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Study of Nutrient Content Variation in Bulb And Stalk of Onions (*Allium Sepa*) Cultivated in Aliero, Aliero, Kebbi State, Nigeria

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ABSTRACT: The proximate, macro and trace-elements, vitamins A and C, and oxalate compositions were determined in onion bulbs and their stalks from three agricultural fields in Aliero, Kebbi state. The bulbs and stalks contained closely related mean values of 93.11g/100g and 91.70g/100g, 6.48g/100g and 6.74g/100g as moisture and crude protein contents respectively. Values of 4.26g/100g (bulbs) and 13.56g/100g (stalks) were observed as ash content, while their fibre contents were 13.56g/100g (bulbs) and 9.33g/100g (stalks). The macro element concentration in the bulbs was in the order Ca>Mg>K>P>Na while that of the stalks was Mg>Ca>K>P>Na. For the trace elements, the order was Fe>Zn>Mn>Cu>Pb>Ni>Cd for the bulbs and Fe>Mn>Zn>Cu>Ni>Pb>Cd for the stalks. Only Iron concentrations were observed to be higher than (100-500$\mu g g^{-1}$) the normal Fe concentrations in plants. There were significant differences ($p<0.05$) in the mean concentrations of Fe, Mn and Pb with stalks having higher values for Fe and Mn. Both the oxalate and vitamins A and C contents of the bulbs were significantly ($P<0.05$) high when compared to other reported values. The presence of oxalate in both the bulbs and stalks could affect the bioavailability of some nutrient elements. The results generally indicate that the bulbs are more nutritious than the stalks. With the current problem of Fe deficiency as identified by WHO, onions could be another source of helping the situation.
Keywords: Onion bulbs and stalks, proximate, nutrient elements, vitamins A and C; oxalate.

INTRODUCTION

Onion (*Allium sepa*) is an essential part of the diets of many Nigerians and like other vegetables; it provides vitamins such as vitamin A and C, and a good amount of mineral elements to the human body (USDA, 2008; Paul, 2006). In addition, onion is among the food plants to which moderate level of anticancer activities is associated with (Micheal, 2006).

The stalks are most often discarded or used only when the bulbs are not available or too expensive. Onions are cultivated twice in a year with application of fertilizers, manure, compost and different types of agricultural chemicals required for good yield by the farmers in Aliero town and its surroundings. Data on the nutrient composition in onions from the study area is limited. In view of this, the present study was initiated to investigate the proximate compositions as well as the presence and the concentrations of macro and trace elements, vitamins A and C and oxalate in onions bulbs and stalks from Aliero town.

MATERIALS AND METHODS

Sample collection and processing: Onion bulbs with their stalks were collected randomly from agricultural fields in three locations in Aliero town in the months of December and January, and were labeled A, B and C taking the fields in to consideration. The samples were immediately taken to the laboratory for further processing and analyses.

Reagents and glass wares: All reagents used in this work were of analytical grades from BDH chemicals (UK) and double distilled water was used throughout the experimentation. The glass wares were washed with liquid soap, rinsed with water and then soaked in 15% HNO_3 solution for

48 hours before rinsing with distilled water and dried in an oven at 55^{o}C for 5 hours (Haw-Tarn, *et al.,* 2004; Uba and Uzairu, 2008).

Proximate analysis: The moisture contents of the samples were determined by monitoring the weight loss of a fresh sample at 105^{o}C until constant weight was observed (Christian, 1980; Aweke and Tadese, 2004; Walter and Bryon, 1981). The ash contents of the samples were determined by using 2.00g of each of the oven dried powdered sample in a muffle furnace (Lenton furnace, England) at 550^{o}C for 3 hours. The protein content was determined by digesting 2.0g of each of the sample with 20cm^3 of concentrated H_2SO_4 ((98% w/v) in the presence of selenium as catalyst. To the digest, 100cm^3 of NaOH solution was added and distilled using Kjeldahl distillation apparatus. The NH_3 produced was collected in a flask containing 50cm^3 of 0.1M HCl and was determined by estimating the amount of the HCl consumed in the reaction. This was carried out by back titrating the excess HCl with 0.1M NaOH solution using Bromocresol green as indicator (Mendham, *et al.,* 2000; AOAC, 1990). The crude lipid was extracted with n-hexane in a soxlet extractor and the crude fibre by acid-base digestion using 10% H_2SO_4 and 10% NaOH solutions. The available carbohydrate was determined as a difference between 100g dry mass of a sample and the sum of the values for ash, fibre, crude lipid and protein (Stewente, *et al.,* 1974, AOAC, 1990; McDonald, *et al.,* 1994).

