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Phytochemical, Nutritional Composition and Heavy Metals Content of *Allium cepa* (Onion) and *Allium sativum* (Garlic) from Wudil Central Market, Kano State, Nigeria

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ABSTRACT: *Allium* plants are common spices used as food ingredients. *Allium cepa* (onion) and *Allium sativum* (garlic) are cultivated in Wudil town. In this study the qualitative and quantitative phytochemicals in *Allium cepa* revealed the presence of alkaloids (6.45mg/kg), tannins (1.25mg/kg), flavonoids (1.51mg/kg), total phenolic (20.68mg/kg) while saponin was absent. On the other hand *Allium sativum* shows alkaloids (4.68mg/kg), tannin (0.25mg/kg) and saponin (0.44mg/kg). Proximate composition of garlic show ($p<0.05$) increase in fat (2.82%), carbohydrate (24.55%), fibre (2.74%), and ash (4.22%) when compared with onion, while protein (2.96%) and moisture (87.36%) are ($p<0.005$) higher in onion. Anti-nutritional factors present in onion show ($p<0.05$) increase in oxalate (11.85mg/kg) and tannins (0.76mg/kg), while garlic shows ($p<0.05$) increase in phytate (1.79mg/kg) and hydrogen cyanide (0.39mg/kg). Heavy metals in onion were ($p<0.05$) higher in Cd, Cu, Fe, Pb, and Mn, while garlic only show ($p<0.05$) increase in Zn and Co. The Cr in onion shows ($p>0.05$) difference when compared with garlic. Cd and Pb in onion and garlic were above WHO recommended safe limits in vegetables. From this study it is observed that the agro-climatic condition may have effect on the phytochemicals of both plants samples from Wudil, while sources of the heavy metals need to be investigated and controlled from level of cultivation to that of processing.

Keywords: Phytochemicals, Heavy metals, *Allium cepa, Allium sativum, Wudil Market*

Introduction

In developing countries, most people have resort to the use of spices as a natural food ingredient. *Allium capa* (onion) and *Allium sativum* (garlic) are among the commonly use spices, this is due to their availability and health promoting values. They are reported to be similar in nutritional, phytochemical, and nutraceutical contents [1,2]. Lintas (1992) and Roa *et al*. (1995) reported that *Allium cepa* and *Allium sativum* are rich in nutrients such as protein, carbohydrate, minerals, dietary fibre and vitamins [3,4]. But some of these nutrients can be made unavailable to human due to the present of anti-nutritional chemicals in them. Anti-nutrients are chemicals which have been evolved by plants for their own defense, among other biological functions and reduce the maximum utilization of nutrients especially proteins, vitamins, and minerals, thus preventing optimal exploitation of the nutrients present in a food and decreasing the nutritive value. Some of these plant chemicals have been shown to be deleterious to health or evidently advantageous to human and animal health if consumed at appropriate amounts [5,6].

The epidemiologic evidence have shown that frequent consumption of *Allium* plants such as garlic, onion, scallions, chieves are protective against cancer. The *Allium* vegetables are also considered an important component of a healthy, cancer and cardiovascular disease (CDV) resistant diet [7]. The active phytochemicals present in these spices are responsible for the reported health benefits [8]. They are cultivated on different soils and climatic conditions. Climate change and agricultural practice are reported to be causing noticeable effects on the distribution and phytochemical composition of the vegetation, including medicinal and aromatic plants [9,10]. Alterations in the accumulation and concentration of phytochemicals in fruits and vegetables may have adverse effects on the health benefits emanating from their consumption [10].

Herbal contamination by heavy metals has become a world-wide problem during recent years due to the fact that heavy metals unlike some other pollutants are not biodegradable [11,12]. Toxicity of phytochemicals, plant-based extracts and dietary supplements, and medicinal plants in general, is of medical importance and must be considered in phytotherapy and other plant uses [13]. Heavy metals pollution is one of the problems that arise due to the increased uses of fertilizers and other chemicals to meet the higher demands of food production for human consumption [14,15].

