EJSIT
European Journal of Science, Innovation and Technology
ISSN: 2786-4936
www.ejsit-journal.com
Volume 3 | Number 3 | 2023

Nutritional Composition and Phyto-Constituents of Corn Silk (*Zea Mays* Hair) Grown in Southern Senatorial District of Kaduna State, Nigeria

Christopher Habu[1*], Kenneth Stephen[2], James Gana Josiah[3], Zakari Ladan[4], O.A Babatunde [5]
[1]Department of Industrial Chemistry, Mewar International University, Abuja, Nigeria
[2]Department of Industrial Chemistry, University of Ilorin, Kwara State, Nigeria
[3]Department of Biotechnology, Mewar International University, Abuja, Nigeria
[4]Department of Pure and Applied Chemistry, Kaduna State University, Nigeria
[5]Department of Chemistry, Nigerian Defense Academy, Kaduna State, Nigeria

ABSTRACT

The data obtained from the results showed the presence of crude lipid, crude fiber, protein, ash, energy value, and total carbohydrate in moderate and high amounts. Mineral contents such as K, Ca, Mn, Fe, and Zn that play a vital role in the metabolic functions of humans were also present. The phytochemical screening results showed the presence of tannins, flavonoids, saponins, phlobatannins, terpenoids, and phenols in both n-hexane and methanol extracts, while glycosides and alkaloids were absent in the methanolic extract and phlobatannins was also not present in the n-hexane extract accordingly. The phytoconstituents identified by the GC-MS characterization are 1-Heneicosanol, Hexadecanoic acid, methyl ester, 9,15-Octadecadienoic acid, 9,17-Octadecadienal, 9,12-Octadecadienoic acid, Capsaicin, Dihydrocapsaicin, 1-Octadecanesulphonyl chloride, Sulphurous acid, 2-propyl tetradecyl, Ergost-5-en-3-ol, Stigmasterol, Beta- Sitosterol, E 8-Hexadecen-1-ol acetate, Cyclohexane, 2-Methyl-E,E-3,13-octadecadien-1-ol, and 1-Methylene-2b-hydroxymethyl-3,3-dimethyl-4b-(3-methylbut-2-enyl)-cyclohexane.

Keywords: Minerals, Corn Silk, Phyto-constituents, Southern-Kaduna, Nutrition

INTRODUCTION

Zea mays are one of the most widely grown cereal crops in southern Kaduna-Nigeria, where virtually every household grows this crop for consumption and commercial purposes. It is also the most important cereal crop in the world other than rice and wheat (Velazquez et al., 2005). Maize silk is also known as corn silk *or Zea mays* hair and it is made up of the styles and stigmas from the grass (*graminea*) family. It has numerous phytochemical compounds such as phenolic acids, phenols, flavonoids, polyphenols, saponins, carotenoids, polysaccharides, terpenoids, alkaloids, steroids, lutein, tannins, vitamins, volatile oils, flavone glycosides, anthocyanins, and some sugars (Ebrahimzadeh, Pourmorad, & Hafezi, 2008; Hasanudin, Hashim, & Mustafa, 2012). Corn silk which is regarded as agricultural by-product and waste has medicinal applications. Due to its effectiveness in treating various ailments, corn silk is frequently chosen and widely used as an old folk therapeutics' agent. Generally, plants are an important primary producer of food playing a significant role in livestock and human diet (Winiarska-Mieczan et al., 2019).

Corn silk is an excellent source of bioactive components such as volatile oils, steroid, alkaloid, and natural antioxidants with beneficial effects on human health. This waste agricultural products contain some mineral composition such as Ca, K, Mg, Mn and Zn. Report showed that matured *Zea mays* hair contains 9.65% moisture content, 17.6% protein, 0.29% fats content, 3.61% ash content, 40% dietary fibre, and 28.55% total carbohydrates. Health hazards of corn silk have been reported in many investigations. Corn silk of some local corn varieties is

* Corresponding Author

ground and used as food additives and flavoring agent in several regions of the world. Corn silk powder is used as food additives to improve the content and characteristics of beef patties.

