ABSTRACT

Background: Onions is the most widely consumed vegetable worldwide and is a rich source of phytochemicals and antioxidants responsible for fighting free radicals in the body and preventing diseases.

Objective: The general objective of the study was to analyze and compare the nutrient and antioxidant properties of red, yellow and white onions in Oyo state, Nigeria.

Materials and Methods: The research design was experimental. Samples were analyzed chemically according to the official method of analysis described by the Association of Official Analytical Chemist (AOAC). All analysis was carried out in triplicate. Data was analyzed using IBM SPSS statistics version 20. ANOVA was used to compare different variables together.

Results: The protein content was same in red and white onions. The crude fibre for red onions was 1.1 ±0.12, yellow onions 1.4±0.08 and white onions 1.2 ±0.12. White Onions had the highest total ash content (0.8 ±0.08), followed by yellow onions (0.6 ± 0.08) and red onions (0.6 ±0.05). The carbohydrate (by difference) was 12.2 ±0.09 for red onions, 11.1 ±0.22 for yellow onions and 11.4 ±0.36 for white onions. The reducing sugars for red onions was 1.8 ±0.12, yellow onions had 1.1 ±0.08 while white onions contained 1.2 ±0.12. The total sugars for red onions, yellow and white onions were 2.6 ±0.12, 1.7 ±0.12 and 2.2 ±0.12 respectively. The ascorbic acid (mg/100g) content was 15.8 ± 0.79 for red onions, 11.2 ±0.21 for yellow onions and 12.4 ±0.53 for white onions. Quercetin (mg/g) was highest in red onions (0.32 ±0.02), followed by yellow onions (0.24 ±0.01) and then white onions (0.19±0.01).

Conclusion: The nutrients and antioxidant (quercetin and vitamin c) properties were higher in red onions compared to the other varieties (white and yellow) of onions.

Key words: Nutrients, Antioxidant, Red Onions, Yellow Onions, White Onions

INTRODUCTION

Onion (Allium cepa L.) is a very important agricultural economic crop that is widely planted around the world and it is also one of the most cultivated and consumed vegetable. People give great importance to the health function of vegetables because of the abundant flavonoid content and the beneficial effects of nutritious antioxidant present in them (1,2,3). Onions come in three different of colours which are red, yellow and white; primarily due to anthocyanins in the epidermal cells of the scale leaves of the bulb (4). Anthocyanin is a group of natural plant pigments that is widely distributed in vegetables including onion which help to prevent neuronal diseases, cardiovascular illnesses, cancer, diabetes, inflammation and many other diseases (4). In Nigeria, onion is grown mostly in Northern states like Kano, Kaduna, Jigawa, Sokoto, Plateau, Bauchi, and Kebbi state. It is one of the most consumed and sold vegetable in Nigeria with, the most common type being the red onion (5).

The consumption of vegetables like onions has been shown to be associated with the reduced risk for the development of chronic diseases, such as cancer because of the presence of quercetin and cardiovascular diseases because of the antioxidants present in onions (6). Phytochemicals, including phenolics and flavonoids, are the major bioactive compounds contributing to the health benefits of onions. Onions are a major source of dietary flavonoids - a large and diverse group of polyphenolic compounds with antioxidant effects, and onion is one of the richest sources (7). However, varietal differences may exist in the composition, concentration, and beneficial activities depending on the cultivation conditions (8). Onion can be consumed in its raw, processed and stored state. The interest in the potential health benefits of allium vegetables, onion in particular, has its origin in antiquity (9).

Some researches carried out on onions include works by Edet et al. (10) on anti-nutrient composition and mineral analysis of cepa in Akwa Obom State, nutrient content variation in bulb and stalk of onions by Yahaya et al. (11) in Kebbi State, proximate content and elemental evaluations of Allium cepa linn by Osuji et al. (12) in Borno State and a review by Nassarawa and Suleiman (13) on extending the shelf life of onion and tomato in Nigeria. Cheng et al. (14) conducted a study comparing the phenolic content and antioxidant capacity of red and yellow onions. The results showed that the red variety showed better antioxidant activity than yellow onion. Lenkova et al. (15) also compared the content of total

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NUTRIENTS AND ANTIOXIDANT PROPERTIES OF RED, YELLOW AND WHITE ONIONS (Allium cepa L.) IN IBADAN, OYO STATE, NIGERIA

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polyphenols and antioxidant activity of selected species of the genus Allium. Their results showed that the value of antioxidant activity ranged from 12.29 – 76.57%. Red onions had the highest antioxidant activity after chives and ransom, then followed by yellow and white onions (15). No research has been carried out in the study area to show the nutrients and antioxidant content of onions. Onions of various colours and flavours are available in the market and consumers are now more health oriented and aware of healthy eating habits and therefore, pay attention to the appearance, nutritional prophylactic and medicinal values of onions (19). This study therefore analyzed and compared the nutrient and antioxidant properties (including quercetin) in red, yellow and white onions in Oyo state, Nigeria.

