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Nutritional and Phytochemical Profiling of the Fruit Pulp and Seeds of Cucumber (*Cucumis sativus* L.): Implication for Dietary Health in Sokoto-Nigeria

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Abstract

Biochemical characterization of fruit pulp and seeds of *Cucumis sativus* was carried out using standard biochemical procedures. Proximate composition revealed that the samples were relatively rich in crude protein with 6.66% to 21.81% in fruit pulp and seeds respectively. Lipid analysis showed that the seeds had a value of 5.81% while 7.51% was obtained in the fruit pulp. Crude carbohydrate content revealed 21.39% and 34.64% in the fruit pulp and seeds respectively. Percentage of crude fiber showed 8.11% and 7.20% were obtained in the fruit pulp and seeds respectively. Vitamin C analysis showed that seeds had a higher content of 122.14 mg/100 g while the fruit pulp had 91.62 mg/100 g respectively. Available energy kj/100 g also showed that 162.82 kj/100 g and 532.71 kj/100 g were recorded for the fruit pulp and seeds respectively. Significant difference (P≤0.05) was observed in crude protein, total carbohydrate, crude fiber, vitamin C and available energy between the samples. Mineral content analyses revealed that the samples were rich in the vital minerals required for healthy growth and development. Potassium ranged from 47.72 mg/100 g in the fruit pulp to 68.96 mg/100 g obtained in the seeds. Sodium content recorded was highest in the fruit pulp with 9.23 mg/100 g while the seeds had 7.72 mg/100 g respectively. Analysis for magnesium revealed that 31.64 mg/100 g in the fruit pulp and 43.12 mg/100 g in the seeds respectively. Analysis for phosphorus revealed that 36.74 mg/100 g was recorded in the fruit pulp while the seeds had 56.64 mg/100 g. Other valuable minerals recorded in both the fruit pulp and the seeds were manganese, calcium and iron with appreciable contents. There was significant difference (P≤0.05) was observed between the fruit pulp and the seeds in contents of potassium, sodium, magnesium and the phosphorus between the samples. Antinutritional composition indicated that there was significant difference (P≤0.05) in the contents of alkaloids, flavonoids, glycosides, and nitrates between the fruit pulp and the seeds. These findings further confirm that cucumber could be regarded as highly nutritious and its incorporation into daily cuisine could be considered necessary for a healthy living.

Keywords: Anti-nutrients, Ascorbic-acid, Biochemical, Cucumber, Nutrients

Introduction

It is not exaggeration that a sizable number of the third world population are now food insecure. This fact can be attributed to the undisputable rising human population. It cannot be disputed that food security has continued to be a growing concern. To make sure that food becomes secured for all, it requires not only improved cultivation of crops, genetic improvement but also paying attention to those crops considered grossly underutilized (Soumya *et al*. 2025) [33]. Cucumber (*Cucumis sativus* L.) is a creeping vine that bears cylindrical fruits that originated in Southern Asia, but a large number of cultivars have over the years been developed and are gown worldwide. *C. sativus* is ranked as one of the most widely cultivated vegetables (Paris *et al*., 2011; Oluwagbenle *et al*., 2019) [28, 26]. Cucumber is regarded as yet another important crop and one of the most popular members of the gourd family, the Cucurbitaceae. Cucumber is said to be one of the oldest vegetable crops cultivated by man with historical records dating back to over 5000 years (Wehner and Guner, 2004) [39]. The crop is established to be the fourth most important vegetable after tomato, cabbage and onion in Asia and the second most valuable vegetable crop after tomato in Western Europe (Phu, 1997) [29]. In tropical Africa, its place has not been ranked due to its limited uses there. Increase in human population and reports of large numbers of undernourished or starving people, especially in the developing countries has made the need for the food production as a major issue of concern (FAO, 2000) [13].

