vegetable used as substitute for Solanaceous tomatoes by rural dwellers was examined in comparison with majorly cultivated tomato cultivars in Nigeria (Roma VF and Ibadan local). The fruit pulp of *T. cucumerina* was higher in carotenoid (2053.33 mg/100g), flavonoid (861.67 mg/100g), cardiac glycoside (11.67 mg/100g), alkaloids (93.33 mg/100g), lycopene (118.5 µg/100g), tannin (555.00 mg/100g), oxalate (2.55 mg/100g) and quercetin (5.25 mg/100g) than Roma VF and Ibadan local. However, Roma VF had the highest concentration of saponin (66.67 mg/100g) but there was no significant difference in steroid among the fruits. The Vitamins A, E and C contents of *T. cucumerina* (5346 µg/100g, 6.23 µg/100g and 25.33 µg/100g) were significantly higher ($P < 0.05$) than those in *S. lycopersicum*. *T. cucumerina* had the highest values of crude protein and crude lipid (1.97% and 0.40%). The fruit pulp of *T. cucumerina* also had the highest ash and total carbohydrate contents (1.63% and 16.50%). Roma VF was significantly higher in crude fibre and moisture contents (1.77% and 89.40%) than other vegetables investigated. All the evaluated mineral elements (Na, K, Ca Mg, Zn, Fe, Mn, P and S) in *T. cucumerina* compared favourably with *S. lycopersicum* cultivars. It was observed that *T. cucumerina* pulp contained an appreciable number of nutrients and secondary metabolites which qualify it as a good substitute to *S. lycopersicum*.

Keywords

Underutilized Vegetable, Comparison, Phytochemical, Nutrition, Nigeria

1. Introduction

Neglected Underutilized Species (NUS) were not receiving attention by mainstream agriculture for a variety of agronomic, genetic, economic, social and cultural reasons; today these crops are receiving increasing recognition because of their potential roles in mitigating risk of agricultural production systems and their nutritional quality [1]. *Trichosanthes cucumerina* is an underutilized plant, the fruit of which is mainly consumed as a vegetable by rural dwellers most especially in western part of Africa. It is an annual climber belonging to the family Cucurbitaceae. It is commonly called snake gourd, viper gourd, snake tomato or long tomato [2]. The endocarp pulp when fully mature is sweet tasting, aromatic and deep red which does not go sour as quickly as the paste of *S. lycopersicum*, this account for the reason why it is employed as an alternative to the Solanaceous tomato [3].

The plant is richly constituted with a series of secondary metabolites like flavonoids, carotenoids, phenolic acids which makes the plant pharmacologically and therapeutically active. It has a prominent place in alternative systems of medicine like Ayurveda and Siddha due to its various pharmacological activities like antidiabetic, hepatoprotective, anti-inflammatory, larvicidal effects [2] and cytotoxicity against some cancer lines [4].

Although, vegetables play a very important role as a source of nutrients to the human body and their consumption ensures intake of various essential vitamins and mineral elements thus avoiding the problem of malnutrition [5] but, less attention has been given to nutritional qualities of some underutilized vegetables. As a result, diets deficient in essential vitamins and nutrients still persist in many parts of the world.

Previous scientific studies have reported some phytoconstituents and antioxidant activities of the fruit of *T. cucumerina* [6]; antidiabetic activities of the seed [7]; anti-inflammatory activity of the aerial part of *T. cucumerina* [8]. However there are few scientific reports about minerals, proximate, vitamins and phytochemical compositions of this plant. This study therefore aimed at providing scientific information on the minerals, proximate, vitamins and phytochemical composition of *Trichosanthes cucumerina* in comparison with two common tomato cultivars in Nigeria (Roma VF and Ibadan local) with a view to establish its potential as a good substitute to the Solanaceous tomatoes.

2. Materials and Methods

2.1. Collection of Materials and Nursery Establishment

Two cultivars of mature and ripe *S. lycopersicum* fruits (Ibadan-local and Roma-VF) and *T. cucumerina* fruit pulps were used for this study. Seeds of *S. lycopersicum* cultivars were collected from the National Horticultural Research Institute (NIHORT), Jericho, Ibadan, Nigeria. *T. cucumerina* seeds were obtained from the Federal University of Agriculture, Abeokuta Botanical Garden, Nigeria (7° 11' 51" N - 32° 6' 12" E).