Analysis of macro elements: Wet ashing technique was used and the digestion processes in triplicates were carried out by weighing 1.0g of each of the oven dried and powdered sample in to separate 100cm^3 Kjeldahl flasks, 30cm^3 of 69.5% (w/w) HNO_3 was added to each of the flasks and heated until about 10cm^3 of each of the solution remained. This was followed with the addition of 2cm^3 of 60% $HClO_4$ acid, 10cm^3 of 69.5% (w/w) HNO_3 and 1cm^3 of 98% (w/w) H_2SO_4 in to each of the flasks. The mixtures were further heated in a fume cupboard until the appearance of white fumes. The resulting solutions after cooling were each filtered in to separate 50cm^3 volumetric flasks and diluted to the mark with distilled water (Miller and Baker, 2000; Daniel, 2003). Sodium and potassium were determined by flame photometry (Corning 400 model), phosphorus was determined by colorimetric (phosphor-vanadomolybdate) method using spectrophotometer (6100, Jenway, UK). Magnesium was determined by AAS (S4 Atomic Absorption Spectrometer Thermo Electron, Cambridge, 2002).

Analysis of trace elements: The process was carried out in triplicates using wet ashing technique by weighing out 1.0g of each of the oven dried and powdered sample in to separate digestion tubes, 30cm^3 of 69.5% (w/w) HNO_3 acid was added to each and heated until about 10cm^3 were left. This was followed with addition of 10cm^3 of 69.5% (w/w) HNO_3 acid and 2cm^3 of 60% $HClO_4$ acid and the heating process continued until clear solutions were obtained. Each of the digests was diluted with about 20cm^3 of distilled water, boiled for another 15 minutes, allowed to cool, filtered in to separate 50cm^3 volumetric flasks and made to the mark with distilled water. The solutions were stored in separate screw capped polyethylene bottles (Audu and Lawal, 2006; John, 2000). Blank solution was prepared in the same way but without any sample.

Spiking experiment: This was carried out to test for the validity of the digestion procedure and analysis of the trace metals. 30cm^3 of the multi-element standard solution was pipetted to spike 1.0g of the onion stalk sample in a digestion flask. The same digestion procedure for the trace metals was observed.

Analysis of vitamins: Vitamin A was estimated by spectrophotometry using a CE440UV/Vis Double Beam Scanning spectrophotometer at 450nm after extraction with petroleum ether from a mixture of 1.0g of a sample in 95% ethanol. The ether extract was concentrated by heating in a rotary vacuum evaporator. Further separation was carried out in a chromatographic column packed with silica gel by eluting with petroleum ether. The first yellow eluate was collected in a 25cm^3 flask and the absorbance was taken immediately (Muchoki, *et al*. 2007; AOAC, 1998). The vitamin C content was estimated by Iodimetric titration with standard $Na_2S_2O_3$ solution after 2.00g of sample was treated with 10cm^3 of metaphosphoric and acetic acid mixture to reduce oxidation of ascorbic acid, inactivate enzymes and reduces interference of ions present (Aminullah, *et al.,* 1993; Ceriwyn, 1998).

Analysis of oxalate: The oxalate content was estimated by heating 2.0g of a powdered sample in

190cm^3 of distilled and 10cm^3 of 6M HCl. The cold filtrate was treated with 2-3 drops of methyl red indicator and NH_4OH solution before heating the mixture to 90-100^{o}C. After cooling, the filtrate was heated further before the addition 10cm^3 of 10% $CaCl_2$ solution and allowed to stand over the night. After filtration, the precipitate formed was washed to remove traces of Ca^{2+} before dissolving in H_2SO_4 solution (1:4). The solution formed was brought to near boiling by heating before titrating with standard $KMnO_4$ solution (Daniel, 2003; Ceirwyn, 1998; AOAC, 1998).