MATERIALS AND METHODS

Source of materials
Red onion, yellow onion and white onions were purchased from Bodija market, Ibadan North Local Government Area in Ibadan, Oyo state, Nigeria.

Preparation of samples
After purchase, the raw onions in fresh mass were washed, peeled and chopped using kitchen knife and chopping board. Some of the onion samples were dried before carrying out the tests while some were done in fresh mass depending on the type of analysis. The samples were dried in the oven to carry out the proximate analysis test while the other analysis was carried out in fresh mass for good results. All the tests and analysis were carried out based on the Official Association of Analytical Chemists (16).

Proximate Analysis
Samples were analysed chemically for dry matter and moisture content, ash, crude fat, nitrogen/protein, crude fibre, carbohydrate, protein, ascorbic acid, quercetin, reducing and total sugars. Analysis was done according to the official method of analysis described by the Association of Official Analytical Chemist (16). All analysis was carried out in triplicate.

Dry Matter and Moisture Determination
Moisture content determination was carried out using the air oven method. Petri Dishes were washed and dried in an oven. They were allowed to cool in the desiccator and weight was noted. A known weight of samples (5g) were then transferred into the crucibles and dried at a temperature between 103-105°C. The dry samples were cooled in a desiccator and the weight noted. They were later returned to the oven and the process continued until constant weights were obtained.

% Moisture content = \( \frac{\text{Weight loss}}{\text{Original Weight of Sample}} \times 100 \)

Determination of Ash Content
A known weight of finely ground sample (2g) was weighed into clean, dried previously weighed crucible with lid (W1). The sample was ignited over a low flame to char the organic matter with lid removed. The crucible was then placed in muffle furnace at 600°C for 6 hours until it ashed completely. It was then transferred directly to desiccators, cooled and weighed immediately (W2). Percentage Ash = \( \frac{W_2 - W_1}{W_1} \times 100 \)

Determination of Crude Fat
The Soxhlets extraction method by AOAC (16) was used. This method could only give the approximate fat content in a sample because all the substances soluble in chosen solvent (Petroleum ether, 40°C 60°C boiling range) were extracted from the sample. A known weight of sample was weighed into a weighed filter paper and folded neatly. This was put inside pre-weighed thimble (W1). The thimble with the sample (W2) was inserted into the Soxhlets apparatus and extraction under reflux was carried out with petroleum ether (40°C – 60°C boiling range) for 6 hours. At the end of extraction, the thimble was dried in the oven for about 30 minutes at 100°C to evaporate off the solvent and thimble was cooled in a desiccator and later weighed (W3). The fat extracted from a given quantity of sample was then calculated thus:

% Fat (w/w) = \( \frac{\text{Loss in Weight of sample}}{\text{Original Weight of Sample}} \times 100 \)

= \( \frac{W_2 - W_3}{W_2 - W_1} \times 100 \)

Nitrogen/Protein Determination
The crude protein content was determined using micro Kjeldahl method as described in AOAC (17). About 0.2077g of sample was weighed into a long necked Kjeldahl flask. One tablet of Kjeldahl catalyst was added to the sample in the flask with 25cm³ of conc. H₂SO₄. The flask was swirled, gently clamped in an inclined position and heated electricity in a fume cupboard. The heating continued until a clear solution was obtained. The clear solution was cooled, poured into a 100cm³ volumetric flask and made up to mark with distilled water, then 10ml of the resulting mixture was measured into the distillation set through the funnel. Boric acid (5cm³) was pipetted into a 100 cm³ conical flask and placed at the receiving end of the distillatory. The conical flask was placed in such a way that the delivery tube dipped completely into the boric acid inside the flask. About 40% NaOH was used to liberate ammonia out of the digest under alkaline condition. During the distillation, 2 drops of methyl orange were always added to the round bottom flask containing the digested sample before 40% NaOH was added. As soon as the contents became alkaline, the red colour changed to yellow showing NaOH to be in excess. Steam was then generated into the distillation set using a steam chest. The liberated ammonia was trapped in the boric acid solution and about 50 cm³ of the solution

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was collected into a conical flask. The solution in the flask was titrated against 0.1M HCl until the first permanent colour change was observed.