The seedlings of *S. lycopersicum* cultivars and *T. cucumerina* were raised in trays filled with sterilized top soil of 10 kg each. They were watered twice daily and transplanted to the field four weeks after planting. The seedlings were raised in a loamy soil without application of fertilizer on a bed at a spacing of 60 x75 cm on one meter wide within and between rows as recommended by NIHORT Production Guide for Tomatoes at the Federal University of Agriculture Abeokuta Botanical Garden. Trellis was prepared for *T. cucumerina* with six sticks (2.5 m each), three in a row and one seedling to a stand. Mulching, weeding, staking and other horticultural operations were carried out.

2.2. Preparation of Samples

Ripe fruits of *T. cucumerina* and *S. lycopersicum* (cultivars) were harvested four months after planting. They were washed and the fruits of *T. cucumerina* were split open exposing their pulps which were extracted and *S. lycopersicum* (cultivars) fruits were cut into slices. The two fruits were oven dried to a constant weight at 60°C in a Gallen camp electric oven. The dried samples were ground into powder and put in dried air tight containers and stored in a cool dry place.

The oven dried powder was extracted in Soxhlet's with distilled water. The extract obtained in the solvent was concentrated, distilling off the solvent and evaporate to dryness. The solvent free extract obtained was subjected to qualitative test for the identification of various plant constituent from the samples.

2.3. Phytochemical Screening of Plant Samples

The phytochemical components of the fruits of *T. cucumerina* and two *Solanum lycopersicum* cultivars were screened by using standard procedures as described by [9] [10] [11] [12].

2.4. Quantitative Determination of Phytochemicals in Plant Samples

Determination of Tannin

Tannin was estimated by the method of [13].

$$TC (g/100 g) = \frac{C(\text{mg}) \times V_{ex}}{A \times M_s}$$

C (mg) = concentration from standard curve; V_{ex} = extract volume (cm^3); A = Aliquot (cm^3); M_s = mass of sample (mg).

Determination of Saponin

Saponin content was calculated as described by [14].

Determination of Oxalate

Oxalate was determined by using the titrimetric method described by [15].

% Oxalic acid = Standard Value \times Average Titre (0.02); 1 ml of 0.1 N KMnO_4 = 0.00450 g anhydrous oxalic acid.

Determination of Carotenoids

Carotenoid content of samples was determined using spectrophotometric method of [16].

Determination of Flavonoids

The ethyl acetate precipitation method was used as described by [12].

$$\% \text{ Flavonoid} = \frac{W_2 - W_1 \times 100}{\text{Weight of sample}}$$

W_1 = weight of empty filter paper; W_2 = weight of filter paper + paper precipitate

Determination of Alkaloids

The alkaloid content was determined gravimetrically [9].

$$\% \text{ Alkaloid} = \frac{W_2 - W_1 \times 100}{\text{Weight of sample}}$$

W_1 = weight of empty filter paper; W_2 = weight of filter paper + paper precipitate

Determination of Lycopene

Lycopene contents of the samples were determined using spectrophotometric evaluation method as described by [17].

$$\text{Lycopene in } \mu\text{g/g} = \frac{\text{Absorbance of sample} \times \text{Gradient factor} \times \text{Dilution factor}}{\text{Wt. of sample taken in g}}$$

Determination of Cardiac glycosides

Cardiac glycoside content of fruit samples was determined using spectrophotometric method of [16].

Determination of Steroid

Estimation of steroid content of samples was carried out using method of Analytical Methods Committee of Royal Society of Chemistry [18].

$$\% \text{ Steroid} = \frac{\text{Absorbance of Sample} \times \text{Gradient} \times \text{Dilution factor}}{\text{Weight of sample} \times 10,000}$$

Determination of Quercetin

Quercetin was determined by using spectrophotometric method [18].

$$\begin{aligned} \text{Quercetin mg/100g} \\ = \frac{\text{Absorbance of sample} \times \text{average gradient factor} \times \text{Dil. factor}}{\text{Weight of sample}} \end{aligned}$$

2.5. Proximate Composition Determination**Moisture content**

Thermal drying method was used in the determination of moisture content of the samples as reported by [19].

$$\text{MC}(\%) = \frac{W_o \times 100}{W_i}$$

MC = Moisture content; W_o = Loss in weight (g) on drying; W_i = Initial weight of sample (g).

