International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

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

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DOI: https://doi.org/10.55248/gengpi.4.823.45799

A B S T R A C T

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. *annum* L. (Lin *et al*., 2013) and some of these varieties include anaheim chili, caribean red pepper, cayenne pepper, hannero hot peppers, poblano/ancho and Thai hot peppers (Gardenersnet, 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 capsaicinoids, 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 35^0C and 21^0C 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 1hr. The sample was allowed to cool down and re-weighed. The moisture content of the samples was then determined as follows:

$$\textbf{\% Moisture} = \frac{\text{initial weight} - \text{final weight}}{\text{Initial weight}} \times 100$$

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;

$$\textbf{\%Ash} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

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 H_2SO_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 carbonate 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;

% Crude fibre = Loss in weight after incineration x 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;

$$\textbf{\% fat} = \frac{\text{Weight of fat}}{\text{Weight of sample}} \times 100$$

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 420ºC. 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:

% crude protein = N x (conversion factor)

$$\textbf{\% Nitogen (N)} = \frac{\text{Vs-Vb x Nacid x 0.01401}}{\text{w}} \times 100$$

Vs = vol(ml) of acid required to titrate sample

Vb = vol(ml) of acid required to titrate the blank

N_{acid} = normality of acid (0.1N)

W = weight of samples in grams

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

% CHO = 100 - (%Ash + % protein% + crude fibre + % 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_2SO_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_2SO_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_2SO_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).

Test for Anthraquinones

The ether and chloroform maceration from each of the pepper sample was filtered and 1 ml of this solution was treated with 1 ml of 10% sodium hydroxide solution. A red coloration indicates the presence of quinines.

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_2SO_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

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

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

Phytochemical	G1	G2	G3	G4	G5	G6
Carbohydrate	+	+	-	+	+	-
Saponins	-	-	-	-	-	-
Flavonoids	+	+	+	+	++	++
Terpenoids	+	+	+	+	+	+
Steroids	+	+	+	+	+	+
Alkaloids	-	-	-	-	-	-
Anthroquinones	-	-	-	-	-	-
Cardiac glycosides	+	+	+	+	+	+
Quinones	-	-	-	-	-	-
Phenols	-	-	-	-	-	-
Anthocyanins	-	-	-	-	-	-
Proteins	-	-	-	-	-	-
Phlobatanins	-	-	-	-	-	-
Tanins	-	-	-	-	-	-

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 depends on it (Onwuka, 2005). Food samples with high moisture contents is susceptible to microbial growth (Gulssepe and Baratta, 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 low protein level obtained in this study is an indication that the potential usage of these peppers is not regarded as a source of protein for food and feed formulation. The carbohydrate contents suggest that pepper could be a good supplement to scarce cereal grains as sources of energy and feed formulations. The values are lower than those of soya bean (26.3%) as reported by Temple *et al*., (1991), Cranberry beans (31.4%) (Aremu *et al*., 2006). The results of this study indicated that these peppers contain a moderate amount of carbohydrate, and this can provide accessible fuel for physical performance and regulate nerve tissues (Onwuka, 2005).

Antioxidants have been constituents of great interest to researchers for many years now owing to their health-promoting capabilities. Their wide applications in different food items, nutraceutical products, and even cosmetics are well documented, and present an excellent prospect for food processors to extract and quantify them from different foods. Cayenne fruits are a rich source of different phytochemicals such as vitamins A and C, flavonoids, and carotenoids (Akhtar *et al*., 2021). This is consistent with the phytochemical profiling in the present study across different growing areas, with the presence of flavonoids, terpenoids and cardiac glycosides. However, their significance for aroma profile is not well reported yet (El-Ghorab *et al*., 2013). According to Akhtar *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.

References

1] Aqsa A, Waqas A, and Nauman. Phytochemical constituents and biological properties of domesticated capsicum species: a review. *Bioactive Compounds in Health and Disease*. 4(9): 201-225, 2021.

2] Albrecht, E., Zhang, D., Saftner, R. A. and Stommel, J. R. Genetic diversity and population structure of *Capsicum baccatum* genetic resources. Genetic Resources and Crop Evolution, 59, 517-538, 2012.

3] Amaechi NC, Udeogu E, Okoronkwo CU and Irondi CP. Nutritional and phytochemical profiles of common pepper (Capsicum spp.) foliage consumed as leafy vegetables in Southeast Nigeria. Food Research 5(5):136–144, 2021. Journal home page: http://www.myfoodresearch.com

4] [AOAC] Association of Official Analytical Chemists. Official methods of proximate analysis, AOAC International, Gaithersburg, MD. 2010; 15. 2010.

5] Aremu MO, Olaofe O. and Akintayo ET. Chemical Composition and Physicochemical Characteristic of Two Varieties of Bambara Groundnut Vigna subterranean. Flours. Journal of Applied Science, 6: 1900-1903, 2006.

6] Bogusz Junior, S., Libardi, S. H., Dias, F. F. G., Coutinho, J. P., Bochi, V. C., Rodrigues, D., Melo, A. M. T. and Godoy, H. T. Brazilian *Capsicum* peppers: capsaicinoids content and antioxidant activity. Journal of the Science of Food and Agriculture, 98, 217-224, 2018.