\[ \% \text{ N} = \frac{\text{Molarity of HCl} \times \text{Sample titre} - \text{Blank titre}}{\text{Weight of sample used}} \times 0.014 \times \text{DF} \times 100 \]

Crude Fibre Determination

Two hundred milliliters (200ml) freshly prepared 1.25% H₂SO₄ were added to the residue obtained from fat extraction and this was brought to quick boil. Boiling was continued for 30 minutes. The mixture was filtered and residue washed until it was free from acid. The residue was transferred quantitatively into a digestion flask, 1.25% NaOH was added and brought to boiling point quickly. Boiling was continued for 30 minutes. The mixture was filtered and residue washed free of alkali. The residue was then washed with methylated spirit, thrice with petroleum ether using small quantities. It was allowed to properly drain and the residue transferred to a silica dish (previously ignited at 600°C and cooled). The dish and its content were dried to constant weight at 105°C. The organic matter of the residue was burnt by igniting for 30 minutes in a muffle furnace at 600°C. The residue was cooled and weighed. The loss on ignition was reported as crude Fibre (17).

Determination of Carbohydrate

The carbohydrate content was calculated by difference thus;

\[ \% \text{ CHO} = 100 - (\text{Sum of the percentages of moisture, ash, fat, protein and crude fibre}) \]

Determination of Ascorbic Acid

The sample (100g) was weighed and grinded with a little glacial acetic acid in a mortar. The extracts were transferred into a 50 ml volumetric flask. Then it was filtered rapidly. Ten milliliters (10mls) of the filtrate was taken into a conical flask with one drop dilute acetic acid. It was titrated against the redox dye, 2:6 dichlorophenol indophenol solution in the burette, the volume of dye required to decolorize the 10 ml of the sample. The titration was repeated using a standard ascorbic solution (1 mg pure vitamin per 10 ml of the sample. The titration was done in triplicate.

Determination of Quercetin

The ethanol extract of sample bulb was taken by hot soxhlet extraction technique for experiment. All the chemicals and reagents were of analytical grade. Solvent [n-butanol, water, acetic acid shows good spectral characteristics. Preparation of standard stock solution. The standard stock solutions of quercetin was prepared by dissolving 100 mg of quercetin standard in developed solvent [n-butanol water, acetic acid and final volume was adjusted with same solvent in 100 ml of volumetric flask to get a solution containing 1000 µg/ml of quercetin. The absorbance of the extracts was measured at 256.30 nm. The quantity of quercetin in the samples was determined from the calibration graph [AOAC (16)].

Statistical Analysis

The data obtained was analysed using Statistical Package for Social Science (SPSS) version 20. Descriptive statistics for mean, standard deviation, frequency and percentage was used in describing the data that was obtained. Analysis of Variance (ANOVA) was used to test the level of significance at p<0.05.

RESULTS

Table 1 shows the proximate composition of the onion samples per 100g. The moisture content ranged from 84.6 ±0.08 to 85.7 ±0.17 with Sample B having the highest moisture followed by Sample C and Sample A respectively. The protein content for Sample A and Sample C was the same (1.3±0.12) while Sample B had a protein content of 1.2 ±0.05. The crude fibre contents of the three samples were 1.1 ±0.12 for Sample A, 1.4±0.08 for Sample B and 1.2 ±0.12 for Sample C. The ash content was 0 ±0.05, 0.6 ± 0.08 and 0.8 ±0.08 for Sample A, Sample B and Sample C respectively. The Carbohydrates (by difference) for Sample A was 12.2 ±0.09, for Sample B it was 11.1 ±0.22 and for Sample C it was 11.4 ±0.36. The fat content ranged from 0.1 ± 0.01 to 0.16 ± 0.01 with sample B having the least and sample A having the highest fat content.
The proximate analysis shows that the onions samples analyzed contained more of moisture than nutrients. Onions are nutrient dense, meaning they are low in calories but high in vitamins and minerals (20). The fair amount of nutrients in the onions can help in meeting the daily nutritional requirements when eaten in combination with other nutrient dense foods. There was significant difference in the moisture content of the onion samples (p=0.000). The highest moisture content of 85.7 ±0.17 was in red onions, which is similar to the result of Sami et al. (21) where a moisture content of 88.65% was recorded. It, however, varies with the result of Yahaya et al. (11) and Osuji et al. (12) where the moisture content was 93.11 ± 0.38 and 96.10% respectively. Also, the carbohydrate content in their study was very high (64.53 ± 0.98) compared to this study which recorded a very low carbohydrate content of 12.2 ± 0.09. There was significant difference in the carbohydrate (p=0.000) and protein (p=0.015) but no significant difference in the crude fibre (p=0.079), ash (p=0.058) and fat (p=0.056) content of the onion samples. The protein content of the onion samples in this study was low (1.3±0.12 to 1.2 ±0.05) which is somewhat close to the result of Osuji et al. (12) where the protein composition of red onions was 2.48% but contrary to the result of Sami et al. (21) who recorded a high protein content ranging from 9.22g/100 to 13.21g/100 in their study on different onion bulbs. The ash content recorded by Yahaya et al. (11) was 4.26 ± 0.22 which is higher than that recorded in this study in which the ash content ranged from 0.6 ±0.05 to 0.8 ±0.08 but the ash content recorded by Rodrígues et al. (22) was lower (0.33±0.02 to 0.39±0.03) than that recorded for the onion samples. The Ascorbic Acid content (mg/100g) for Sample A was 15.8 ±0.79, Sample B (0.32 ±0.02), Sample B (0.24 ±0.01) and Sample C (0.19±0.01).