LITERATURE REVIEW

In some rural areas of Africa, common ailments such as typhoid, malaria, and cough are treated with local plants that contain several bioactive compounds such as flavonoids, alkaloids, phenolic compounds. Hence, corn silk has been applied as herbal medicine for the treatment of hypertension, tumors, hyperglycemia, hepatitis, cystitis, gout, kidney stones diabetes nephritis, and prostatitis in numerous parts of the world (WHO, 2017). The extracts are reported to increase insulin level and healed injured β-cell of the pancreas and control blood sugar levels in rats (Habtemariam, 1998). The efficiency and safety of corn silk tea (CST) in improving the clinical effects of hypertensive patients has been reported (Shi et al., 2019) where it exerts an antihypertensive outcome in clinical trials. Furthermore, corn silk is also known to be an excellent source of biologically active components like volatile oils, steroids, alkaloids, natural antioxidants minerals such as Ca, K, Mg, Mn, and Zn having beneficial effects on human health (Eman, 2011). The microelements are essential in human health as they play important roles in physiological functions, enzyme synthesis, hormones, and regulating growth, boosting the immune and reproductive systems (Cakmak, McLaughlin, & White, 2017; Izydorczyk et al., 2020). However, deficiency of microelements in human diets can result in health challenges such as anaemia, nervous system damage, and heart diseases (Potiron et al., 2010; Kalache et al., 2019).

Corn silk was reported to consist of 9.65% moisture, 0.29% fats, 17.6% protein, 3.61% ash, 40% dietary fiber, and 28.55% total carbohydrate and its extract has a large quantity of maysin, a flavonoid type specific only to corn (Lee et al., 2016). In addition, maysin in corn silk extract is a flavone glycoside comprising luteolin, which is a bioactive compound well-known to exhibit high anticancer and antioxidant activities. Previous reports on maysin have assessed its anti-dementia anti-obesity, anti-allergy, anti-oxidant, anti-asthma, anti-cancer, and anti-dementia effects (Kim & Jung, 2001). It has been reported by Ha et al. (2018) that corn silk extract is effective in treating kidney diseases and as a diuretic agent as well as being effective in treating hypertension, urinary tract, prostatitis, and nephritis infections (Hasanudin, Hashim, & Mustafa, 2012). With the abundance of these crops grown almost all over Nigeria especially in the southern part of Kaduna State, Nigeria, the need to study and publicize its nutritional and bioactive components cannot be overemphasized. The nutritional composition or proximate analysis was determined using standard protocols (Association of Official Analytical Chemists, 2005; 2007). Parameters determined were: moisture, ash content, Crude lipid content, crude protein, total carbohydrate, crude fibre, estimated energy (kcal), and elemental composition of K, Na, Ca, Mn, Fe, and Zn. The Qualitative evaluation of the crude extracts was done out according to standard methods (Tiwari et al., 2011). The following bioactive constituents were determined**:** flavonoids, alkaloids, phenols, tannins, phlobatannins, terpene and terpenoids, saponins, cardiac glycosides.

METHODOLOGY

The mature plant of *Zea Mays* was collected from two different farmlands in a composite farm in Gwantu, Sanga local government area (L.G.A) of Kaduna state in November 2019 and authenticated at the Department of Biological Science with voucher number 3224 which was deposited at the Herbarium section of the Department. Figure 1 illustrates the map of the Gwantu ward as study area, Sanga L.G.A of southern senatorial district of Kaduna state, Nigeria.

