Proximate and Phytochemical Properties of Selected Cayenne Pepper Accessions from Different Growing Areas in Northern Nigeria

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ABSTRACT

Cayenne pepper has a great nutritional value and it is present in the diet of most countries. This study was carried out to determine the different accessions of cayenne pepper predominantly grown in different areas in the Northern part of Nigeria. Selected accessions of cayenne pepper were evaluated for their proximate composition and antioxidant properties using standard analytical techniques. The result of the proximate composition indicated that the moisture, ash, crude fibre, crude fat, crude protein and carbohydrate content ranges between 32.42 – 45.00, 22.22 – 28.00, 1.60 – 3.04, 15.40 – 18.00, 3.41 – 4.20 and 9.00 – 21.25 respectively. The phytochemical analysis indicated that there is the presence of flavonoids, terpenoids, steroids and cardiac glycosides. Cayenne pepper accessions selected across the growing areas contain appreciable number of phytochemicals comparable with other pepper varieties as well as the proximate composition which underscores the nutritional and health benefits of cayenne pepper.

Keywords: Cayenne, proximate, phytochemical, antioxidants, accessions

1. Introduction

The origin of pepper extends from Mexico in the north to Bolivia in the south of Latin America, where it has been a staple food in the human diet since approximately 7500BC (Purseglove et al., 1981). Pepper is one of the most widely grown and consumed spice crop in the world. It is ranked third among the world's most significant vegetable crops, after tomato and onion (Idowu-agida, 2010). Currently the crop is produced in various countries around the world including India, China, Pakistan, Indonesia, Sri Lanka, Thailand, Japan, Ghana, Nigeria, Uganda, and Ethiopia among others. Pepper production in Nigeria in year 2021 totalled 759,133.99 tonnes (FAO, 2022).

Capsicum species can be divided into several groups based on fruit/pod characteristics ranging in pungency, colour, shape, intended use, flavor, and size. Despite their vast trait differences, most commercially cultivated cultivars of peppers in the world belongs to the species C. annuum L. (Lin et al., 2013) and some of these varieties include anaheim chili, caribbean red pepper, cayenne pepper, hannerho hot peppers, poblano/ancho and Thai hot peppers (Gardnersnet, 2015). The Capsicum fruit is an excellent source of natural, micronutrient antioxidants (vitamins C and E, carotenoids and flavonoids) which appear to be critically important in preventing or reducing chronic and age-related diseases; and also contain specific component such as capsacinoids, responsible for the pungency (Bogusz Junior et al., 2018). Fruit from the pungent hot type of pepper plant is historically employed in traditional medicine and are being used in modern herb biology and conventional medicines (Palevitch and Craker 1996).

Cayenne pepper is consumed in soups, salad, stew and medicines in Nigeria. Thus, the use of the fruit based on the nutritional components represents a key point for improving health and flavour related compounds in cayenne peppers (Albrecht et al., 2012). The greater part of its production is undertaken in northern Nigeria where common accessions are largely grown. However, a little or no information is available in the scientific literature regarding the proximate and phytochemical properties of these accessions.

2.0 Materials and Methods

2.1 Description of the Study Area

The accessions were selected from six (6) growing regions in Northern Nigeria. The climatic condition of the region favours the production of vegetables and spices. The prevailing climatic condition is the Sahelian and semi-arid climate with an average day time temperature of 35°C and 21°C at nighttime. The region have very low annual mean rainfall below 700mm.
2.2 Materials

Cayenne pepper (*Capsicum annuum*) accessions were collected from six different locations in four states in the northern part of Nigeria namely: Zaria (Kaduna), Bassa (Plateau), Deba (Gombe), Miango (Plateau), Mia (Bauchi), and Quanpan (Plateau).

2.3 Procedure for Proximate Analysis

The method recommended by the association of official analytical chemist (AOAC, 1973) was used in the determination of the proximate composition in the different pepper samples. The parameters screened are moisture content, crude protein content, carbohydrate content, crude fibre, total fat content and total ash content.