7] Bosland PW and Yotava EJ. Peppers: Vegetable and Spices Capsicums publishing, Oxon, Uk and New York. 204P, 2000.

8] Botelho AFM, Pierezan F, Soto-Blanco B, Melo MM. A review of cardiac glycosides: Structure, toxicokinetics, clinical signs, diagnosis and antineoplastic potential. Toxicon. 2019 Feb;158:63-68. doi: 10.1016/j.toxicon.2018.11.429. Epub 2018 Dec 4. PMID: 30529380.

9] Cox-Georgian D, Ramadoss N, Dona, C, Basu C. Therapeutic and Medicinal Uses of Terpenes. In: Joshee, N., Dhekney, S., Parajuli, P. (eds) Medicinal Plants. Springer, Cham. https://doi.org/10.1007/978-3-030-31269-515, 2019)

10] Delelegn S.. Evaluation of Elite Hot Pepper Varieties (Capsicum Species) for Growth, dry pod yield and quality under Jimma Condition, South West Ethiopia. M.Sc. Thesis Jimma University College of Agriculture and Veterinary Medicine, 2011.

11] El-Ghorab A. Pakistani bell pepper (Capsicum annum L.): chemical compositions and its antioxidant activity. Int J Food Propr. 16(1): 18-32, 2013. https://doi.org/10.1080/10942912.2010.513616.

12] VN and Agbede JO. Nutritional and anti-nutritional characteristics of African oil bean (*Pentaclethra macrophylla*) seeds. *Applied Tropical Agriculture*, 2000, 5: 11-4.

13] FAO, 2017. FAOSTAT. Food and Agriculture Organization of the United Nations, Rome, Italy.

14] Gardenersnet. The varieties of pepper. 2015. Retrieved from www.gardenersnet.com on the 20th of August 2021.

15] Giani SY. Effect of processing on the proximate composition and functional properties of cowpea (Vigna unguiculata) flour. Food. Chem. 47: 153-158, 1993.

16] Guisseppe R, and Baratta TM. Antioxidant activity of selected essential oil Components in two lipid model systems. African Journal of Biotechnology, 69(2): 167 – 174, 2000.

17] Idowu-Agida OO, Nwaguma EI and Adeoye IB. Cost implication of wet and dry season pepper production in Ibadan, Southwestern Nigeria. Agricultural and Biology Journal of North America ISSN print: 21st-7517 ISSN online 2151-75210 210, 2010. sciences http://www.scihub.org/abjma

18] Lin SW, Chou YY, Shieh HC, Ebert AW, Kumar S, Mavlyanova R et al. Pepper (Capsicum spp.) germplasm dissemination by AVRDC–The World Vegetable Center: an overview and introspection. *Chronica Horticulturae*. 53(3):21-27, 2013.

19] Melgar-Lalanne G, Oleoresins from Capsicum spp.: Extraction Methods and Bioactivity. Food Bioproc Tech 2017, 10(1): 51-76. doi:10.1007/s11947-016-1793-z, 2017.

20] Ogunlade I, Ilugbiyin A. and Osasona AL. A Comparative Study of the Proximate Composition, Antinutrients Composition and Functional Properties of Pachiraglabraand Afzelia Africana Seed Flour. African Journal of Food Science, 5(1): 32-35, 2011.

21] Onwuka GI. Food Analysis and Instrumentation: Theory and Practice. Naphthali Print, Lagos, 133-137, 2005.

22] Palevitch D and Craker LE. Nutritional and Medical Importance of Red Pepper (*Capsicum* spp.), Journal of Herbs, Spices & Medicinal Plants, 3:2, 55-83, 1996. DOI: 10.1300/J044v03n02_08

23] Panche AN, Diwan AD and Chandra SR. Flavonoids: An overview. J. Nutr. Sci. 5:e47, 2016. Doi: 10.1017/jns.2016.41. eCollection 2016.

24] Purseglove JW, Brown EG, Green CL, Robins SRJ. Spices: Volume 2, 1981. Longman Group Limited, London. Pruthi J

25] Siddhuraju P, Vijayakumari K, and Janardhanan K. Chemical Composition and Protein Quality of Little Known Legume, Velvet Bean Mucunapruriens L. (DC). Journal of Agriculture and Food Chemistry, 44: 2636-2641, 1996.

26] Sofowora, A. Medicinal Plants and Traditional Medicine in Africa. 2nd ed. Ibadan, Nigerian: Spectrum Books Ltd.; 1993; 289, 1993.

27] Temple VJ, Odewumi L, Joseph K. Soybeans and soybean based diets. In: Proceedings of the 3 rd regional workshop on rural development, Jos, 31 st July – 2nd Aug 1991. pp. 45-50, 1991.

28] Trease GE and Evans WC. Pharmacognosy: a Physician's Guide to Herbal Medicine. 13th ed. London: Bailliere Tindall; 176-80, 1989.

29] Wadood A, Ghufran M, Jamal SB, Naeem M, Khan A, Ghaffar R, and Asnad. Phytochemical Analysis of Medicinal Plants Occurring in Local Area of Mardan. Biochemistry and Analytical Biochemistry. 2:4, 2013. http://dx.doi.org/10.4172/2161-1009.1000144.

30] Yadav RNS and Agarwala M. Phytochemical Analysis of Some Medicinal Plants. Journal of Phytology, 3, 10-14, 2011