This study was aimed at determining the phytochemical, proximate composition, anti-nutritional factors and heavy metals present in *Allium cepa* L. (onion) and *Allium sativum* (garlic) sold in Wudil market in Kano.

Materials and Methods

Chemicals

Chemicals of analytical grade purity and distilled deionized water were used. All glass wares and plastic containers used were washed with detergent solution followed by (20% v/v) nitric acid and then rinsed with tap water and finally with distilled deionized water.

Sample Collection and Authentication

The two samples (onion and garlic) were purchased from Wudil Central Market, Kano State, Nigeria, from the traders on 4th of September, 2020. The samples were identified and authenticated at the Department of Plant Biology Herbarium, Bayero University, Kano, with a voucher (BUKHAN 0267), specimen of plant deposited for reference.

Processing and Sample Preparation

The samples were air dried separately in Biochemistry laboratory (Nigeria Police Academy, Wudil) for two weeks, and then blended using an automated blender into a very fine powder and kept in a sterile air tight plastic container.

Phytochemical Analysis

The phytochemical analysis was carried out for both samples as per the standard methods with some modifications [16,17,18].

Proximate Analysis

The proximate analysis (carbohydrate, fats, protein, moisture and ash) of the samples was carried out using [19] methods. Carbohydrate was determined by difference (100 – (protein + fat + moisture + ash). The fibre was also determined according to the method of [20].

Anti-nutrient Analysis

Tannin, oxalate, phytate and hydrogen cyanide content were determined according to the official methods of analysis described by the Association of official Analytical chemist [21, 22]. Values are reported in mg/kg.

Heavy Metals Analysis

Heavy metal analysis using AAS was carried out after sample digestion with 24 cm^3 mixture of conc. HNO_3, Conc. H_2SO_4 and 60% $HClO_3$ (9:2:1 v/v). The mixture was digested on hot plate till the solution became transparent. The resulting solution were filtered and diluted to 50ml using deionized water and analyzed [23].

Statistical analysis

Statistical analysis of the data was carried out using Independent Student t-test to assess significant variation in the mean concentrations. Results were presented in Mean ± SEM (Standard Error of mean) (n = 3). A Probability level of $p < 0.05$ was considered statistically significant. All statistical analyses were done using SPSS version 21.0 (IBM Corp., USA) software for windows.

Results and Discussion

The result of qualitative phytochemical for the two spices showed presence of alkaloid and tannins, while flavonoids and total phenolic are presence in *Allium cepa* and saponin presence in *Allium sativum.* Steroid, anthraquinone and terpenoids are absent in both samples (Table 1). This result is in agreement with work of [2] who also reported the presence of alkaloid, tannins and flavonoids in *Allium cepa* and absent of saponin, from samples gotten from Sokoto, while tannin was absent in *Allium sativum* of their sample, but present in this study. The result obtained in this study (Table 1) is in contrast with the work of [24] who reported saponin in both samples from India and presence of flavonoid in *Allium sativum.* Due to the difference in the phytochemical components of the samples from [24], the medicinal values and potency of the two samples from [24] might be different from the samples collected from wudil.

Table 1: Qualitative phytochemical of *Allium cepa and Allium sativum*

Parameters	*Allium cepa*	*Allium sativum*
Alkaloids	+ve	+ve
Tannins	+ve	+ve
Flavonoids	+ve	-ve
Total Phenolic	+ve	-ve
Saponin	-ve	+ve
Steroids	-ve	-ve
Anthraquinone	-ve	-ve
Terpenoids	-ve	-ve

+ve = Present –ve = Absent

The result of quantitative phytochemical showed significant ($p < 0.05$) difference in alkaloid, tannins, flavonoids and total phenolic of *Allium cepa* when compared with *Allium sativum*, while in *Allium sativum*, soponin showed significant ($p < 0.05$) increase (Table 2). These differences may be due to climatic condition and farming methods [9,25]. The phytochemical present in spices are known to possess both physiological and medicinal activities. Tannins from *Allium cepa* skin have been reported to have antioxidant activity [26], and their presence may supports the anti-inflammatory property of the plant and this may also explain its use in the treatment of ulcer, earache and as antitussive as reported by [2]. Alkaloids are very useful in medicine and are used in the production of several valuable drugs [27].