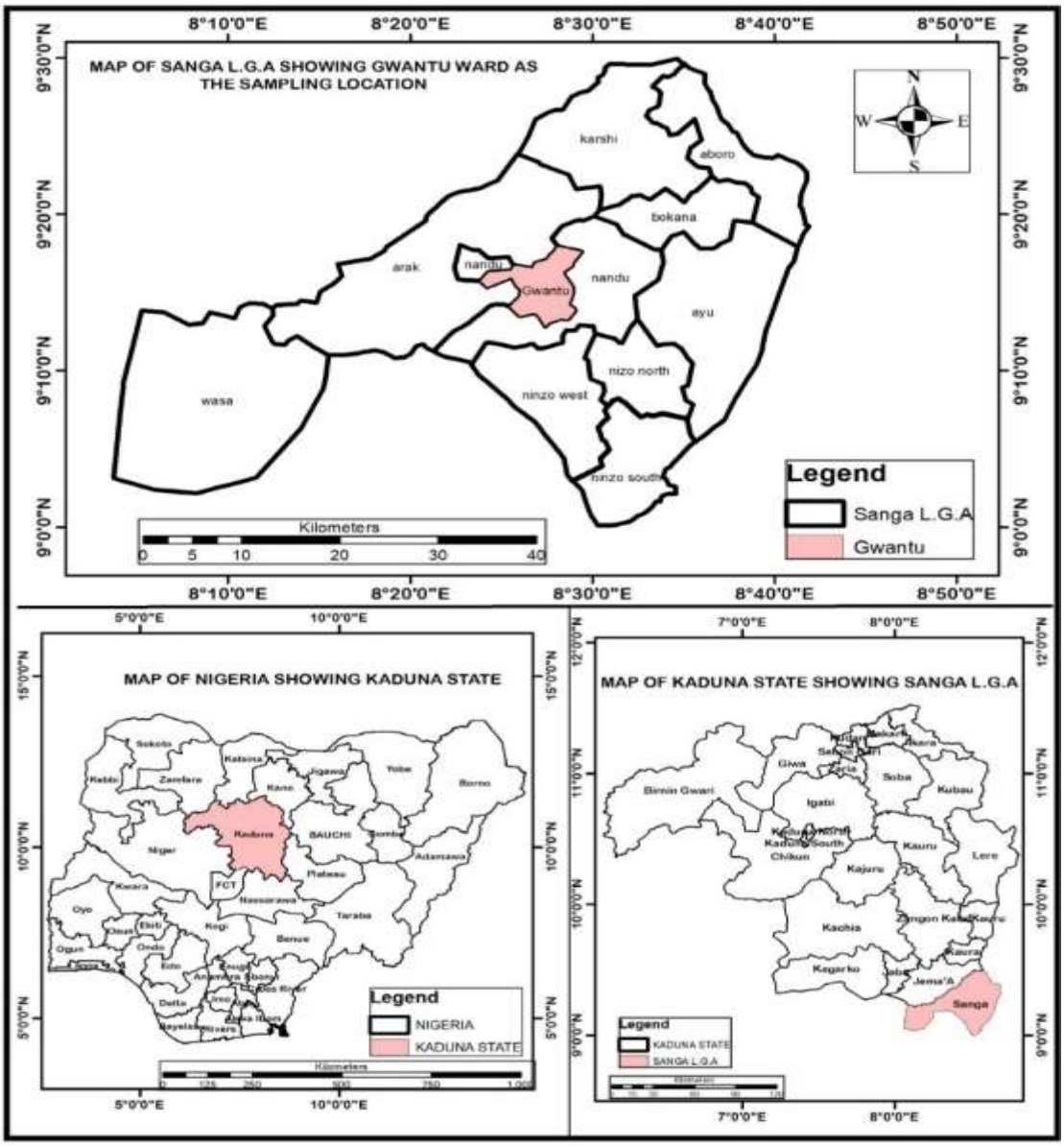

Figure 1. Map of Gwantu ward as study area, Sanga L.G.A of southern senatorial district of Kaduna state, Nigeria

The corn silk (*Zea Mays hair*) was detached from the matured corn and allowed to dry in the shade for two weeks and ground to powder using pestle and mortar in the laboratory. Exactly 300g of the powdered material was weighed into a soxhlet thimble and extracted using n-hexane and methanol successively to afford the extracts which were concentrated *in vacuo* to obtain the crude extracts. The crude extracts were kept in an airtight container at 4^{o}C in a refrigerator until required for use.

RESULTS

In this study, a two-way analysis of variance (ANOVA) tests was executed to determine the statistical differences in the data generated using SPSS 17.0 for Windows and Microsoft Excel (2013). The means concentration values were separated by Duncan Multiple range test and significant differences at $P \leq 0.05$ confidence interval.

