Comparative evaluation of the mineral profile and other selected components of onion and garlic

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Abstract

Mineral profile and some selected components of three cultivars of onion (*Allium cepa* L.) (Dan Zaria, red creole and white creole) bulb were compared with garlic (*Allium sativum* L.) clove. This was pertinent to establish their potentials in ensuring adequate nutrition and food security. Simultaneous multi-element analysis was done by inductively coupled plasma-optical emission spectroscopy (ICP-AES). Selected components determined were pyruvic acid, total soluble solids (TSS), ash content, moisture content, vitamin C and pH. The most abundant quantity minerals in the *Allium* species are potassium (14291.17-17297.88 mg/Kg), phosphorus (2491.04-4777.88 mg/Kg) and calcium (694.41-1824.29 mg/Kg). Garlic had highest amount of phosphorus and zinc (4777.88 and 66.08 mg/Kg, respectively) with least contents of calcium, magnesium, iron and aluminium. Garlic had significantly (p<0.05) higher contents of pyruvic acid, ash and TSS contents than onion cultivars, with increase of 88%, 130% and 104% more than the highest obtained in onion cultivars. Except for moisture and vitamin C contents, highest value (with significant difference) of all the selected components was obtained in garlic. Onion cultivar (red creole) with least content of pyruvic acid and highest content of TSS would be preferred for culinary purpose. The comprehensive mineral profile of garlic and onion samples obtained in this work is an information that could sensitize people on their need for more consumption. This can be a good opportunity to enhance micronutrient supply of the diet of low income earners which form majority of the society.

Keywords

Onion cultivars
Garlic
Mineral contents
Pyruvic acid
Total soluble solids

Introduction

Onion (*Allium cepa* L.) bulb and garlic (*Allium sativum* L.) clove have been cultivated since antiquity as vegetable and flavoring agents due to their characteristic pungent flavour. Their widespread use as a flavoring agent in food and for the treatment of many diseases is well known. Onions find widespread usage in both fresh and dried forms. It is used as a flavour additive in a wide variety of food formulations such as comminuted meats, sauces, soups, salad dressings and pickle relishes (Kumar et al., 2006). From time immemorial, onion and garlic have been used by diverse cultural groups for treatment of parasitic, fungal, bacterial and viral infections, with investigations suggesting sulphur compounds as the main active antimicrobial agents (Rose et al., 2005). Other components that can also contribute to this activity are some proteins, saponins and phenolic compounds (Griffiths et al., 2002). Garlic is among the most used vegetables for treating Type II diabetes mellitus in diabetic women group from United States (Johnson et al., 2006). The combination of essential oils of onion (75%) and garlic (25%) could substitute synthetic preservatives in food safety to control fungal contamination and mycotoxin production (Kocić-Tanackov, 2012). Garlic and onion have a promoting influence on the bio accessibility of iron and zinc from food grains (Gautam et al., 2010).

Scientific research studies support the fact that onions and garlic are worthy of being eaten every single day in order to provide optimum health benefits. Although pungent and giving off a sulphurous odour, these foods should not be brushed aside. Consumers’ tendency is currently towards foods with beneficial attributes for health and good organoleptic characteristics. The benefits of onion and garlic are well known yet many people do not eat them as much as possible. Information on multi-elements (mineral content) of onion is scanty. The present study was conducted to compare the mineral profile and selected properties of different cultivars of onion with garlic. This is important to guide in the choice to be used more often for culinary purposes.
Materials and Methods

Plant material

Three cultivars of fresh onion bulbs, which were white creole, red creole and Dan Zaria (with white, red and brown skin, respectively), and garlic clove were used for this study. They were obtained from National Horticultural Research Institute, Ibi-idishin, Jericho, Ibadan, Nigeria. The experimental design was randomized complete block design with three replicates.

