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Comparative Studies of White and Red *Allium cepa* Cultivated in Sokoto, Nigeria

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ABSTRACT

White and red *Allium cepa* were individually analysed quantitatively for proximate compositions and flavonoids % in dried grinded bulbs. All results were presented as mean ± standard deviation of three replicates; white and red *Allium cepa* contained 89.62 ± 0.83 and 88.48 ± 0.03% moisture, 3.33 ± 0.56 and 3.17 ± 0.29% ash, 2.17 ± 0.29 and 6.50 ± 1.00% crude lipid, 3.22 ± 0.07 and 3.02 ± 0.29% crude protein, 3.83 ± 0.29 and 2.83 ± 0.29% crude fibre, 87.44 ± 0.24 and 84.48 ± 0.93% available carbohydrate, 382.11 and 408.5 kcal/100g energy value, as well as 64.0 ± 0.93 and 61.20 ± 0.24% flavonoids, respectively. Hence, this research justifiably proved that both species would provide flavouring, nutritional and medicinal importance. Thus, the white *Allium cepa* possessed a more nutritional and medicinal properties than the red but provides less energy and lower resistance to storage.

Keywords: *Allium cepa*, Flavonoids, Proximate, Sokoto, Spices

INTRODUCTION

Spices together with herbs composed of numerous natural vitamins, phytochemicals, minerals and antioxidants, which are sometimes higher in concentration than that of the cereals, fruits and vegetables (Heber, 2014). However, many researchers in the field of nutritional food sciences believed that the government should encourage the general public on the consumption of these plant species. This is because the antioxidants activity of herbs and spices aids in the reduction of oxidative stress, caused by free radicals that promotes protein, DNA and cell lipid oxidations, thereby activating inflammatory reactions, which damages tissues and cells, at long run causing cancer, diabetes, obesity, arthritis and diseases of neurodegenerations, like Alzheimer and Parkinson (Heber, 2014). Notwithstanding, Sokoto, Nigeria (Fig. 1) is one of the states in the northern region popularly known for many years practicing irrigation farming for the production of many spices and herbs which includes white and red *Allium cepa* (Ayoola, 2014).

Fig. 1: Map of the Study Area

Allium cepa is an edible bulb as one of the major spices used by man throughout recorded history, mostly for medicinal and culinary purposes (Suleria *et al.*, 2015). The firm spherical-conical bulb shoots with papery skins are vertically grown under the ground from an approximately diameter size of 10mm to 8cm or more. They appear in varieties of colours such as white, purple and red (Jensen, 2014).

Moreover, the red and white *Allium cepa* (Figs. 2 & 3) are traditionally known as "*Farar-albassa"* and "*Jar-albassa"*, respectively by the majority of the Hausa speaking tribes in Nigeria (Blench and Dendo, 2007). A lots of healthily and economic benefits are acquired as a results of the cultivation of these spices (Hyun *et al.*, 2013).

Fig. 2: *Allium cepa* (red) bulbs

Fig. 3: *Allium cepa* (white) bulbs

The health benefits of *Allium* species especially *Allium cepa* (white and red onions) and *Allium sativum* (garlic) have been known for many years. Recently *Allium* species have been found to alleviate tumor, cardiovascular diseases and ageing (Reuter, 1995; Stajner *et al.*, 2006; Colina-Coca *et al.*, 2014). In addition, microbial and animal studies, intercropping and field trials confirmed the ability of *Allium*-derived organosulphur compounds to repel predators and kill insect pests and plant pathogens, thereby protecting crops and serving as useful, non-toxic biocides (Block, 2010). Thus, the benefits of the *Allium cepa* is due to the accumulation of flavonoids (Fig. 4) as their major secondary metabolite (Griffiths *et al.*, 2002).