Table 1: Proximate composition of the onion samples percentage per 100g

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>Sample A</th>
<th>Sample B</th>
<th>Sample C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture Content</td>
<td>84.60 ±0.08</td>
<td>85.70 ±0.17</td>
<td>85.40 ±0.12</td>
</tr>
<tr>
<td>Protein</td>
<td>1.30 ±0.12</td>
<td>1.20 ±0.05</td>
<td>1.30 ±0.12</td>
</tr>
<tr>
<td>Crude Fibre</td>
<td>1.10 ±0.12</td>
<td>1.40 ±0.08</td>
<td>1.20 ±0.12</td>
</tr>
<tr>
<td>Ash</td>
<td>0.60 ±0.05</td>
<td>0.60 ±0.08</td>
<td>0.80 ±0.08</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>12.20 ±0.09</td>
<td>11.10 ±0.22</td>
<td>11.40 ±0.36</td>
</tr>
<tr>
<td>Fat</td>
<td>0.16 ±0.01</td>
<td>0.10 ±0.01</td>
<td>0.13 ±0.01</td>
</tr>
</tbody>
</table>

Superscripts represented with "a" are significantly (p<0.05) different while those represented with "b" are not significantly different.

Table 2: Reducing and total sugars (%) in the onion samples

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Sample A</th>
<th>Sample B</th>
<th>Sample C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducing Sugar</td>
<td>1.80 ±0.12</td>
<td>1.10 ±0.08</td>
<td>1.20 ±0.12</td>
</tr>
<tr>
<td>Total Sugar</td>
<td>2.60 ±0.12</td>
<td>1.70 ±0.12</td>
<td>2.20 ±0.12</td>
</tr>
</tbody>
</table>

Superscripts represented with "a" are significantly (p<0.05) different while those represented with "b" are not significantly different.

Table 3: Anti-oxidant properties of the onion samples (mg/100g)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Sample A</th>
<th>Sample B</th>
<th>Sample C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ascorbic Acid</td>
<td>15.80 ± 0.79</td>
<td>11.20 ± 0.21</td>
<td>12.40 ± 0.53</td>
</tr>
<tr>
<td>Quercetin</td>
<td>0.32 ± 0.02</td>
<td>0.24 ± 0.01</td>
<td>0.19 ± 0.01</td>
</tr>
</tbody>
</table>

Superscripts represented with "a" are significantly different (p<0.05) while those represented with "b" are not significantly different.

DISCUSSION

The proximate analysis shows that the onions samples analyzed contained more of moisture than nutrients. Onions are nutrient dense, meaning they are low in calories but high in vitamins and minerals (20). The fair amount of nutrients in the onions can help in meeting the daily nutritional requirements when eaten in combination with other nutrient dense foods. There was significant difference in the moisture content of the onion samples (p=0.000). The highest moisture content of 85.7 ±0.17 was in red onions, which is similar to the result of Sami et al. (21) where a moisture content of 88.65% was recorded. It, however, varies with the result of Yahaya et al. (11) and Osuji et al. (12) where the moisture content was 93.11 ± 0.38 and 96.10% respectively. Also, the carbohydrate content in their study was very high (64.53 ± 0.98) compared to this study which recorded a very low carbohydrate content of 12.2 ± 0.09. There was significant difference in the carbohydrate (p=0.000) and protein (p=0.015) but no significant difference in the crude fibre (p=0.079), ash (p=0.058) and fat (p=0.056) content of the onion samples. The protein content of the onion samples in this study was low (1.3±0.12 to 1.2 ±0.05) which is somewhat close to the results of Osuji et al. (12) where the protein composition of red onions was 2.48% but contrary to the result of Sami et al. (21) who recorded a high protein content ranging from 9.22g/100 to 13.21g/100 in their study on different onion bulbs. The ash content recorded by Yahaya et al. (11) was 4.26 ± 0.22 which is higher than that recorded in this study in which the ash content ranged from 0.6 ±0.05 to 0.8 ±0.08 but the ash content recorded by Rodrígues et al. (22) was lower (0.33±0.02 to 0.39±0.03) than that recorded for the onion samples.
in this study. However, the fibre content (1.4±0.08) was close to that recorded by Sami et al. (21) which ranged from 1.69 g/100 g to 1.81 g/100 g but low when compared to the results of Yahaya (11) which recorded a fibre content as high as 13.65±0.95.