Sample preparation

Representative samples of the fresh onions and garlic in three replicates were freed of their outer dry skin and sorted to remove dirt and extraneous materials. They were then cleaned with distilled water until no foreign material remained and allowed to air-dry under ambient condition for 3 h. All cleaned samples were divided into three portions. One part was cut into slices of about 2 mm thickness and dried in a cabinet drier (Hotbox Oven with fan, size 2, GallenKamp, England) at initial temperature of 50°C for 6 h and then increased to 55°C for 18 h. The dried slices were milled into flour with a micro mill to pass through a mesh of 150 mm screen size. The flour samples were packed in zip-lock bags and kept in covered plastic containers until used for analyses. The second part of the cleaned samples was cut into small sizes before being homogenized in Ace homogeniser for two minutes at the minimum speed setting available on the blender. The blending was intermittently done to prevent the samples from heating up. The juice of fresh tissue was strained through cheesecloth to remove pulp.

Total soluble solids, total titratable acidity, pH and vitamin C were determined for fresh homogenized samples while ash content and multi-element (i.e. mineral profile determination) were carried out on the dry-milled samples. The third portion, i.e. the fresh sample, was used for the determination of pyruvic acid and moisture contents.

Determination of multi-elements

Determination of the multi-elements was done according to the method of Zarcinas et al. (1987). Aliquots of three replicates (about 0.5 g) from each of the samples were weighed into cleaned digestion tube (Pyrex 50 mL-culture tubes). Into each tube was added 2 mL concentrated redistilled Nitric acid (HNO$_3$), covered with cling film and then left overnight at room temperature for cold digestion. The tubes were subsequently placed to a digestion block at 120°C. Heating was continued and as the liquid dried off, additional 2 mL HNO$_3$ was added and was eventually heated to dryness. This step was repeated until the sample no longer gave off reddish–brown (ferrous oxide) fumes and the solution was clear. Addition of 1 mL solution of Nitric acid and Perchloric acid (50/50) was done into the solution in the tubes and the temperature of the block was raised to 180°C and digested for 2 h. There was further increase in temperature to 220°C and the solution was heated to dryness. The tubes were then removed from digestion block and allowed to cool to room temperature. The ash obtained was re-dissolved in 1 mL conc. HCl and 10 mL of 5% Nitric acid, mixed and transferred into plastic nunc tubes for analysis. The sample ash solution was injected into Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES) (model Questron Technologies Corp. TL 6000) to determine the mineral content.

Determination of total pyruvic acid content

Extraction of pyruvic acid: Pyruvic acid content was determined using dinitro pheny hydrazine (DNPH) reagent according to the method of Anthon and Barrett (2003). The samples were cut longitudinally into two pieces. One half was chopped and homogenized in Ace homogeniser with water (1:1). The filtered homogenate with cheesecloth was centrifuged at 62.61 g for 5 min and the clear extract was used for pyruvate assay to measure total pyruvic acid (Pt). The remaining half was microwaved (microwave power of 1200 W) for 1 second/g of the bulb weight to deactivate the allinase. It was cooled, homogenized in water, filtered and centrifuged as mentioned above and was used to evaluate the native pyruvic acid.

Pyruvic acid analysis: Spectrophotometric assay was carried out using 25 µL of clarified filtrate with 1 mL of distilled water and 1 mL of 0.25 g/L DNPH (prepared in 1M HCN) added to it. The reaction mixture was placed in a water bath at 37°C for 10 min to allow the reaction to proceed. After removing the samples from the water bath, 1 mL of 1.5 N NaOH was added. The absorbance was recorded at 515 nm. The standard curve was constructed using 0, 2, 4, 6 and 8 mM sodium pyruvate (Sigma, Italy). The difference between the pyruvic acid content of the homogenates from unheated (Pt) and heated samples (PC) is defined as µ moles of enzymatically produced pyruvic acid (Pe) per gram garlic.