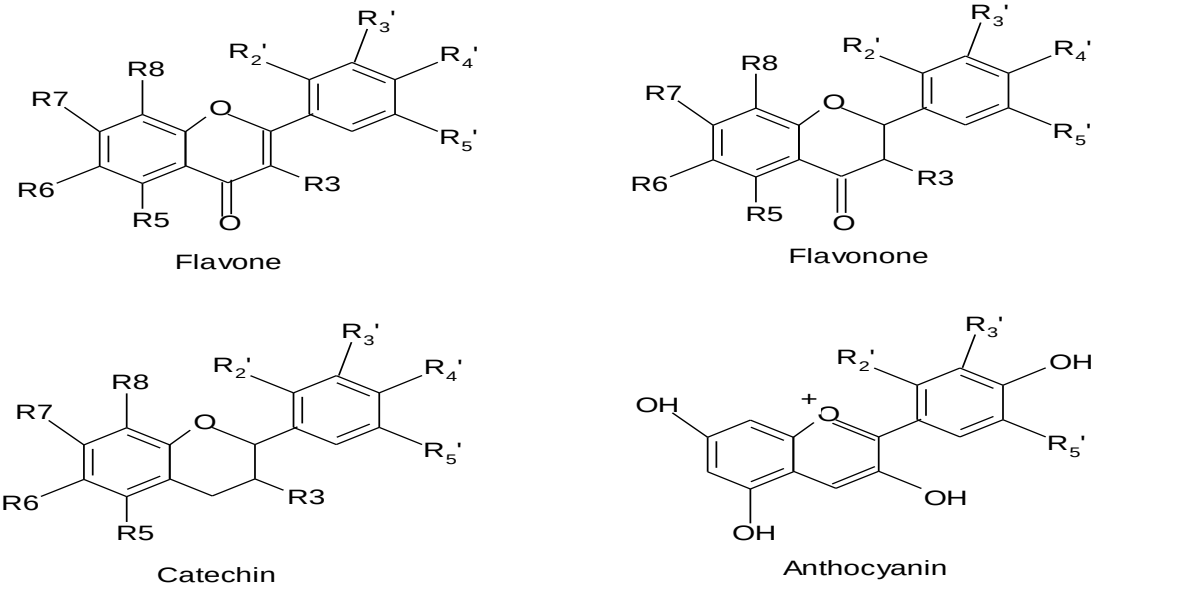

Fig. 4: Molecular Structure of Each Group of Flavonoids

To this end, the cultivation and consumption of the different coloured species for *Allium cepa* has been raising questions of; which of the species between the white and red is more beneficiary in terms of nutritional contents and more adaptation to long time storage. Thus, the objective of these studies is to provide the information on the comparative proximate and the percentage flavonoids in *Allium cepa* (white and red onions) cultivated in Sokoto (Nigeria), hoping that this research would more so encourage consumption of the *Alliums* towards providing maximum satisfaction in flavouring, medicinal, nutritional benefits and cultivation of these species, as well as to serve as referencing platform to readers and researchers.

MATERIALS AND METHODS

Sampling and Treatments

The bulb samples of white and red *Allium cepa* were purchased from Sokoto central market at three different places and were transported in polyethylene bags to the Botany unit, Usmanu Danfodiyo University, Sokoto for identification purpose. The epicarps of the bulbs were removed and separated from the stalks for easy assessment. The bulbs were completely dried in an oven at 60 – 80^{o}C for 3 days after they were cut into smaller pieces. Electric blender was used to grind the sliced bulbs into powder.

Proximate Analysis

Proximate analysis of *Allium cepa* (white and red onions) were carried out, respectively using the method demonstrated by Lawal and Matazu (2012) as well as Lawal and Dangoggo (2014), which involves the determination of ash content, moisture content, crude protein, crude fibre, crude lipid, available carbohydrate and energy value;

(a) Determination of % Moisture

Initially, an empty crucible was weighed, and 5.0g of raw (wet) analyte sample was transferred into it and reweighed. The content of the crucible was subjected to continuous drying in a hot air drying oven at 105-110^{o}C for 24 hours, cooling and weighing until a constant weight was obtained. The percentage moisture was calculated using equation 1.0:

$$\text{Moisture content (\%)} = \frac{\text{Loss in weight} \times 100}{\text{Sample weight}} \qquad \text{(Eq. 1.0)}$$