Crude protein Determination

Determination of crude protein was done by determining the total organic nitrogen using the macro-Kjeldhal method [20].

$$\% N_2 = \frac{14 \times M \times V_t \times V}{\text{Weight of sample (mg)} \times Va}$$

% Crude Protein = % N₂ (Nitrogen) × 6.25

M = Actual Molarity of Acid; V = Titre Value (Volume) of HCl used; V_t = Total volume of diluted digest; V_a = Aliquot volume distilled

(6.25 is a general factor suitable for products in which the proportions of specific proteins are not well defined).

Crude lipid Determination

Determination of crude lipid content of the samples was done using Soxhlet type of the direct solvent extraction method [21].

$$\% \text{ Crude Lipid content} = \frac{W_2 - W_1 \times 100}{\text{Weight of Sample}}$$

Ash Determination

The ash content was determined using the ignition method [19].

$$\% \text{ Ash} = \frac{M_a \times 100}{M_s}$$

M_a = Mass of ash (g); M_s = Mass of sample used (g).

Crude Fibre Determination

Crude fibre was determined using the method of [19].

Calculation: The loss in weight on incineration = $C_1 - C_2$.

$$\% \text{ Crude fibre} = \frac{C_1 - C_2 \times 100}{\text{Weight of original sample}}$$

Carbohydrate Determination

Total carbohydrate content of each sample was estimated by “difference”. In this, the sum of the percentages of all the other proximate components was subtracted from 100 [22].

$$\begin{aligned} \text{Total carbohydrate (\%)} = & 100 - (\% \text{ Moisture Content} + \% \text{ Crude Protein} \\ & + \% \text{ Crude Lipid} + \% \text{ Crude Fibre} + \% \text{ Ash}). \end{aligned}$$

Vitamin Analysis

The vitamins (*A*, *E* and *C*) in the fruits of both *T. cucumerina* and *S. lycopersicum* (Roma VF and Ibadan local) were determined by the methods of the Association of Official Analytical Chemists [19].

2.6. Determination of Mineral Composition

The samples were digested with concentrated nitric and perchloric acids. Potassium (K) and Sodium (Na) were determined with the aid of corning 400 flame photometer according to the method of [23]. Phosphorus was determined using UV-visible Spectrophotometer (JASCO V-630) at 436 nm [19]. Calcium (Ca), Magnesium (Mg), Zinc (Zn), Iron (Fe), Manganese (Mn) and Sulphur (S) were determined by Atomic Absorption Spectrophotometer (Model 3030 Perkin Elmer, Nortwalk, USA) according to the established procedures of [24].

2.7. Statistical Analysis

Data were subjected to analysis of variance (ANOVA); means of the samples were separated by Duncan Multiple Range Test (DMRT) at 5% level of probability using SPSS software version 17.0.

3. Results and Discussion

The results of the phytochemical screening conducted show that the extracts from the fruit samples contained tannins, carotenoids, flavonoids, saponins (Table 1). Negative results were recorded for alkaloids and lycopene in all the extracts except the fruit of *T. cucumerina*. Also oxalate, cardiac glycosides, steroids and quercetin were found absent in all the extracts of the three fruit samples. These phytochemicals were present in varying level in all the fruits. This variation in level of visibility may be due to quantity of the phytochemicals in the fruits while absence of phytochemical denotes minute presence of phytochemical which could not trigger qualitative changes due to the adopted method (Table 2). These phytochemicals play a crucial role in maintaining optimal immune response, such that deficient or excessive intakes can have negative impact on health [25].