C. sativus requires a warm climate, in cool temperate countries it is grown in greenhouses; only during hot summers can it be grown in the open. The optimum temperature for growth is about 30˚C and the optimum night temperature 18˚C - 21˚C; the minimum temperature for good development is 15˚C. High light intensity is needed for optimum yields. Cucumber needs a fair amount of water but it cannot withstand water-logging. Low relative humidity results in high plant evaporation due to the large leaf area, and sufficient irrigation is then very important. High relative humidity facilitates the occurrence of downy mildew. In tropical Africa elevations up to 2000 m appear to be suitable for cucumber cultivation. In Nigeria, cucumbers are grown majorly in the North particularly the Jos-Plateau; due to the climatic requirements. Cucumber grows anywhere provided the right production method and management of the environmental factor were strictly followed (FAO, 2000) [13]. However, in Nigeria with moderate rainfall, it is grown in the southern part with favourable yield compared with that grown in Jos, the Northern Nigeria. The crop may also root in a soil-less medium, and sprawls along the ground especially where it does not have supports. The vine has a large leaf that forms a canopy over the fruits of typical cultivars of cucumber is roughly cylindrical, but elongated with tapered ends, and may be as large as 60 cm long and 10 cm in diameter. Botanically, the cucumber fruit is classified as pepo, a type of botanical berry with a hard-outer rind devoid of internal divisions (Shrader *et al*., 2002) [32]. Cucumber has three main varieties of notably the slicing, pickling and seedless. Within these varieties, there are several other varieties developed (Rauf *et al*., 2011).

Nutritionally, cucumber contains about 90 - 95 percent water with limited nutritional value compared with other vegetables. In one serving, there are about 45 calories along with the daily recommended intake; 6% of Vitamin A and Vitamin B6, and 14% Vitamin C (Werner, 2005). Being rich in vitamin A, B1, B6, C and D, Magnesium, Folate, Calcium, and Potassium, cucumber is as well rich in silica, that allows the connective tissue to be strengthened while promoting healthy joints (Clark, 2007) [9]. Cucumber fruits are an important part of the human diet, often used in salads, pickles, and sauces, due to their nutritious qualities and health benefits. They are a rich source of vitamins, minerals, soluble carbohydrates as well as proteins (Hina *et al*., 2024) [15]. Abiodun and Adeleke (2010) [1] reported that seeds of cucumber serve as good source of protein, fat, mineral and calcium. Although its calorie and nutritional values were quite low. Due to its relative high content of potassium (with usual value ranging from 50-80 mg/g), cucumber could be considered as being highly useful for both high and low blood pressures (Kashif *et al*., 2008) [20]. It is however, due to increased awareness on the health role of vegetables in our cuisines, it is necessary to increase cucumber production in order to supplement the high intake of carbohydrates in Nigeria especially in the Southern parts of the country where there are sparse and overdependence of its supply for salad vegetables and fruits on major suppliers from the Northern parts of the country (Chinatu *et al*., 2024) [8]. Cucumbers are now known to play an intermediate in the fight against the micronutrients deficiency that makes them veritable in the daily cuisine of every household (Antoine *et al*., 2023) [4].

Materials and Methods

Collection of Cucumber Samples

Fresh and ripe fruits of cucumber (*C. sativus*) were sourced at Abu Dankure vegetable market in Sokoto. The fruits were taken to the Departmental Herbarium, Department of Plant Science where authentication was done and where voucher specimens were deposited. The seeds were first ground into fine powder while the fruits were sliced as the seeds were removed and samples were then air-dried to constant weight and ground into fine powder. The samples were kept in cleaned and labeled bottles until needed.

Proximate and the Samples Vitamin Content Analysis

The micro-kjeldal method was followed for the determination of crude proteins. Crude lipids, crude fibre, percentage moisture and ash were determined using the methods of (AOAC 2005) [5], while carbohydrate was determined by difference. The calorific values in kilo joule (kj) were calculated by multiplying the crude fat, protein and carbohydrate by At-water factors of (k) 4, 4 and 9 respectively. Ascorbic acid was determined according to the method described by Musa *et al*. (2010) [23].