(b) Determination of % Ash content

The 2.0g of the dried sample was transferred into an initially weighed crucible and ashed in a muffle furnace at temperature of 500-600^{o}C for 3 hours. The resulted ash was cooled and weighed. Percentage ash content was calculated using equation 2.0;

$$\text{Ash (\%)} = \frac{\text{Weight of ash} \times 100}{\text{Sample weight}} \qquad \text{(Eq. 2.0)}$$

(c) Determination of % Crude Fat

The 250 cm^3 soxhlet extraction flask was washed and oven dried at 105 - 110 ^{o}C, cooled and weighed. 20g of the dried analyte sample was transferred into a porous thimble and it was covered with clean white cotton wool before placing it in the extraction flask. Extraction was carried out for 6 hours after the introduction of 200 cm^3 of n-hexane into the set-up. The thimble was carefully removed at the end of the extraction. The flask containing the extracted crude lipid was disconnected and oven dried at 105 - 110 ^{o}C for one hour and weighed. Finally, the percentage of crude lipid was calculated using equation 3.0:

$$\text{Crude fat (\%)} = \frac{\text{Weight of Lipid} \times 100}{\text{Sample weight}} \qquad \text{(Eq. 3.0)}$$

(d) Determination of % Crude Protein

The 15 cm^3 of conc. H_2SO_4 was mixed with 1 g of the dried (ground) analyte sample and addition of 0.1 g digestion tablets into a micro-Kjeldahl flask. The flask was heated in a digestion block (heater) for 24 hours until the content became a clear solution. The cleared mixture was diluted to 50 cm^3 with distilled water. Then, 10 cm^3 of the sample aliquot, 40 cm^3 of distilled water and 20 cm^3 of 40% NaOH were transferred into a macro-Kjeldahl flask before introducing it to a macro-Kjeldahl distillation set-up. The distillation process took about 5 minutes and resulted distillate was collected into a flask containing 20 cm^3 of boric acid changing the colour from purple to green. The flask content was titrated with 0.01M H_2SO_4 and the colour changed from green to purple at end point. The average titre value recorded was used to determine the percentage of nitrogen, using equation 4.0:

$$\% \text{ N } = \frac{\text{Titre value} \times \text{MA} \times \text{NF} \times \text{DF} \times 100}{\text{Sample weight} \times \text{aliquot}} \quad \text{(Eq. 4.0)}$$

Where; MA = Molarity of acid., NF = Nitrogen factor., DF = Dilution factor, hence, % Crude protein = % N × 6.25

Chemical Equation for Sample Digestion To determine % N:

Analyte sample + conc. $H_2SO_4 \rightarrow (NH4)_2SO_{4\,(aq)} + CO_{2\,(g)}$ (Eq. 5.0)

Distillation of the aliquot:

$\therefore (NH_4)_2SO_{4\,\mathbf{(aq)}} + 2NaOH \rightarrow 2NH_{3\,\mathbf{(g)}} + H_2O_{\,(g)} + Na_2SO_{4\,(aq)}$ (Eq. 6.0)

$NH_{3\,\mathbf{(g)}} + H_3BO_{3\,\mathbf{(aq)}} \rightarrow NH_4^{+}{}_{\mathbf{(aq)}} + H_2BO_3^{-}{}_{\mathbf{(aq)}}$ (Eq. 7.0)

Titration: $H_2BO_3^{-}{}_{\mathbf{(aq)}} + H^{+}{}_{\mathbf{(aq)}} \rightarrow H_3BO_{3\,(aq)}$ (Eq. 8.0)

(e) Determination % crude fibre

The 2 g of dried (ground) analyte sample (W_0) was mixed with 20 cm^3 of 1.25% H_2SO_4 and gently boiled for 30 minutes after it was introduced into a 100cm^3 conical flask. The mixture was filtered with muslin cloth and the residue was rinsed with hot distilled water into another 100cm^3 conical. The 20 cm^3 of 1.25% NaOH was added into the flask and filtered with a muslin cloth after it was boiled for 30 minutes. The resulted residue was rinsed with hot distilled water and later rinsed once with 10% HCl and twice with ethanol. It was finally rinsed 3 times with petroleum ether at boiling point of 40 - 60 ^oC. The residue was scraped into a weighed crucible and oven dried for 12 hours at 105 ^oC. The dried residue was weighed (W_1) and then ashed at 600 ^oC in a muffle furnace. The resulted ash was allowed to cool and weighed (W_2). The percentage of crude fibre was calculated using equation 9.0:

$$\text{Crude fibre (\%)} = \frac{\text{W1} - \text{W2} \times 100}{\text{W0}} \quad \text{(Eq. 9.0)}$$