The quantitative screening of these phytochemicals revealed significant differences ($P < 0.05$) among the extract of the fruit samples (Table 2). *T. cucumerina* had the highest contents of tannin, oxalate, carotenoids, flavonoids, alkaloids, lycopene, cardiac glycoside and quercetin. Roma VF cultivar had the highest value in saponin and steroid. All the fruits exhibit appreciable amount of carotenoid with the highest present in *T. cucumerina* (2053.33 mg/100g) and the lowest in Roma VF (1345.00 mg/100g). The high carotenoid present in *T. cucumerina* fruit shows that the fruit has antioxidant properties which are associated with good health and reduced risk of diseases [26].

Table 1. Qualitative phytochemical screening of *T. cucumerina* and two *S. lycopersicum* cultivars (Roma VF and Ibadan Local) fruits.

Parameters	<i>T. cucumerina</i>	Roma VF	Ibadan Local
Tannins	++	++	++
Saponins	+	+	+
Oxalates	-	-	-
Carotenoids	+++	+++	+++
Flavonoids	+++	++	++
Alkaloids	+	-	-
Lycopene	+	-	-
Cardiac Glycosides	-	-	-
Steroids	-	-	-
Quercetin	-	-	-

Key: +++ = highly present; ++ = moderately present; + = slightly present; - = absent.

Table 2. Quantitative phytochemical screening of *T. cucumerina* and two *S. lycopersicum* cultivars (Roma VF and Ibadan Local) fruits.

Phytochemical (mg/100g)	<i>T. cucumerina</i>	Roma VF	Ibadan Local
Tannin	555.00 ± 2.86 ^a	368.33 ± 9.28 ^b	318.33 ± 10.14 ^c
Saponin	36.67 ± 1.67 ^c	66.67 ± 1.67 ^a	53.33 ± 1.67 ^b
Oxalate	2.55 ± 0.06 ^a	1.95 ± 0.14 ^b	1.22 ± 0.08 ^c
Carotenoid	2053.33 ± 14.81 ^a	1345.00 ± 7.64 ^c	1755.00 ± 10.41 ^b
Flavonoid	861.67 ± 6.01 ^a	461.67 ± 6.01 ^c	608.33 ± 24.87 ^b
Alkaloid	93.33 ± 1.67 ^a	16.67 ± 1.67 ^c	23.33 ± 1.67 ^b
Lycopene (µg/g)	118.53 ± 0.33 ^a	12.47 ± 0.33 ^b	9.27 ± 0.33 ^c
Cardiac Glycoside	11.67 ± 1.67 ^a	1.67 ± 1.67 ^b	3.33 ± 1.67 ^b
Steroid	3.33 ± 1.67 ^a	8.33 ± 1.67 ^a	6.67 ± 1.67 ^a
Quercetin	5.25 ± 0.00 ^a	4.85 ± 0.00 ^b	4.35 ± 0.03 ^c

Mean value in the same row having different alphabets are significantly different ($P < 0.05$). Data are means of triplicate determinations ± standard errors.

The fruit pulp of *T. cucumerina* (118.53 µg/100g) also showed a considerable quantity of Lycopene—a derivative of carotenoid compared to *S. lycopersicum* cultivars examined. Lycopene is responsible for the red colour of fruits [27]. It is a very good antioxidant that is associated with reduction in the risk of prostate cancer as reported by [28].

The values of flavonoid and its derivative Quercetin in the fruits are significantly different ($P < 0.05$) with the peak value of flavonoid obtained in *T. cucumerina* (861.67 mg/100g). This also make *T. cucumerina* potentially endowed with the capacity to carryout biological activities, such as anti-inflammatory, anti-allergic, antischemic, immunomodulatory, and antitumoral activities [29] [30].

The results also showed that *T. cucumerina* had high quantity of alkaloid and cardiac glycosides compared to the mostly consumed tomato cultivars in Nigeria. Many alkaloids are pharmacologically active substances, which possess various physiological activities in both humans and animals [31]. They also exhibit antibiotic activities, and form part of drugs used in the treatment of congestive heart failure in a moderate dose [32].