Statistical analysis: Except for moisture content, mean and standard deviation of results obtained in this research work were on dry weight basis either expressed in g/100g (proximate composition), µgg^{-1} (macro and trace elements composition) or mg/100g (vitamins and oxalate composition). Student't test was further used to compare the means of the bulbs and that of the stalks (John, 2000; Daniel, 2003).

RESULTS AND DISCUSSION

Proximate composition: Table I present the proximate composition of the onion bulbs and their stalks expressed in g/100g dry weight. Closely related values of 93.11g/100g and 91.70g/100g were obtained as the mean moisture content of the onion bulbs and stalks respectively. The ash content of the onion bulbs was 4.26g/100g which was lower than 13.54g/100g for the stalks. Low crude protein content of 6.48g/100g and 6.74g/100g were observed in onion bulbs and stalks respectively when compared with 14.11g/100g (tomatoes) and 8.95g/100g (onions) reported by USDA (2008). The onion samples showed appreciable fibre content of 13.56g/100g (onion bulbs) and 9.33g/100g (onion stalks) when compared with 8.14g/100g for cassava leaves (Tiaga, *et al.,* 2008). Fibres passes through the intestine track intact and help to move waste out of the body. Diets high in fibre have been shown to decrease risks of heart disease, obesity, and help lower cholesterol (Mckinley Health Center, 2007; Hassan *et al.,* 2005). Their carbohydrate contents of 64.53g/100g for onion bulbs and 63.84g/100g for onion stalks compare well with the values reported for ugwu and cassava leaves (Tiaga, *et al.,* 2008).

Table I: Proximate composition of the bulbs and stalks (g/100g dry mass)

Sample	Moisture	Ash	Crude protein	Crude lipid	Crude fibre	Available carbohydrate
Bulbs	93.11±0.38	4.26±0.22	6.48±1.23	11.13±1.28	13.56±0.95	64.53±0.98
Stalks	91.70±1.58	13.54±2.27	6.74±0.78	6.56±1.13	9.33±1.41	63.84±3.48

Macro elements composition: Table II present the macro elements in both the onion bulbs and stalks expressed in µgg^{-1} dry masses respectively. The mean levels of the macro elements in onion bulbs were found to be in the order: Ca>Mg>K>P>Na, while for the stalks, the order was Mg>Ca>K>Mg>P>Na. The mean values of 238.3µgg^{-1} and 203.3µgg^{-1} were observed as the sodium concentration for onion bulbs and stalks respectively. The mean values fall within the range of 2 - 150mg/100g Na content in vegetables (Lintas, 1992) and also compare well with the value of 21mg/100g for dried onion flakes reported by USDA (2008). The potassium content of both onion bulbs (3583.3µgg^{-1}) and the stalks (2733.3µgg^{-1}) were high but slightly lower than 1622.0mg/100g for dehydrated onion flakes (USDA, 2008). The high concentration of K in the samples is not surprising because plants absorb it as K^+ ion in large amounts from the soil than any other nutrient except N and Ca (ICAR, 2006). Both onion bulbs and the stalks showed high Mg content with values of 4221.1µgg^{-1} for onion bulbs and 11449.4µgg^{-1} the stalks. The mean value of the stalks was significantly ($p>0.05$) higher than that of the bulbs and this could be related to the fact that it is an essential constituent of chlorophyll and also regulate the activities of many enzymes in plant (ICAR, 2006). Onion bulbs and their stalks are therefore good source of meeting the Recommended Daily Allowance (RDA) of 350mg/100g for Mg (NRC, 1989). For the phosphorus content, the samples showed concentration values of 2395.8µgg^{-1} and 2169.4µgg^{-1} for onion bulbs and stalks respectively. Both mean values were lower than the 303mg/100g reported by USDA (2008), but fall within the range of 166 - 640mg/100g

reported for P in some green leafy vegetables consumed in Sokoto (Ladan, *et al.,* 1996). Phosphorus like Ca is an important component of the body, about 85% of the 600g required is found in the body skeleton in the form of calcium phosphate $\{Ca_{10}(PO_4)_6(OH)_2\}$, the remaining 15% is found in the soft body tissues and blood largely as phospholipids, phosphoproteins and nucleic acids as well as inorganic phosphate (Paul, 2006).