Table 2: Quantitative phytochemical of *Allium cepa and Allium sativum*

Parameters	*Allium cepa* **(mgkg^{-1})**	*Allium sativum* **(mgkg^{-1})**
Alkaloids	6.45 ± 0.053^{a}	4.68 ± .051^{b}
Saponins	-	0.44 ± 0.003^{a}
Tannins	1.25 ± 0.009^{a}	0.25 ± 0.013^{b}
Flavonoids	1.51 ± 0.059^{a}	-
Total Phenolic	20.68 ± 0.022^{a}	-

Superscript a and b show statistically significant different ($p < 0.05$); Mean ± SEM; n = 3.

Proximate composition showed significant increase ($p < 0.05$) in *Allium sativum* crude fat, carbohydrate, fibre and ash content when compared with *Allium cepa*, while total protein and moisture content of *Allium cepa* shows significance increase ($p < 0.05$) (Table 3). The results from wudil samples indicated that the crude fat, fibre, and ash content were higher than that of Sokoto [2]. Lintas (1992) and Roa *et al*. (1995) have reported the richness of the two spices in nutrients [3,4]. Crude fibre help in maintenance of normal peristaltic movement of the intestinal tract, it may help in the digestion of food. Higher fibre content in *Allium sativum* and *Allium cepa* makes it suitable for recommendation for patients who have problem of food digestion [20,2].

Table 3: Proximate composition of *Allium cepa and Allium sativum*

Parameters	***Allium cepa*** **(%)**	***Allium sativum*** **(%)**
Crude Fat	1.11 ± 0.006^{b}	2.81 ± 0.009^{a}
Total Protein	2.96 ± 0.006^{a}	2.33 ± 0.009^{b}
Carbohydrate	3.51 ± 0.012^{b}	24.55 ± 0.009^{a}
Fibre	2.51 ± 0.015^{b}	2.74 ± 0.012^{a}
Ash	2.55 ± 0.00882^{b}	4.49 ± 0.006^{a}
Moisture	87.36 ± 0.053^{a}	63.61 ± 0.009^{b}

Superscript a and b show statistically significant different ($p < 0.05$); Mean ± SEM; n = 3.

Ash content is an indication of high inorganic mineral content [28]. This result indicates that *Allium sativum* is richer in inorganic minerals than *Allium cepa* (Table 3). Proteins are essential component of the diet needed for the survival of animals and human, they serve as source of nitrogen in the body system along with the amino acids. Good skin, increase in growth and ability to replace the worn-out cells are the quality of protein in the body [20]. Both samples *Allium cepa* and *Allium sativum* had protein concentration below 5 %. The moisture content of the samples from Wudil and Sokoto shows that they cannot be stored for a long time without microbial and biochemical spoilage [2], when compared with the samples reported from Akure [7]. Nwinuka *et al.,* (2005) reported that food with low moisture content (especially those with less than 10 %) have longer shelf-life with limited deterioration in quality due to microbial activities, but those with moisture content higher than 10 % cannot be stored for long period of time [29].