Meanwhile, the results of this study revealed that *T. cucumerina* also recorded highest value in the anti-nutritive concentration of tannin and oxalate but recorded lowest value of saponin as shown in **Table 2**. This is in agreement with the result of [33] when *T. cucumerina* was compared with *Jatropha curcas* and *Citrillus vulgaris*. These anti-nutrients could be toxic when consumed in an unprocessed food. However, at the present concentration they may not constitute major danger provided the fruits are cooked before consumption [34]. Oxalates are leached out during the soaking, boiling and processing of the plant materials [35] [36]. Despite the negative impact of these anti nutrients, tannins have been reported to be beneficial when applied to the mucosal lining of the mouth [37]. They also exert some physiological effects such as acceleration of blood clotting,

reduce blood pressure, decrease serum lipid level and modulate immunoresponses [38].

Vitamins A, E and C present in the fruit pulp of *T. cucumerina* were significantly higher than those of *S. lycopersicum* cultivars (Table 3). *T. cucumerina* pulp had the highest values of Vitamin A, E and C with the value of 5346.40 µg/100g, 6.23 µg/100g and 25.33 µg/100g respectively. Ibadan local showed the lowest value of Vitamins E and C with the value of 4.66 µg/100g and 22.47 µg/100g respectively while Roma VF had the lowest value of Vitamin A (4459.70 µg/100g). The results of this study agree with the report of [39] that *T. cucumerina* fruit pulp is a good source of Vitamins. Vitamin A, a derivative of beta carotene helps to maintain good sight and prevent certain diseases of the eye [40]. Vitamin E helps maintain cell membrane, red blood cell integrity and also involved in immune function [41]. Vitamin C also known as ascorbic acid promotes wound healing [40]; strengthens resistance to infections by boosting the immune system and improves absorption of iron [41] [42].

The proximate content of the fruits examined is shown in Table 4. The moisture in the fruit pulp of *T. cucumerina* and the two other tomato cultivars are high although varies significantly with highest volume reported to be that Roma VF (89.40%). The moisture content influences the rate of food absorption and digestion [43]. Also high moisture content of the fruits indicates high water

Table 3. Vitamins composition of *T. cucumerina* and two *S. lycopersicum* cultivars (Roma VF and Ibadan Local) fruits.

Constituent (µg/100g)	<i>T.cucumerina</i>	Roma VF	Ibadan Local
Vitamin A	5346.40 ± 0.10 ^a	4459.70 ± 0.10 ^c	4643.33 ± 0.33 ^b
Vitamin E	6.23 ± 0.00 ^a	5.26 ± 0.09 ^b	4.66 ± 0.00 ^c
Vitamin C	25.33 ± 0.89 ^a	23.27 ± 0.67 ^b	22.47 ± 0.33 ^c

Mean value in the same row having different alphabets are significantly different ($P < 0.05$). Data are means of triplicate determinations ± standard errors.

Table 4. Proximate composition of *T. cucumerina* and two *S. lycopersicum* cultivars (Roma VF and Ibadan Local) fruits.

Parameter (%)	<i>T. cucumerina</i>	Roma VF	Ibadan Local
Moisture content	78.40 ± 0.15 ^c	89.40 ± 0.10 ^a	87.76 ± 0.09 ^b
Crude Protein	1.97 ± 0.09 ^a	1.30 ± 0.06 ^b	1.50 ± 0.06 ^b
Crude Lipid	0.47 ± 0.03 ^a	0.30 ± 0.58 ^b	0.30 ± 0.00 ^b
Ash	1.63 ± 0.15 ^a	0.93 ± 0.33 ^b	1.03 ± 0.33 ^b
Crude Fibre	1.03 ± 0.09 ^b	1.77 ± 0.09 ^a	1.50 ± 0.58 ^a
Carbohydrate	16.50 ± 0.15 ^a	6.23 ± 0.20 ^c	7.90 ± 0.12 ^b

Mean value in the same row having different alphabets are significantly different ($P < 0.05$). Data are means of triplicate determinations ± standard errors.