Total sugars are sugars which are naturally present in foods such as fruits and milk as well as any added sugars (23). There is a little amount of total sugars in the onion samples which means that they are low in calories and can be consumed in considerable amounts without adverse health effects. There was significant difference (p=0.015) in the total sugars present in the onion samples. The highest total sugar was found in the red onions (2.6 ±0.12) while the lowest was found in yellow onions (1.7 ±0.12). This trend is similar with the results of Jurgiel-malecka et al. (19) in which the highest content of total sugars was determined in red cultivar while the lowest was yellow cultivar. However, the result of Rodríguez et al. (22) showed higher contents of total sugars which ranged from 3.20±0.93 to 4.1±0.72. A reducing sugar is a type of carbohydrate or natural sugar that contains a free aldehyde or ketone group and can react with other parts of the food, like amino acids, to change the color or taste of the food (24) such as glucose, fructose, lactose and maltose. The reducing sugars in this study ranged from 1.7 ±0.12 to 2.6 ±0.12, with no significant difference (p=0.053) in the reducing sugars present in the red, white and yellow onion. However, the study of Jurgiel-Malecka et al. (19) showed significant differences in terms of the content of reducing sugars which ranged from 95.7 g/kg to 277.7 g/kg. A study carried out for three years by Kazimiernczak et al. (25) to see effect of different fertilization regimes on some onion characteristics showed a higher total sugar (3.10 ± 0.14 to 10.58 ± 0.20) and reducing sugars (2.04 ± 0.04 to 3.52 ± 0.10) content, which can be due to the fertilizer applied.

There was significant difference (p=0.047) in the ascorbic acid content but no significant difference (0.073) in the quercetin content of the onion samples. The ascorbic acid (vitamin C) content determined in fresh mass ranged from 15.8 ± 0.79 in red onions to 11.2 ±0.21 in yellow onions. This is similar to the results obtained by Hallmann and Rembialowska (26) which showed a vitamin C content ranging from 7.52 to 16.96 mg/100 g. However, this is different from the result of Jurgiel-Malecka et al. (19) where the vitamin C content ranged from 8.13 mg/100g to 10.87 mg/100g and the result of Bieżanowska-Kopeć et al. (27) showed slightly lower content of vitamin C. Vitamin C - a water-soluble vitamin, is an antioxidant and an essential co-factor needed for collagen biosynthesis, carnitine and catecholamine metabolism, and dietary iron absorption (28). Onion is the most widely consumed vegetable across the globe and is also the richest source of quercetin and its conjugates (29). This study recorded a quercetin content of 0.19±0.01 to 0.32±0.02. This varies with the result of Salamatullah et al. (30) that recorded a quercetin content ranging from 0.89 ± 0.18 to 1.09 ± 0.06 in the control (un-dried) group, whereas they recorded the highest quercetin content in red onions oven-dried at 50°C. It also varies with the work of Jung-Ho et al. (31) who recorded total quercetin glycosides varying from 16.10 to 103.93 mg/g DW extensively among three varieties of onions. Interestingly, Majid et al. (29) found out in their research that sprouted onion powders contained more phytochemicals than raw onion powder which can be of importance in product development. Both vitamin C and quercetin are antioxidants and it has been established that antioxidants help to prevent or slow damage to cells caused by free radicals in the body (32).

CONCLUSION

The study revealed the nutrients and antioxidant properties of red, yellow and white onions sold at Bodija market in Ibadan, Oyo state, Nigeria. The results show that onion is a fair source of macro nutrients and a rich source of antioxidants such as ascorbic acid and quercetin, which are important for health and wellbeing. However, the nutrients and antioxidant properties were higher in red onions compared to the other varieties (white and yellow) of onions.

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Ethics approval:

Not applicable

Informed Consent:

Not applicable

Conflict of interest

No conflict of interest

Funding

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Author Contribution

Ani and Alfa: designed and conducted the research, wrote the paper. Adetutu: provided the materials and analyzed the data

Data and material availability

The data for the study is available on request

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