Other analyses

Moisture, ash, pH, total soluble solids and vitamin C were analyzed according to the procedures of AOAC (2000). Moisture content was determined...
by drying the samples of fresh material at 105°C till constant weight was obtained (950.46B). Ash content was determined by incinerating about 2 g sample in a muffle furnace (ELF 11/6B, Carbolite Ltd) at 600°C for 6 h until the ash turned to white color (920.153). Little drops of the juice were used to measure pH with pH meter (model 3505, Jenway). A drop of the juice was placed on the prism of refractometer (BS Eclipse 45-05) to obtain total soluble solids. Vitamin C level was estimated by iodine titration method.

Statistical analysis

Statistical analysis of all data of the three replicates was done with Statistical Analysis System (SAS) (version 9.2). Statistical significant difference (p<0.05) in all data was determined by analysis of variance (ANOVA) procedure. Means were separated with least significant difference using Fisher’s procedure.

Results and Discussion

Mineral profile

The mineral profile of the three onion cultivars and garlic is presented in Table 1. Quantity minerals, which are potassium, calcium, phosphorus, magnesium, and sodium, have values that ranged between 14291.17-17297.88 mg/Kg, 694.41-1824.29 mg/Kg, 2491.04-4777.88 mg/Kg, 710.12-990.59 mg/Kg, and 322.73-407.08 mg/Kg, respectively. Highest contents of potassium, calcium, and magnesium were obtained in Dan Zaria (brown skinned onion), which is not significantly different (p<0.05) from the amount in garlic (16675.75 mg/Kg). Garlic clove had highest content of phosphorus. Phosphorus content in garlic is higher by 91.8% when compared to that in Dan Zaria and by 29.5% in red creole that has highest value among the onion cultivars. Potassium, magnesium and calcium are important in prevention and treatment of hypertension and their high intake may reduce coronary heart disease and stroke (Houston and Harper, 2008). Increases phosphorous intake also has potential to lower blood pressure (Elliot et al., 2008).

For the trace elements, iron, aluminium, zinc, copper, manganese and nickel have range of values of 30.16-160.69 mg/Kg, 23.30-41.46 mg/Kg, 24.73-28.83 mg/Kg, 2.87-5.17 mg/Kg, 2.91-7.26 mg/Kg, and 0.18-0.21 mg/Kg, respectively. Garlic had highest content of zinc but with least contents of calcium, magnesium, iron and aluminium compared to the onion cultivars. According to Andreini et al. (2008), some transition metals including iron, zinc, manganese, and copper are very essential for life through their function as both structural and catalytic cofactors for proteins. Zinc supplementation for children between three months and five years reduces frequency and severity of diarrhea and respiratory illnesses (Aggarwal et al., 2007). Selenium functions as a dietary antioxidant and thus has been studied for its possible role in

| Table 1. Mineral contents (mg/Kg) of the Allium species |
|----------------|----------------|----------------|-------------------|
| Mineral | Dan Zaria | Red Creole | White Creole | Garlic |
| K | 17297.88 | 16022.90 | 14291.17 | 16675.75 |
| Ca | 1824.29 | 1315.85 | 1368.82 | 694.41 |
| P | 2191.04 | 3689.49 | 3091.80 | *4777.88 |
| Mg | 990.59 | 979.95 | 862.09 | 710.12 |
| Na | 322.73 | 374.28 | *407.08 | 341.04 |
| Fe | 160.69 | 118.15 | 93.12 | 30.16 |
| Al | 41.46 | 28.15 | 30.63 | 23.30 |
| Zn | 38.44 | 31.24 | 26.87 | *66.08 |
| Cu | 27.23 | 25.81 | 24.73 | *28.83 |
| Mn | *17.39 | 14.09 | 11.53 | 12.26 |
| Ni | 4.38 | 5.11 | 4.58 | 4.48 |
| As | 3.64 | 2.87 | 2.98 | *5.17 |
| B | 2.91 | 3.38 | *7.26 | 5.82 |
| Mo | 0.42 | 0.15 | 0.11 | 0.26 |
| Se | 0.29 | 0.10 | 0.73 | *1.08 |
| Co | 0.20 | 0.18 | *0.21 | 0.19 |
| Cd | 1.18 | 1.11 | 0.93 | *1.21 |
| Pb | 0.26 | 0.40 | 0.24 | *0.54 |

Means followed by different letters down the column are significantly different (p<0.05) from one another
*Highest value of each mineral content
chronic diseases (Boosalis, 2008). Only two toxic metals, i.e. cadmium and lead, were found to be present in the samples with values within the range of 0.93-1.21 mg/Kg and 0.24-0.54 mg/Kg, respectively.