Samples Mineral Analysis

Samples mineral analysis was evaluated by first dry ashing the samples at 550 ºC in the muffle furnace. Atomic Absorption Spectrophotometer (AAS) [Buck Scientific Model-200A/210, Norwalk, Connecticut (06855) was used to determine the proportion Na, K, Mg, Ca, Fe, Cu, Zn, Co, Cd, and Ni while the amount of phosphorus was determined calorimetrically by Spectronic 20 (Gallenkamp, UK) using the phosphovanado molybdate method (AOAC, 2005) [5].

Samples Phytochemical Screening

To assess the amount of alkaloid, tannin and flavonoid in the samples, the method of Trease and Evans, (2002) [36] was followed. Phytate contents was determined using the method as described by Van-Buren and Robinson, (1981) [38]. Oxalate and cyanide contents were evaluated following the methods of Young and Greave (1940) [40] and Day and Underwood, (1986) [11]. Nitrate and saponin contents were determined following the method of Wang *et al*. (2005) [41] and El-Olemy *et al*. (1994) [12] while flavonoid content was evaluated using the method of Bohn and Kopaci (1994) [7].

Data Analysis

The obtained results were presented as Means ± SE. of the means. Data collected was subjected to analysis of variance (ANOVA) using GenStat(r) 18th edition, and where the treatments were found to be significantly different, mean separation was done using Duncan's multiple range test (DMRT) at 5% level.

Results and Discussion

Proximate and Ascorbic acid Contents of the Samples

Proximate and ascorbic acid contents of the samples was presented in Table1. Proximate analysis revealed that moisture content (%) ranged from 3.90% in seeds to 14.11% obtained in the fruit pulp. Values obtained in the current study were however, lower than that reported for various parts of *Borassus aethiopium* Mart. Ranging from 11.30% to 24.10% as reported by Akinniyi and Waziri, 2011 on various parts of *Borassus aethiopium* Mart. Crude proteins ranged from 21.81% in the seeds to 6.66% obtained in the fruit pulp respectively. Crude lipid analysis revealed that 5.18 % was obtained in fruit pulp while 27.51% was obtained in the seeds respectively. More so, crude carbohydrate contents revealed 22.39% in fruit pulp while 44.64% was obtained in the seeds. The obtained results were however lower than the reported 52.86% on *C. sativus* seed oil by Oragwu *et al*. (2021) [27]. Also, higher values of 50.24% was reported by Cosmos *et al*. (2020) [10] on *Cucumis metuliferus*. The above disparity could be attributed to species variability. Crude fibre of both the fruit pulp and seeds revealed that 8.11 % and 7.20 % respectively. Epidemiological evidences have indicated that consumption of reasonable amount of dietary fiber (20 – 35 g/day) could hep lower the risk of a number of chronic diet related diseases such as diverticular disease, coronary heart disease, Obesity and type II diabetes mellitus among others (Duru *et al*., 2012).

Ash (% composition) of the samples revealed 5.16% obtained in fruit pulp while 12.23 % was obtained in the seeds respectively. Available energy (kj/100 g) revealed that 608.87 kj was obtained in the fruit pulp while 660.04 kj was obtained in the seeds respectively. With significant difference (P≧0.05) in the composition of percentage moisture, crude proteins, percentage ash, crude lipid and calorific value between the samples. Vitamin C analysis revealed the contents to be appreciably high in both the samples with 122.14 and 91.62 mg/100 g of fruit pulp and seeds respectively. With significant difference (P≤0.05) between the two samples. In a report by Jet *et al*. (2019) [17], higher values of crude protein and crude lipid were reported on cucumber seeds as 26.68% and 14.14% respectively. The values were higher than obtained in the current study. In another study by Uzuazokaro *et al*. (2018) [37] on cucumber fruits, 3.01%, 1.02% and 0.94% were reported as the crude protein, crude fibre and percentage ash respectively. In another study by Oragwu *et al*. (2021) [27] on *C. sativus* seed oil, low value of crude protein was 4.50%. this reported value was however lower than that obtained in the current study. Low values of available energy were reported with 274.17 kj/mol and 325.37 kj/mol respectively by Sadiq *et al*. (2021) [31] on fruit pulp and seeds of watermelon.