(f) Available Carbohydrate

Available carbohydrate was calculated by subtracting the total of the percentages of ash, crude protein, crude lipid, and crude fibre from the 100% moisture free samples.

(h) Energy Value

The energy value was estimated using the method of Umar *et al*. (2006) in kilocalorie (kcal/100g) using, the expression; (% crude protein x 4) + (% crude lipid x 9) + (% available carbohydrate x 4).

Quantitative Analysis of Flavonoids

The quantitative analysis of flavonoids on the dried ground samples of white and red *Allium cepa* were respectively carried out using the method of Okwu and Josiah (2006), as follows: Ten grams (10g) each of the dried (ground) samples was extracted with 100cm^3 of 80% aqueous methanol at room temperature. The solutions were filtered through no. 42 filter paper into a weighed crucible and evaporated to dryness over a water bath and the final weight was determined. The determination of % flavonoids content was calculated using equation 10;

$$\text{Flavonoids content (\%)} = \frac{\text{Loss in weight} \times 100}{\text{Sample weight}} \quad \text{(Eq. 10)}$$

RESULTS AND DISCUSSION

Proximate Composition of white and red *Allium cepa*

The proximate composition is expressed in percentage dry matter. The result showed that white and red *Allium cepa* (sample) respectively contained 89.62 ± 0.83% and 88.48 ± 0.03% moisture, 3.33 ± 0.56% and 3.17 ± 0.29% ash, 2.17 ± 0.29% and 6.50 ± 1.00% crude lipid, 3.22 ± 0.07% and 3.02 ± 0.29% crude protein, 3.83 ± 0.29% and 2.83 ± 0.29% crude fibre, 87.44 ± 0.24% and 84.48 ± 0.93% available carbohydrate and energy values are 382.11 and 408.50 kcal/100g, respectively as recorded in Table 1.

The moisture content for the white (89.62 ± 0.83%) and red (88.48 ± 0.03%) samples were statistically similar ($p>0.05$) and showed to be in the same range with 85.52% for *Allium cepa* (Odebunmi *et al.,* 2007) but both species were higher than that of *Allium sativum* 66.57, 67.66 and

73.86% (Hussain *et al.,* 2009; Odebunmi *et al.,* 2010 and Hussain *et al.,* 2010), respectively. However, high moisture content in a sample implies its poor storage quality because samples with moisture content more than 15% encourages microbial attacks during storage (Umar *et al.,* 2006).

Statistical similarity ($p>0.05$) of the ash content for the white (3.33 ± 0.56%) and red (3.17 ± 0.29%) samples were observed and both were higher than that of red *Allium cepa* (0.70%) reported by Odebunmi *et al.* (2007), but lower than 8.48% (Nwinuka *et al.,* 2005). Thus, high amount of ash content implies the high availability of essential minerals present in a sample (Umar *et al.,* 2006).

The crude lipid content for the white *Allium cepa* (2.17 ± 0.29%) was statistically lower ($p<0.05$) than red *Allium cepa* (6.50 ± 1.00%) but both species were higher than 0.24% for red *Allium cepa* (Odebunmi *et al.,* 2007) and 0.95% (Nwinuka *et al.,* 2005). Therefore, high amount of crude lipid in a sample enhances its energy giving value, as fat is broken down in the body by oxidation process with the release of energy; one gram of fat gives 37kcal of energy (Lawal and Dangoggo, 2014).

Statistical similarity ($p>0.05$) of the crude protein content for the white (3.22 ± 0.07%) and red (3.02 ± 0.29%) *Allium cepa* were observed and showed to be in the same range with 3.72% for red *Allium cepa* (Odebunmi *et al.,* 2007) but lower than 10.45% (Nwinuka *et al.,* 2005). However, food samples with high amount of crude protein contributes as a source of energy and helps in building tissues in animals' body (Adeniyi *et al.,* 2012).