Bello et al. (2013) reported higher values for some minerals, i.e. 2.98%, 1.22%, 0.05%, 0.04% and 0.13% for potassium, calcium, manganese, iron and copper respectively in onion bulb. In contrary, Cota et al. (2013) reported lower mean values for some minerals i.e. 1.313 mg/Kg, 0.72 mg/Kg, 0.324 mg/Kg, 0.221 mg/Kg, 0.015 mg/Kg and 0.003 mg/Kg for Zn, Fe, Mn, Cu, Cd and Pb, respectively, in bulbs of the new varieties of onion from Bosnia and Herzegovina. Red skinned onion (Dan Zaria) and garlic had highest content in 44% and 33%, respectively, of all the minerals discovered to be present in the analysed samples. White creole had least contents of the toxic metals. In all, garlic had the highest contents of phosphorous, zinc, copper, arsenic, selenium and lead.

Other selected components

The contents of other selected components of the allium species are shown in Table 2. Pyruvic acid level differed significantly among all the Allium samples with highest value of 53.33 μmol/g in garlic and least value of 15.00 μmol/g in red creole. This confirms the strong pungency of garlic compared to onion cultivars. White creole had higher values than Dan Zaria and red creole. This is in contrary to the report of Gallina et al. (2012) with white onion having lower value of pyruvic acid than red and yellow onions obtained from breeders’ accession in Italy. Abedi et al. (2013) also reported variation in pyruvic acid content in some garlic cultivars. Pungency level in Allium species is an indirect measure of thiolsulfinates content like allicin (Sance et al., 2006).

Consumer demand is oriented toward onion cultivars with lower pungency. Pyruvic acid content of onions is highly correlated with their pungency (Gallina et al., 2012). Lower content of pyruvic acid (3.35 to 8.13 μmol/g) reported for ten cultivars from Poland (Leja et al., 2008) could be as a result of their lower dry matter content (7.79 – 12.45%) compared to those used for this research.

Highest content for ash (2.37%) was obtained garlic and was followed by 1.03% obtained in red creole, with least content of 0.77% in Dan Zaria, which is not significantly different (p>0.05) from the value obtained in white creole. This means that the total mineral contents of garlic is higher than that in onion cultivars. Highest content of TTS (19.87 °Brix) was also obtained in garlic. Range of 8.83 – 9.73 °Brix was obtained in onion cultivars. Although there were highest contents of pyruvic acid and TSS in garlic, there is no relationship between pyruvic acid and TSS in onion cultivars.

Higher values of vitamin C (range of 14.67 – 20.67 mg/100 g) were obtained in onion cultivars while garlic had least value of 8.00 mg/100 g. Highest value of 6.61 for pH was recorded for garlic while range of 5.85 – 5.90 (in white creole and red creole, respectively) was obtained in onion cultivars. Least amount of moisture content (76.93%) was obtained in garlic while range of 86.60-88.67% was obtained in the three onion cultivars. Lower moisture content of garlic is an indication that it could be kept for longer period of time than onion.

Conclusions

As it has been shown that the Allium spp have potassium in abundance with very low content of sodium. This research finding could be useful to develop a food-based strategy to increase the bioavailability of trace minerals and therefore contributes to the benefit of human health. Smaller quantity of garlic could conveniently be used to flavour foods to obtain the similar nutritional benefit of some components that is obtained when higher quantity of onion cultivars is used. This is important since the current consumers’ tendency is towards foods with beneficial attributes for health and good organoleptic characteristics. Regular inclusion of Allium spp in meals, especially in powdery form can also be a good opportunity to enhance micronutrient supply of the diet of low income earners which form majority of the society.
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References