**Moisture Content:** Five grams (5 g) of the sample was weighed and dried for 1 hr. The sample was allowed to cool down and re-weighed. The moisture content of the samples was then determined as follows:

\[
\% \text{ Moisture} = \frac{\text{initial weight} - \text{final weight}}{\text{initial weight}} \times 100
\]

**Ash Content:** Five (5 g) of the samples were weighed and heated on a crucible for 30 minutes to char; the sample was heated till it turned white to light grey after which the samples were allowed to cool and re-weighed again. Percentage ash content was calculated as follows:

\[
\% \text{ Ash} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100
\]

**Crude Fibre:** 5 g of the samples were weighed and defatted in 20 ml of petroleum ether to remove fat content. The samples were further boiled under reflux for 30 minutes with 200 ml solution of \(\text{H}_2\text{SO}_4\), then filtered through cheese clothes on fluted funnel. This was followed by washing in boiling water until no acid traces were found in the content. The sample was transferred into a beaker and boiled for 30 minutes with 80 ml free carbon dioxide sodium hydroxide then filtered. The residual was then transfer into an oven and dried for 30 minutes. The residual was incinerated, cooled and later weighed. Percentage crude fibre was then calculated as follows:

\[
\% \text{ Crude fibre} = \frac{\text{Loss in weight after incineration}}{\text{Initial weight}} \times 100
\]

**Percentage Fat:** 80 g of the sample was weighed into a thimble extractor and assembled into a Soxhlet apparatus and allowed to reflux for 1 hour. The fat content was precipitated out and collected into a beaker and then allowed to cool. Percentage fat content was then calculated as follows:

\[
\% \text{ fat} = \frac{\text{Weight of fat}}{\text{Weight of sample}} \times 100
\]

**Protein:** 5g of the sample was weighed into Kjeldahl flask and 5 g anhydrous sodium sulphate was added. This was followed up with the addition of 1 g of copper sulphate and selenium speck. 25 ml concentrated sulphuric acid and glass beads were added. The mixture in the fume cupboard was heated gently at first then increased with occasional shaking till the solution assumes a green colour at a digester temperature above 420°C. After the digestion, the digested sample was transferred into Markham distillation apparatus and steamed for 15 minutes with 100 ml conical flask containing 5 ml of boric acid indicator such that the condenser tip is under the liquid. The filtrate solution was received in the receiving flask and titrated with 0.01 N HCl acid. The protein content was calculated as follows:

\[
\% \text{ crude protein} = \frac{N \times (\text{conversion factor})}{w}
\]

\[
N = \frac{V_s - V_b \times N_{\text{acid}} \times 0.01401 \times 100}{w}
\]

\[
V_s = \text{vol(ml) of acid required to titrate sample}
\]

\[
V_b = \text{vol(ml) of acid required to titrate the blank}
\]

\[
N_{\text{acid}} = \text{normality of acid (0.1N)}
\]

\[
w = \text{weight of samples in grams}
\]

**Percentage Carbohydrate (CHO):** this was determined using the formula below

\[
\% \text{ CHO} = 100 - (\% \text{ Ash} + \% \text{ protein} + \% \text{ crude fibre} + \% \text{ moisture content})
\]

2.3 Procedure for Phytochemical Analysis

Phytochemical analysis of the different pepper samples was carried out according to the methods described by Trease and Evans (1989) and Sofowora (1983). The Phytochemicals examined in the pepper sample include alkaloids, saponin, tannins, flavonoids, terpenoids, carbohydrates, steroids, anthraquinones and cardiac glycosides.

*Test for Flavonoids*
The phytochemical method for the determination of flavonoids was carried out according to the method of Wadood et al. (2013). For the confirmation of flavonoids in the pepper sample, 0.5 g of sample was placed in a test tube and 10 ml of distilled water and 5 ml of dilute ammonia solution was added to a portion of the aqueous filtrate of the extract followed by addition of 1 ml concentrated H$_2$SO$_4$. Indication of a yellow colour confirmed the presence of flavonoids in the sample.

**Test for Alkaloids**

Confirmation of alkaloids was done according to the procedure used by Wadood et al. (2013). Briefly, 0.2 g of pepper sample was added to a glass test tube containing 3 ml of hexane. The powder and hexane were thoroughly mixed by shaking after which it was filtered. 5 ml of 2% HCl was added to the mixture above after which it was heated until boiling. The mixture was then filtered, and 1-3 drops of picric acid was added to the hexane, HCl and pepper extract filtrate. The presence of alkaloids in the sample was confirmed by the occurrence of yellow coloured precipitate.