Table 1. Proximate analysis of the corn silk (*Zea mays* hair)

Parameter	Composition
Moisture (%)	5.0258 ± 0.01
Ash (%)	3.7867 ± 0.02
Crude Lipid (%)	1.2616 ± 0.035
Crude Protein (%)	1.2616 ± 0.035
Crude Fibre (%)	42.3570 ± 0.025
Total Carbohydrate (%)	28.8439 ± 0.01
Caloric Value (Kcal)	201.6300 ± 0.21

Note: The data are expressed as mean values ± standard deviation (SD) of three replicates

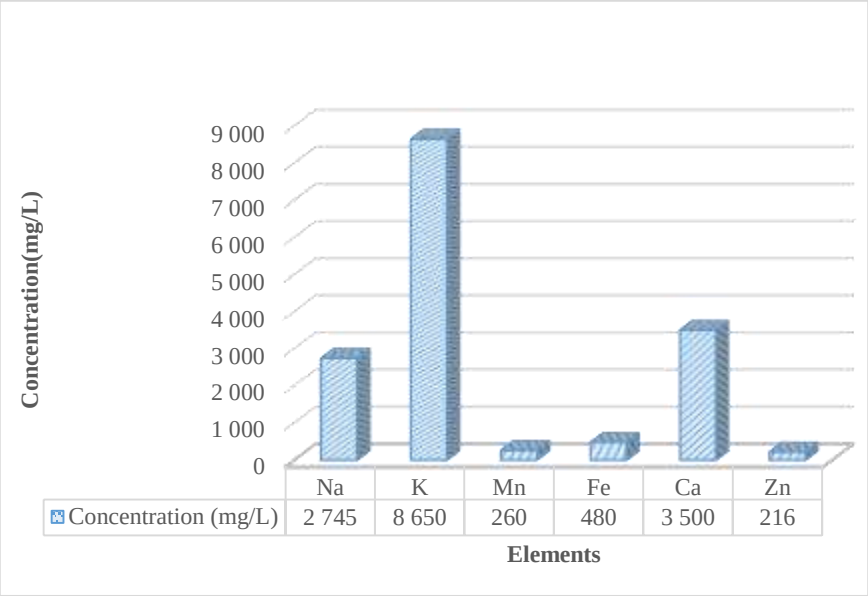

Figure 2. Mineral composition of the matured corn silk (*Zea mays hair)*

Table 2. Qualitative evaluation of phyto-components in a matured corn silk (*Zea mays hair)*

Bioactive components	Crude Extracts	
	Methanol	Hexane
Flavonoids	+	+
Steroids	+	+
Alkaloids	+	-
Phenols	+	+
Tannins	+	+
Carbohydrates	+	+
Terpene and terpenoid	+	+
Saponin	+	+
Cardiac glycosides	-	-