Table 1: Proximate (% DW) and Ascorbic acid (mg/100 g) Contents of the Samples

Parameters	Fruit Pulp	Seeds
Moisture Content	14.11±1.49^a	3.90±0.63^b
Crude Protein	6.66±0.96^a	21.81±1.99^b
Crude lipid	5.18±1.17^a	27.51±1.17^b
Total carbohydrates	22.39±.2.10^a	44.64±2.19^b
Crude Fibre	8.11±0.99^a	7.20±0.86^a
Ash	5.16±0.76^a	12.23±0.93^b
Calorific Value	162.82±3.46^a	532.71±4.26^b
Vitamin C	122.14±3.19^a	91.62±3.46^b

Values are means ± standard error of three replications. There is significant difference (P≥0.05) for values within a row with different superscripts.

Mineral Contents of the Samples

Cucumber, *Cucumis sativus* is known to be a rich source of various minerals, vitamins, and antioxidants. Several studies have analyzed the mineral contents of cucumber, often comparing different parts (fruit pulp, seeds, peel). Based on sodium and Potassium contents, obtained values in the current study were in conformity with that reported by Niyi *et al.* (2019) [25] on fruit pulp and seeds of cucumber. Mineral composition of fruit pulp and seeds of cucumber have been presented in Table 2. From the Table, appreciable contents of valuable minerals identified in the samples have been presented. The mineral with the most abundance in both the samples was potassium 68.96 mg/100 g in the seeds while 37.72 mg/100 g was obtained in the fruit pulp. The obtained values were however, higher than the reported potassium with 4.04 mg/100 g as reported by Jacob *et al*. (2015) [16] on *Citrullus lanatus*. In another study on Bala and Bashir (2017), on the nutritional contents of some Nigerian fruits, higher values of potassium were reported on banana pulp and husk with 66.60 mg /100 g and 84.40 mg/100 g respectively. The above differences could be attributed to species variability. Amount of sodium obtained in the current study revealed 9.23 mg/100 g and 7.72 mg/100 g respectively in the fruit pulp and seeds respectively. These values were however, higher than the reported values of 0.39 mg/100 g and 0.32 mg/100 g respectively on fruit pulp and the seeds of watermelon by Sadiq *et al*. (2021) [31]. More so, in a study on the mineral composition of cucumber reported that cucumber is relatively low in sodium, making it suitable for people with hypertension and those on a low-sodium diet. This is consistent with the result of the study carried out, where the fruit pulp has higher sodium content than the seeds, which might contribute to its role in electrolyte balance (Niyi *et al*., 2019) [25]. The recommended daily allowance of sodium is 1500 mg/day (NIN, 2009). Sodium is involved in the maintenance of osmotic pressure of the body fluids and that change in osmotic pressure largely depends on sodium concentration (Aremu and Ibrahim, 2014; Murray *et al*., 2000; Malhotra, 1998). Amount of phosphorus was appreciable in both the fruit pulp and the seeds with 46.74 mg/100 g in fruit pulp and 56.72 mg/100 g recorded in the seeds. Phosphorous functions as constituent of bone and teeth, nucleic acids and also serves as phosphorylated metabolic intermediate (Aremu and Ibrahim, 2014). The recommended daily allowance of phosphorous in foods is 700 mg/day as established by the Institute of Medicine (IOM, 1997). Values obtained in this study are therefore within the dietary recommendations of phosphorous. In another study by Imran *et al.* (2017), it was reported that significant concentrations of calcium and magnesium in cucumber seeds. They observed that the seeds were more mineral-dense compared to the pulp, which aligns with the results from the table. This suggests that cucumber seeds may be a good source of these important minerals (Imran *et al*., 2017).