Table II: Macro-elements composition of the onion bulbs and stalk (μgg^{-1} dry mass)

Sample	Na	K	P	Ca	Mg
Bulbs	238.3±12.6	3583.3±375.3	2395.8±173.7	7101.4±637.2	4221.1±449.5
Stalks	203.3±10.4	2733.3±251.7	2169.4±120.1	8227.5±322.4	11449.4±1197.2

Table III shows the results of the application of the method of standard additions to the onion stalk sample which serve as a final test of the adopted analytical method and provided estimates of the contents of trace metals. The results obtained showed that the method offer a satisfactory precision of the measurements and good sensitivity for each of the element determined (Ojeka and Ayodele, 1997, Uzairu, *et al.,* 2008).

Table III: Mean percentage recoveries of trace metals from spiked onion stalk Sample

Trace metal	Expected conc. in spiked sample digest in μgg^{-1}	Observed conc. in spiked sample digest in μgg^{-1}	% Recovery
Fe	1141.07	1140.86	95.8
Zn	44.98	44.92	97.53
Mn	146.54	146.45	92.27
Cu	18.7	18.55	97
Ni	11.45	11.22	95.33

Average of three observations of the spiked onion stalk sample

Trace element composition: Table IV presents the mean concentrations of trace elements expressed in μgg^{-1} dry weight The mean levels of the trace elements in the onion bulbs were in the order: Fe>Zn> Mn> Cu>Pb>Ni>Cd and that of the stalks were in the order of Fe>Mn>Zn>Cu>Ni>Pb>Cd. The mean Zn concentration in onion bulbs was $45.25\mu gg^{-1}$, while that of the stalks was $48.49\mu gg^{-1}$. Both values were higher than the 18.90 μgg^{-1} reported for dehydrated onion flakes (USDA, 2008) and $18.89\mu gg^{-1}$ for onion bulbs (Audu and Lawal, 2006). On the contrary, the values were much lower than the range of 738 - $414\mu gg^{-1}$ reported as Zn concentrations in vegetable grown on soils near metal smelters in New South Wales Australia (Anthony and Balwant, 2009). There were no significant differences ($P<0.05$) between the mean concentrations of Zn in both onion stalks and their bulbs The observed values for the Zn concentration in this research work indicates that the onions from Aliero town are good source of meeting the recommended daily allowance of 12 - 15mg/day.

The mean copper concentration in the samples was $30.45\mu gg^{-1}$ (onion bulbs) and $31.86\mu gg^{-1}$ (onion stalks). The values were higher than the reported mean value of $7.50\mu gg^{-1}$ dry mass (Audu and Lawal, 2006). Similarly, the values were higher than the reported mean range of 5 - $8.54\mu gg^{-1}$ dry mass (Abdullahi, 2008), but much lower than the reported mean value of $245\mu gg^{-1}$ dry mass (Anthony and Balwant, 2009). There were no significant ($P>0.05$) differences between the mean concentration of the onion bulbs and that of the stalks. High iron content was observed in both onion bulbs ($657.75\mu gg^{-1}$) and stalks ($1180.25\mu gg^{-1}$). The values obtained were much higher than the values of $27.35\mu gg^{-1}$ and 15.50 μgg^{-1} dry mass reported by Audu and Lawal (2006) and USDA (2008) respectively. Similarly, the values were also higher than the reported range of 100 - $500\mu gg^{-1}$ dry mass as the normal Fe concentration in plants by ICAR (2006). The Fe concentration in the onion stalks was significantly