retention capacity and could therefore easily be spoiled by fungi if not consumed on time [44]. The fruits generally have low protein content (Table 4). The ether extract (crude fat) content of the fruit pulp of *T. cucumerina* (0.47%) was slightly higher than that of Roma VF and Ibadan local (0.30%) each. A diet providing 1% - 2% of its caloric energy as fat is said to be sufficient to human beings as excess fat consumption yields certain cardio vascular disorder such as atherosclerosis, cancer and aging [45]. From the result, the fruits contain little crude lipid which makes them very healthy for consumption. There are also significant differences for both ash and crude fibre contents of the fruit samples (Table 4). Ash on food determines largely the extent of mineral matters likely to be found on food substance [46]. *T. cucumerina* has higher carbohydrate and lower fibre content than other Solanaceous tomato cultivars (Table 4). Carbohydrates and lipid are the principal sources of energy. The values of carbohydrates content in these samples per 100 g can provide a lower calorie of energy preventing the breakdown of the body's store of protein [46].

T. cucumerina fruits had highest percentage of all the analyzed minerals compared to the two Solanaceous tomato cultivars (Table 5). The quantity of the mineral elements ranges from Sodium to Manganese (Na-Mn) in all the fruit samples: *T. cucumerina* (1645.00 - 0.06 mg/100g), Roma VF (878.33 - 0.02 mg/100g) and Ibadan local (948.33 - 0.03 mg/100g). This is in accordance with the study of [33] where manganese, sodium and iron were compared among *T. cucumerina*, *Jatropha curcas* and *Citrillus vulgaris*.

Mineral elements also play important roles in health and disease states of humans. For example, [47] reported that high amount of potassium in the body increases iron utilization. Calcium and phosphorous containing substances are required by children, pregnant and lactating woman for bones and teeth development [46]. This result showed that *T. cucumerina* can contribute 341.66 mg of the recommended daily allowance of 800 mg of Ca and P required per day for both adults and children [48].

Table 5. Mineral elements of *T. cucumerina* and two *S. lycopersicum* cultivars (Roma VF and Ibadan Local) fruits.

Mineral (mg/100g)	<i>T. cucumerina</i>	Roma VF	Ibadan Local
Sodium (Na)	1645.00 ± 10.41 ^a	878.33 ± 6.01 ^c	948.33 ± 6.01 ^b
Potassium (K)	93.33 ± 1.67 ^a	66.67 ± 4.41 ^b	73.33 ± 1.67 ^b
Calcium (Ca)	163.33 ± 6.01 ^a	91.67 ± 1.67 ^b	85.00 ± 2.87 ^b
Magnesium (Mg)	73.33 ± 1.67 ^a	43.33 ± 1.67 ^b	48.33 ± 1.67 ^b
Zinc (Zn)	0.57 ± 0.33 ^a	0.40 ± 0.58 ^b	0.51 ± 0.33 ^b
Iron (Fe)	12.50 ± 0.15 ^a	9.17 ± 0.09 ^c	9.63 ± 0.15 ^b
Manganese (Mn)	0.06 ± 0.00 ^a	0.02 ± 0.00 ^b	0.03 ± 0.00 ^b
Phosphorus (P)	178.33 ± 9.28 ^a	85.00 ± 2.89 ^b	85.00 ± 2.89 ^b
Sulphur (S)	0.48 ± 0.00 ^a	0.37 ± 0.02 ^b	0.35 ± 0.00 ^b

Mean value in the same row having different alphabets are significantly different ($P < 0.05$). Data are means of triplicate determinations ± standard errors.

Magnesium, a constituent of bones, teeth and enzyme cofactor [49] and Iron which is required for the formation of haemoglobin were found to be more in *T. cucumerina* compared to the Solanaceous tomato cultivars.

Zinc, Sulphur and Manganese were of low quantity in all the fruit samples. They are required for building immune system; regulation of cellular growth and acts as a co enzyme for carbohydrates, protein and nucleic acids metabolism; regulation of blood sugar level and production of energy [46].

4. Conclusion

This study has revealed that most of the phytochemicals, vitamins, proximate composition and mineral contents of *T. cucumerina* are high enough and compare favourably with the composition of those *S. lycopersicum* cultivars examined. *T. cucumerina* also have low and safe oxalate content, and other anti-nutrients which could leach out during cooking making it safe for consumption. This result recommends *T. cucumerina* for households, food industries and pharmaceutical industries utilization as a substitute for *S. lycopersicum* due to its high nutrient composition and its potential roles in medicare.

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