Table 2: Mineral Contents of the Samples

Mineral (mg/100 g)	Fruit Pulp	Seeds
Sodium	9.23±0.93^a	7.72±1.13^b
Potassium	47.72±2.26^a	68.96±2.69^b
Magnesium	11.64±0.62^a	48.12±2.86^b
Phosphorus	46.74±1.83^a	56.72±2.99^b
Manganese	18.66±0.76^a	26.76±1.85^a
Calcium	12.54±0.98^a	46.64±2.14^b
Iron	21.07±0.92^a	23.06±1.02^a
Copper	0.31±0.04^a	6.24±0.16^a
Chromium	0.02±0.01^a	0.06±0.03^a
Zinc	3.74±0.98^a	6.36±0.09^a
Cyanide	0.01±0.01^a	0.03±0.02^a
Nickel	0.02 ±0.02^a	0.03±0.04^a

Values are means ± standard error of three replications. There is significant difference (P≥0.05) for values within a row with different superscripts.

Samples Phytochemical Contents

Results on photochemical screening of the Seeds of the seeds and Fruit Pulp of *Cucumis sativus.* Flavonoid was the highest in both samples with 23.12 mg/100 g in seeds of the cucumber while 11.64 mg/100 g was obtained in the fruit pulp. This was followed in abundance by phytate with 19.64 mg/100 g in the seeds while 2.54 mg/100 g was obtained in the fruit pulp respectively. To sum it, phytochemicals were extracted more in the seeds than in the fruit pulp. With significant difference (P1≥0.05) between the composition in fruit pulp and the seeds. In a study by Karaye *et al*. (2013), low levels of oxalate and tannins were reported on five selected Nigerian cucurbits seeds. The differences could be attributed to species variability as well as the different methods of analysis employed. More so, in another study by Karaye *et al*. (2023) [19], low values of phytate and oxalate were reported on *Sorghum bicolor* and *Zea mays* respectively. The difference could as well be attributed to species variability and the methods employed as the method of analysis produces different results. It cannot be unconnected that climatic factors and stages of maturity could cause variation in the distribution of Phytochemicals Bamishaiye *et al.* (2011) [6] as well as the choice of solvent as different solvents have different extraction capabilities and spectrum of solubility for phytoconstituents (Handa *et al.,* 2008) [14]. In another study by Nweze and Nwafor, (2014) [24], on phytochemical composition of leaf extract of *Moringa oleifera* Lam. From Nsukka, South Eastern Nigeria, flavonoid, alkaloids, saponins and tannins were reported with 3.56 mg/100 g, 3.07 mg/100 g, 1.46 mg/100 g and 9.26 mg/100 g in aqueous extracts of *Moringa oleifera* seeds. The above values were however lower than the obtained values in the current study. The reason for the above disparity could be attributed to species variability (Bamishaiye *et al*., 2011) [6].

Table 3: Samples Phytochemical Contents (mg/100 g)

Parameters	Fruit Pulp	Seeds
Alkaloids	9.23±1.04^a	21.72±1.23^b
Cyanide	0.02±0.01^a	0.06±0.07^a
Flavonoid	11.64±0.62^a	23.12±1.86^b
Glycosides	6.74±0.83^a	28.72±1.99^b
Nitrate	6.66±0.76^a	19.36±1.45^b
Phytate	22.54±1.08^a	21.64±1.03^a
Oxalate	21.07±0.92^a	26.76±1.22^a
Saponin	23.31±0.04^a	26.24±1.016^a
Tannins	6.02±0.09^a	22.56±1.03^b
Terpenoids	21.74±1.28^a	19.36±1.99^a

Values are means ± standard error of three replications. There is significant difference (P≥0.05) for values within a row with different superscripts.

Conclusion

To conclude, it is important to reiterate the need to increase the cultivation and consumption of cucumber and other related vegetables in order to benefit from their many laden health benefits that could help significantly in reducing the onset of many chronic diseases associated with nutrition especially in the African sub region where health problems associated with nutrition are now on the increase.

Conflict of Interest

The authors wish to affirm that there is no conflict of interest of whatsoever amongst them.

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