**Test for terpenoids**

The method described by Wadood et al., (2013) was employed in determining the presence of terpenoids in the pepper sample. An amount of 0.8 g of the powdered sample was placed in a test tube, then 10 ml of methanol was added, mixed by proper shaking and then filtered. 5 ml of the filtrate was taken after which 2 ml of chloroform was added, as well as 3 ml of sulphuric acid. Formation of reddish-brown colour indicated the presence of terpenoids in the pepper samples.

**Test for Tannins**

Crude extract of the powdered sample was mixed with 2 ml of 2% solution of FeCl$_3$. A blue-green or black coloration indicated the presence of tannins in the pepper sample (Yadav and Agarwala, 2011).

**Test for Steroids**

Powdered pepper sample from each of the different locations were mixed with 2 ml of chloroform and concentrated H$_2$SO$_4$ was added sidewise. A red colour produced in the lower chloroform layer indicated the presence of steroids. Another test was performed by mixing crude extract with 2 ml of chloroform. Then 2 ml of each of concentrated H$_2$SO$_4$ and acetic acid were poured into the mixture. The development of a greenish coloration indicated the presence of steroids in the pepper sample (Yadav and Agarwala, 2011).

**Test for Saponins**

The crude extract of the pepper sample was obtained and mixed with 5 ml of distilled water in a test tube after which it was mixed by shaking vigorously. The formation of stable foam was taken as an indication for the presence of saponins (Yadav and Agarwala, 2011).

**Cardiac Glycosides**

Few drops of glacial acetic acid were added to 2 ml of the aqueous extract of the pepper samples. Drops of 10% ferric chloride (FeCl$_3$) and then concentrated sulphuric acid (H$_2$SO$_4$) was then added. The formation of a reddish-brown colouration between the two layers showed the presence of cardiac glycosides.

### 3.0 Result

**Table 1: Proximate compositions of cayenne pepper across different growing areas**

<table>
<thead>
<tr>
<th>Accessions</th>
<th>Moisture Content (%)</th>
<th>Total Ash (%)</th>
<th>Crude Fibre (%)</th>
<th>Crude Fat (%)</th>
<th>Protein (%)</th>
<th>Carbohydrate Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>40.00$^b$</td>
<td>24.39$^b$</td>
<td>2.70$^b$</td>
<td>18.00$^a$</td>
<td>3.64$^{ab}$</td>
<td>11.63$^c$</td>
</tr>
<tr>
<td>G2</td>
<td>41.00$^b$</td>
<td>28.00$^a$</td>
<td>3.01$^c$</td>
<td>15.40$^c$</td>
<td>3.41$^{ab}$</td>
<td>11.17$^c$</td>
</tr>
<tr>
<td>G3</td>
<td>32.42$^d$</td>
<td>24.44$^c$</td>
<td>2.37$^b$</td>
<td>16.00$^b$</td>
<td>3.52$^a$</td>
<td>21.25$^a$</td>
</tr>
<tr>
<td>G4</td>
<td>45.00$^a$</td>
<td>26.60$^b$</td>
<td>2.37$^b$</td>
<td>17.00$^{ab}$</td>
<td>4.20$^c$</td>
<td>9.00$^d$</td>
</tr>
<tr>
<td>G5</td>
<td>39.00$^b$</td>
<td>22.44$^d$</td>
<td>1.60$^c$</td>
<td>17.86$^c$</td>
<td>3.50$^{ab}$</td>
<td>15.96$^b$</td>
</tr>
<tr>
<td>G6</td>
<td>37.00$^c$</td>
<td>26.80$^b$</td>
<td>3.04$^a$</td>
<td>17.59$^a$</td>
<td>4.00$^c$</td>
<td>13.46$^b$</td>
</tr>
<tr>
<td>SEM</td>
<td>1.48</td>
<td>1.79</td>
<td>1.56</td>
<td>4.21</td>
<td>3.47</td>
<td>1.86</td>
</tr>
<tr>
<td>P value</td>
<td>0.05</td>
<td>0.05</td>
<td>0.03</td>
<td>0.82</td>
<td>0.09</td>
<td>0.04</td>
</tr>
</tbody>
</table>

The proximate analysis of the selected cayenne pepper accessions from the different growing areas in Northern Nigeria is presented in Table 1. The moisture content of the accession G4 recorded the highest value of 45% which is significantly (P<0.05) higher than the moisture content of other accessions from other growing areas. The total ash content of the accession G2 (28%) is significantly (P<0.05) higher than the values recorded for the
other accessions. Accessions G2 and G6 recorded the highest values for the crude fibre. The crude protein content of the accession G4 is higher (P<0.05) though not significantly different from the value recorded for the accession G6 while the carbohydrate content of the accession G3 is significantly (P<0.05) higher than other accessions.