(P>0.05) higher than in the onion bulbs. Due to problems of Fe toxicity, non-acceptability caused by change of colour or taste and cost of fortified iron products, the use of natural source of Fe such as vegetables have been emphasized by WHO as the best way of remedying iron deficiency (Agte, *et al.,* 2000). The high Fe content of the onions and their stalks from Aliero town could be considered as a good source of Fe to Iron deficient people. For the Mn content in the samples, the mean of 31.31μgg^{-1} (onion bulbs) and (109.96μgg^{-1} (onion stalks) were observed. The values were high when compared with values of 13.89μgg^{-1} dry mass for onion bulbs (USDA, 2008) and 6.59μgg^{-1} for onion stalks (Uzairu, *et al.,* 2008), but were within the range of 25 - 500μgg^{-1} reported as the normal Mn concentration in plants (ICAR, 2006). The Mn content of the onion stalks was significantly (P>0.05) higher than that of the onion bulbs. The nickel content of the samples was generally low with the mean of 3.30μgg^{-1} (onion bulbs) and 3.56μgg^{-1} (onion stalks). The values were lower than the 8.00μgg^{-1} and 7.02μgg^{-1} reported for onion bulbs and onions stalks respectively (Abdullahi, 2008), but higher than the value of 0.73μgg^{-1} for rain fed onions (Audu and Lawal, 2006). The values fall within the recommended range of 0.1-10μgg^{-1} as the normal Ni concentration in plants (ICAR, 2006). Similarly, there were no significant differences (P>0.05) between the Ni content of the onion stalks and that of onion bulbs. The mean concentration of Pb in the samples was 4.56μgg^{-1} (onion bulbs) and 3.24μgg^{-1} (onion stalks). Both mean values were lower than the values reported by Anthony and Balwant (2009) for vegetables grown near metal smelters in New South Wales of Australia. The values on the other hand were observed to be slightly higher than the 2.00μgg^{-1} set as Pb critical level for edible portions of vegetables by WHO, but lower than the 6.00μgg^{-1} standard set by Hong Kong (Haw-Tarn, *et al*., 2004; Yi, *et al*., 2004). There were no significant differences (p>0.05) between the two means. The samples gave 0.24μgg^{-1} and 0.28μgg^{-1} as the mean concentrations of Cd in the bulbs and stalks respectively. There were no significant differences (p>0.05) between the two mean values.

Table IV: Trace element composition of onion bulbs and stalks expressed (μgg^{-1})

Sample	Fe	Cu	Zn	Mn	Ni	Pb	Cd
Bulbs	657.75±51.81	30.45±2.77	45.25±7.05	31.31±6.16	3.30±0.98	4.56 ±0.52	0.24±0.13
Stalks	1180.25±43.88	31.86±5.86	48.49 ±7.24	109.96±20.55	3.56±1.01	3.24±0.90	0.26±0.10

Table V present the mean concentrations of vitamins A and C, and oxalate in both the bulbs and the stalks expressed in mg/100g dry weight. Both indicated the presence of vitamin A with the bulbs having the highest value of 88.50mg/100g and the stalks 45.00g/100g. Both mean values were higher than 5.4mg/100g (bulbs) reported by USDA (2008) and 15.50mg/100g (stalks) reported by Agte, *et al*. (2000). There were significant differences (p>0.05) between the two means. Since mammals cannot synthesize vitamin A which is an important precursor to 11-cis-retinal a key chemical component in vision, onions and their stalks could be another good source of meeting the 2.7mg per day requirement (Daley and Daley, 2005). There were also significant differences (p>0.05) in the mean values of 108.65mg/100g (bulbs) and 36.29mg/100g (stalks) observed in their vitamin C content. The mean value for the bulbs was higher than the 75.00mg/100g reported by USDA (2008). Human beings are among the few vertebrates that cannot synthesize vitamin C which is an important antioxidant in the body (David, *et al.,* 2008). The use of onion bulbs and their stalks in our meals could help in meeting the body requirement of the vitamin. The bulbs in particular gave high oxalate mean concentration which could be a serious treat in the bioavailability elements like Ca and Mg to consumers. The possibilities of oxalate poisoning in human body is remote because of the various processing treatments it undergoes before consumption and also it is usually taken in very low quantity.

Table V: Vitamins and oxalate composition in onion bulbs and stalks expressed (mg/100g dry weight)

Sample	Vitamin A	Vitamin C	Oxalate
Bulbs	88.50±3.97	108.65±12.79	415.3±62.5
Stalks	45.00±3.97	36.29±9.37	93.9±25.2

Conclusion: Results of this research work have indicated that even though both the onions bulbs and their stalks are good natural source of fibre, mineral elements, vitamins A and C, the bulbs are more nutritious. Going by the report of Food and Agriculture Organization of the United Nations (FAO) in 1997, about 616 million people are at risk of iron deficiency, anemia, (Agte, *et al*., 2000). The concentrations of Fe in onions (bulbs and stalks) from Aliero are therefore good source of combating iron deficiency problems. Similarly, people with haemochromatosis problem that find themselves in this area will be able to control themselves on how they consume onions from the area. The presence of oxalate in both the bulbs and stalks could affect the bioavailability of the nutrient elements.

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