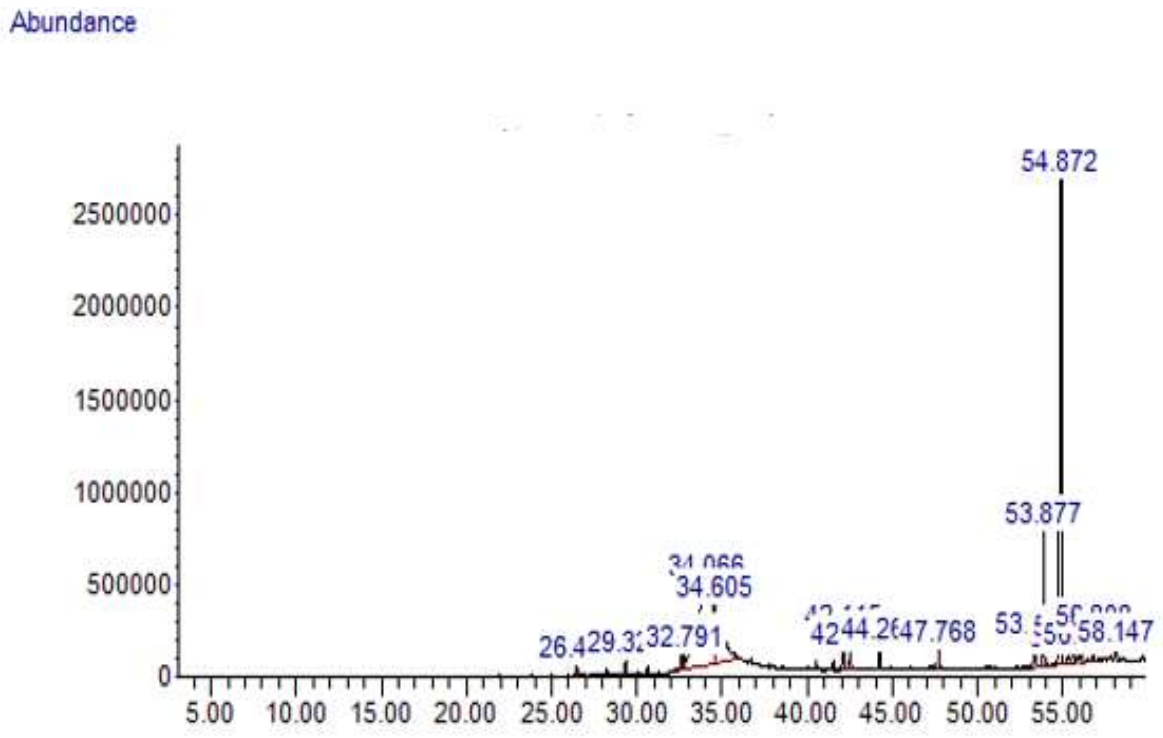

Figure 3. GC-MS profile of constituents of the matured corn silk extracts (*Zea mays hair)*

Table 3. Phytochemical constituents detected in the GC-MS chromatogram of the matured corn silk extracts (*Zea mays hair)*

Peak No.	R_t (Mins)	Area (%)	Constituents
1	26.482	0.30	1-Heneicosanol
2	29.325	0.44	Hexadecanoic acid, methyl ester
3	32.664	0.64	9,15-Octadecadienoic acid, methyl ester
4	32.791	0.57	9,17-Octadecadienal
5	34.066	51.11	9,12-Octadecadienoic acid
6	42.115	2.28	Capsaicin
7	42.522	1.00	Dihydro capsaicin
8	44.261	0.81	1-Octadecanesulphonyl chloride
9	47.768	0.65	Sulphurous acid, 2-propyl tetradecyl
10	53.331	1.44	Ergost-5-en-3-ol
11	53.877	6.00	Stigmasterol
12	54.872	30.58	Beta- Sitosterol
13	55.288	0.70	E-8-Hexadecen-1-ol acetate
14	55.578	1.12	Cyclohexane
15	56.123	0.52	2-Methyl-E,E-3,13-octadecadien-1-ol
16	56.808	1.34	Stigmasterol
17	58.147	0.50	1-Methylene-2b-hydroxymethyl-3,3-dimethyl-4b-(3-methylbut-2-enyl)-cyclohexane.

DISCUSSION

The results of proximate analysis of the corn silk (Table 1) showed significant low moisture content (5.0258% ±0.01) compared to (10.23% ±0.03) as reported by Wan Rosli et al. (2011) in the literature. The ash content as the index of mineral composition shows relatively

low (3.7867% ± 0.02) when compared with the metal composition (Table 2). The crude lipid and crude proteins (1.2616% ± 0.035 and 18.725% ± 0.79) are significantly higher than 0.29% and 17.6% as reported (Nurhanan, Wan Rosli, & Mohsin, 2012). According to Pearson (1976), any waste agricultural products that provide more than 12% of their caloric value from protein are considered a good source of proteins. Therefore, these waste products (corn silk) with a protein value of 18.725% ± 0.79 meets this requirement, as such could be considered a good source of protein. The crude fibre content is 42.357% which is higher when compared to the reported value of 40% showed its usefulness in dietary formulations for good health (Tiwari et al., 2011). The high fibre content in human nutrition lowers nutrients bioavailability and can invariably cause intestinal irritation (Wan Rosli et al., 2011). On the other hand, intake of dietary fibre within the recommended daily allowance lowers the serum cholesterol level, hypertension, diabetes, colon and breast cancer (Wan Rosli et al., 2011; Nurhanan, Wan Rosli, & Mohsin, 2012). The standard recommended dietary allowance (RDA) of fibre content for children, adults, pregnant and lactating mothers are 19-25%, 21-38%, 28%, and 29% respectively (Simpson & Campbell, 2015; Ishida et al., 2000). Therefore, corn silk could be considered as a rich source of dietary fiber which may confer positive health benefits. The total carbohydrate content is 28.84% in the *Zea mays* hair which is comparable with 28.55% reported while the caloric value of corn silk was found to be 201.63kcal/100g which is higher than 165.34kcal/100g reported in the literature (Tiwari et al., 2011). The calorific values of corn silk from this study are in agreement with the general observation that all cereals crops have high energy values and therefore are good sources of energy.