Table 2: Phytochemical compositions of selected cayenne accessions from different growing areas

<table>
<thead>
<tr>
<th>Phytochemical</th>
<th>G1</th>
<th>G2</th>
<th>G3</th>
<th>G4</th>
<th>G5</th>
<th>G6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrate</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Saponins</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Flavonoids</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Terpenoids</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Steroids</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Alkaloids</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Anthraquinones</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cardiac glycosides</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Quinones</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Phenols</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Anthocyanins</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Proteins</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Phlobatansins</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tannins</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

KEYS

1) = Not present, + = Present, ++ = Strong present

The result of the phytochemical constituents of the different accessions of cayenne pepper from different growing zones in Northern Nigeria is as shown in Table 2. The result indicated that carbohydrate, flavonoids, terpenoids and cardiac glycosides were present in all the accessions. There was the strong presence of flavonoids in the accessions from Mia and Zaria.

4. Discussion

The moisture content of any food is an indication of its water content, and it is important as several biochemical and physiological changes in food depend on it (Onwuka, 2005). Food samples with high moisture contents is susceptible to microbial growth (Gulssepe and Barata, 2000). The moisture content recorded for the selected accessions are below the value recorded by Amaechi et al. (2021) The ash content recorded are higher than those recorded for Pachira glabra (4.34%) and Afrelia Africana (4.0%) seed flour (Ogundale et al., 2011). The ash content obtained in this study is relatively high, as a result, they may be considered as a good source of minerals for compounding animal feed. The values of the fat contents are higher than the values reported for scarlet runner bean (7.5%) and higher than cowpea (3.1%), kersting groundnut (5.9%) and Bambara nut (6.7%) (Aremu et al., 2006). The crude fibre contents are within the range recorded for legumes such as cowpea (2.1%) (Giani, 1993), cream coat Bambara groundnut (2.1%) (Aremu et al., 2008). These values are within acceptable limits which help to maintain the health of gastrointestinal tract, but in excess may bind trace elements, leading to deficiency of iron and zinc (Sidduraju et al., 1996). The amount of crude protein obtained in these samples are considerable even though their percentages are low compared to the protein level in some oil seeds consumed in Nigeria (Enujiugha and Agbede, 2000). The moisture contents suggest that pepper could be a good supplement to scarce cereal grains as sources of energy and feed formulations. The amount of ash content obtained in this study is significantly different from the value recorded by Amaechi et al. (2021). The phenolic compounds of pepper tend to inhibit lipid autoxidation by acting as radical scavengers and, consequently, are essential antioxidants that protect against the propagation of oxidative stress. Research studies indicate that hotter varieties of pepper contain more phenolic compounds as compared to the sweeter ones (Melgar-Lalanne et al., 2017). Flavonoids are beneficial as antioxidant, anti-inflammatory agent, preventing mutation and interfering with the development of cancer, and regulating key cellular enzyme functions (Panche et al., 2016). Terpenes, also known as terpenoids are the largest and most diverse group of naturally occurring compounds, which are mostly found in plants and form the major constituent of essential oils from plants (Cox-Georgian et al., 2019). Among the natural products that provide medical benefits for an organism, terpenes play a major and variety of roles and they have a wide range of medicinal uses among which anti-plasmodial activity, which is notable as its mechanism of action is
like the popular antimalarial drug in use—chloroquine (Cox-Georgian et al., 2019). Cardiac glycosides (CGs) are secondary compounds found in plants and amphibians and are widely distributed in nature with potential cardiovascular action. Their mechanism is based on the blockage of the heart's sodium potassium ATPase, with a positive inotropic effect (Botelho et al., 2019). The confirmation of the presence of these compounds in the cayenne pepper underscores its importance in the diets and the role it plays in promoting health and well-being of the human populace as well as in livestock production.

Conclusion

From the study, it was observed that selected cayenne pepper accessions across the various growing areas contained appreciable number of phytochemicals comparable with other pepper varieties as well as the proximate composition which underscores the nutritional and health benefits of cayenne pepper.

Conflict of Interest

There was no conflict of interest in the course of carrying out this study.

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