The anti-nutritional factors have been related to many health issues [30]. Onion shows significant increase ($p < 0.05$) in oxalate and tannins, while phytate and hydrogen cyanide are significant ($p < 0.05$) in garlic (Table 4). The level of phytate, tannins and oxalate in these samples are low, when compared to that of *Allium cepa* reported by [6]. Eka, (1997)[31] reported the capability of oxalates in chelating the bivalent metal ions like Mn^{2+}, Ca^{2+}, Mg^{2+}, and Fe^{2+} and some may even precipitates in kidney tubules which may result into oxaluria, the level in onion and garlic (Table 4) showed that it won't cause such effects. The low level of oxalate in this study indicated that the two samples may be a good source of adjunct food. The low phytate content also indicated that its role in hindering absorption and utilization of certain mineral elements in human and animal bodies [31,6] will be minimal when consuming as a spices. The anti-nutrient, tannin is noted for its role in inhibiting the activity of some enzymes such as trypsin, chymotrypsin and amylase by forming complexes with the protein [31,6]. Tannin content in these samples was low; hence, the tendency of inhibiting these digestive enzymes will be low on consumption of diets garnished with the spices.

Table 4: Anti-Nutritional factor in *Allium cepa and Allium sativum*

Parameters	*Allium cepa* (mgkg^{-1})	*Allium sativum* (mgkg^{-1})
Phytate	1.45 ± 0.064^b	1.79 ± 0.099^a
Oxalate	11.85 ± 0.427^a	11.13 ± 0.158^b
Hydrogen Cyanide	0.24 ± 0.046^b	0.39 ± 0.023^a
Tannins	0.76 ± 0.121^a	0.46 ± 0.006^b

Superscript a and b show statistically significant different ($p < 0.05$); Mean ± SEM; n = 3.

The level of heavy metals like Cd, Cu, Fe, Pb, and Mn, are significantly ($p < 0.05$) high in *Allium cepa*, than in *Allium sativum*, where Zn and Co are the significantly ($p < 0.05$) high metals in *Allium sativum*. But, the Cr in both samples are non-significant ($p > 0.05$) different. Only Cd in *Allium cepa* and Pb in *Allium sativum* are above the FAO/WHO safe limit in vegetable (Table 5). From this study, it can be observed that the onion have high amount of Cd, Fe, and Pb, while garlic have high amount of Fe, Pb, Zn and Co. The four major heavy metals of health concern are arsenic, cadmium, mercury and lead [32,33,34], which are biologically non-essential and toxic to both plants and animals. The permissible limits for arsenic, cadmium, lead and mercury in herbal medicines and products as reported by AOAC (1994) are 10.0(μg/g), 0.3(μg/g), 10.0(μg/g) and 0.1(μg/g) respectively [15]. This indicated that the Cd and Pb are almost higher than the herbal medicine permissible limit [15]. Fertilizers and other chemicals used in order to meet high demands for these spices may be responsible for the increase in heavy metals [14,15].

Table 5: Average Concentration of heavy metals in *Allium cepa and Allium sativum* samples

Elements	*Allium cepa* (mgkg^{-1})	*Allium sativum* (mgkg^{-1})	FAO/WHO Safe limit (mgkg^{-1})
Cadmium (Cd)	0.27 ± 0.003^a	0.18 ± 0.000^b	0.2
Copper (Cu)	1.67 ± 0.029^a	0.68 ± 0.000^b	73.3
Chromium (Cr)	0.15 ± 0.004^a	0.14 ± 0.004^a	2.3
Iron (Fe)	10.50 ± 0.289^a	5.61 ± 0.029^b	425.5
Lead (Pb)	1.63 ± 0.038^a	0.33 ± 0.000^b	0.3
Manganese (Mn)	0.88 ± 0.006^a	0.25 ± 0.001^b	500
Zinc (Zn)	0.96 ± 0.005^b	10.47 ± 0.003^a	99.4
Cobalt (Co)	0.01 ± 0.000^b	0.78 ± 0.003^a	50

Superscript a and b show statistically significant different ($p < 0.05$); Mean ± SEM; n = 3

Conclusion

It could be concluded from this study that *Allium cepa and Allium sativum* from wudil can be a good source of nutrition supplement, likewise the anti-nutrients may not pose any toxicity on consumption because of their low concentrations, while the agro-climatic condition may have effect on the nutrition and phytochemicals components of the two samples. For the heavy metals their sources need to be investigated and controlled from level of cultivation to that of processing.

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