Mineral Composition

The results of the mineral composition of corn silk (*Zea mays* hair) in Figure 2 showed potassium (K) concentration to be higher than sodium (Na), the Na/K ratio in the diet is an important factor in the prevention of hypertension (Ramula & Rao, 2003; Rainakari et al., 2016) indicated that the Na/K ratio range of 0.3 – 0.4 is considered the most adequate for the normal retention of proteins during the growth stage. The present study revealed the Na/K ratio to be 0.32 which is within the range indicated by Guil-Guerrero et al. (1998). Moderate consumption of corn silk can regulate high sodium (Na) intake (World Health Organization, 2012). Corn silk is rich in macronutrient elements such as calcium, iron, and potassium. Calcium is associated with the growth and maintenance of bones, teeth, heart functions, and muscles and was found in the corn hair to be present in high concentration (3,500mg/L). Deficiency of calcium can lead to bone deterioration. Iron is an important mineral element and is found to be present in *Zea Mays* hair. Iron is an essential trace element for haemoglobin formation, oxygen supply, boosting immunity, and normal functioning of the central nervous system (Adeyeyei & Otokiti, 1999). The deficiency of iron leads to anaemia. Potassium helps in maintaining blood pressure thereby reducing the risk of stroke and cardiovascular disease in humans.

Zinc which is involved in the normal function of the immune system was found to be present (216mg/ml), Figure 2 in the corn silk. It is an essential trace element that plays an important role in the growth, development, and maintenance of immune function. It influences all organs and cell types, representing an integral component of approximately 10% of the human proteome, and encompassing hundreds of key enzymes and transcription factors. Zinc deficiency has been associated with increased susceptibility to infectious diseases, including viral infections, and can lead to growth retardation and skin disorders (Adeyeyei & Otokiti, 1999). Studies have shown that the zinc status of an individual is a critical factor that can influence immunity against viral respiratory infections (Eman, 2011; Rainakari et al., 2016). Zinc-deficient populations are at increased risk of acquiring infections, such as HIV or HCV. It also regulates the function of some genes, enables many proteins to carry out their vital roles,

and helps speed the chemical reactions that keep us alive (Adeyeyei & Otokiti, 1999; Read et al., 2020). Manganese is a trace mineral and was found to be present (260mg/L) in the corn silk analyzed. It has many bodily functions, such as the metabolism of amino acids, cholesterol, glucose, and carbohydrates. It also plays a role in bone formation, blood clotting, and reducing inflammation. Manganese helps form an antioxidant enzyme called superoxide dismutase (SOD). Antioxidants shield the body from free radicals, which are molecules that destroy or damage cells in the body. For people with diabetes, manganese may help lower blood sugar levels (World Health Organization, 2012). The nutritional significance of minerals elements is usually compared with the standard recommended dietary allowance (RDA) for foods consumed.