The crude fibre content for the white sample (3.83 ± 0.29%) is statistically higher ($p<0.05$) than the red sample (2.83 ± 0.29%) but both of them were higher than 0.73% of red *Allium cepa* documented by Odebunmi *et al.* (2007). Hence, samples with higher amount of crude fibre improves protection against constipation and it also prevents cardiovascular disease because studies have shown that soluble fibre lowers levels of artery-clogging cholesterol in the blood stream (Krishnamurthy *et al.,* 2012)

The white sample provided higher amount ($p<0.05$) of available carbohydrate (87.44 ± 0.24%) than the red sample (84.48 ± 0.93%), and both of them are higher than 76.71% of red *Allium cepa* (Nwinuka *et al.,* 2005) and 73.22% of *Allium sativum* (Otunola *et al.,* 2010). Notwithstanding, the major energy source in animals' diet comes from available carbohydrates (Grieshaber, 2013).

The energy value for the white *Allium cepa* (382.11kcal/100g) was lower than red *Allium cepa* (408.5 kcal/100g) and both of them appeared to be higher than 357.19 and 367.64 kcal/100g of red *Allium cepa* and *Allium sativum*, respectively (Nwinuka *et al.,* 2005). Hence, the report of Sharma *et al.* (2002) demonstrated that samples with higher energy value contribute in providing more energy in animals' body, i.e. the energy value of food is a measure of the heat energy available by the complete combustion of a weighed food sample.

Table 1: Proximate composition of white and red *Allium cepa*

Component	white *Allium cepa*	red *Allium cepa*
Moisture (%WM)	89.62 ± 0.83^a	88.48 ± 0.03^a
Ash (DM)	3.33 ± 0.56^a	3.17 ± 0.29^a
Crude lipid (DM)	2.17 ± 0.29^b	6.50 ± 1.00^a
Crude protein (DM)	3.22 ± 0.07^a	3.02 ± 0.29^a
Crude fibre (DM)	3.83 ± 0.29^a	2.83 ± 0.29^b
Available carbohydrate	87.44 ± 0.24^a	84.48 ± 0.93^b
Energy value (kcal/100g)	382.11	408.5

- Values are expressed as mean ± standard deviation of three replicates
- WM = Wet matter
- DM = Dry matter
- Different superscript (a & b) of values in the same row are significantly different **($P < 0.05$)**.

Percentage (%) of Flavonoids in white and red *Allium cepa*

The percentage flavonoids of the white and red samples are as provided in Table 2. The % flavonoids for the white sample (64.0%) was statistically ($p<0.05$) higher than the red (61.20%) and both of them are higher than 49.70% for red *Allium cepa* and 33.40% for *Allium sativum* reported by Stajner *et al.* (2006). Thus, samples with higher content of flavonoids contributes healthily as antioxidants; i.e. preventing the destructive effects of oxidation which damages the body tissue that leads to heart diseases, strokes and cancer (Carocho and Ferreira, 2013).

Table 2: Percentage flavonoids (%) in white and red *Allium cepa*

Sample	white *Allium cepa*	red *Allium cepa*
Flavonoids (%)	64.0 ± 0.93^{a}	61.20 ± 0.24^{b}

* Values are expressed as mean ± standard deviation of three replicates

* Different superscript (a & b) of values in the same row are significantly different **($P < 0.05$)**

CONCLUSION AND RECOMMENDATION

The results of proximate analysis and percentage flavonoids of white and red *Allium cepa* justifiably proved that both species would provide flavouring, nutritional and medicinal importance when properly consumed. Thus, the white *Allium cepa* possesses more nutritional and medicinal properties than the red but provides less energy and lower resistance to storage. Further research should be carried out on the *Allium cepa* because of their high rate of culinary and medicinal advantages. Thus, cultivation of white species should be encouraged due to their higher percentages of crude fibre, available carbohydrates and flavonoids in order to have more profitable consumptions.

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