Phytochemical Screening

The results of the bioactive components of the methanolic and n-hexane extracts of the corn silk in Table 2 revealed the presence of flavonoids, phenols, tannins, steroids, alkaloids, terpenoids, and saponins in the methanolic extract while cardiac glycoside was absent. In the n-hexane extract, steroids, saponins terpenoids, tannins, phenols, and flavonoids were present while alkaloids and cardiac glycosides were absent. These bioactive compounds are important in the pharmaceutical and medicinal field due to their antioxidant, antimicrobial, and other biological properties. The presence of these bioactive components of the methanolic and n-hexane extracts of the matured corn silk justifies its use for the treatment of various ailments such as prostatitis, hyperglycemia, etc. Flavonoids were found in the two extracts which make the plant resistant to attack by microbes and insects and can protect animals against various diseases. The potent antioxidant activity of flavonoids, their ability to scavenge hydroxyl radicals, superoxide anions, and lipid peroxyl radicals may be the most important function of flavonoids. Flavonoids have been shown to have hepatoprotective, antibacterial, anti-inflammatory, antiallergic, antimutagenic, antiviral, antithrombotic, and vasodilatory activity (Ebrahimzadeh, Pourmorad, & Hafezi, 2008; Shi et al., 2019). Saponins were found present in the methanolic and hexane extracts (Table 3) and are well known for their antioxidant properties (Shi et al., 2019). Saponins exhibit cytotoxic effects and growth inhibition against a variety of cells, making them have anti-inflammatory and anticancer properties (Guil-Guerrero et al., 1998). They have the property of precipitating and coagulating red blood cells (Juttukonda & Skaar, 2017). Saponins have been reported to have hepatoprotective, antibacterial, antifungal, and antiviral activities (Sodipo et al., 1991). Biological actions are primarily due to phytochemical components in a very complicated concert of synergistic or antagonistic activities. Therefore, the presence of saponin justifies the use of the extracts to stop bleeding and in treating wounds. The methanolic and hexane extracts showed the presence of tannins, which are complex phenolic compounds found in different parts of plant tissues. Tannins are widely used in herbal medicine and possess antioxidant, anti-diarrhea, anti-hemorrhoid, and ant-viral properties (Okwu & Josiah, 2006; Soetan et al., 2006). Tannins have been reported to also prevent the development of microorganisms by precipitating microbial protein and making nutritional protein unavailable to them (Aires, 2019; Njoku, Obi, & Onyema, 2011). The presence of these bioactive components in the methanolic and n-hexane extracts of matured corn silk (*Zea Mays* Hair) can be a source of pharmaceuticals for the treatment of cystitis, gout, kidney stones, nephritis, diabetes mellitus and prostatitis. Alkaloid was present in the methanolic extract and absent in the hexane extract, alkaloids mostly contain basic nitrogen atoms derived from amino acids and possess pharmacological properties such as anti-malarial, anti-pyretic, anti-bacterial amongst others (Siddique & Brunton, 2019; Kurek, 2019).

GC-MS Characterization of the Matured Corn Silk (*Zea mays* hair)

Figure 3 shows the GC-MS profile which further analyzed the various constituents in the *Zea mays* silk. The GC-MS data revealed four major constituents such as 9,12-Octadecadienoic acid (51.11%), Beta-Sitosterol (30.58%), Stigmasterol (6.00%) while 1-Heneicosanol (0.30%), Hexadecanoic acid, methyl ester (0.44%) and 1-Methylene-2b-hydroxymethyl-3,3-dimethyl-4b-(3-methylbut-2-enyl)-cyclohexane (0.50%) were the least constituents (Table 3).

CONCLUSIONS

The possible benefits of the nutritional composition and Phyto-constituents found in the matured corn silk (*Zea Mays* hair) from the southern zone of Kaduna state, Nigeria could be useful in the prevention and management of viral infections such as Covid-19 and HIV. The natural antioxidants, anti-hypertensive, anti-bacterial, anti-malarial agents found in the extracts of corn silk can be a substitute for conventional drugs used for the management of diseases and boosting the human immune system.

The presence of the major (4) constituents such as 9,12-Octadecadienoic acid (51.11%), Beta-Sitosterol (30.58%), Stigmasterol (6.00%) in the matured corn silk rationalizes its usage in medicine which could improve the health quality of the rural dwellers in the region as well as in animal feed formulation for proper utilization of the waste.

COMPETING INTERESTS

The authors declare that they have no competing interests.

REFERENCES

Adeyeyei, E. I. & Otokiti, M. K. O. (1999). Proximate Composition and Some Nutritionally Valuable Minerals of Two Varieties of Capsicum Annum L. (Bell and Cherry Peppers). *Discovery and Innovation*, *11*(1-2), 75-81. doi:10.4314/dai.v11i1.15537

Aires, A. (2019). *Tannins - Structural Properties, Biological Properties and Current Knowledge*. BoD–Books on Demand. doi:10.5772/intechopen.80170

Association of Official Analytical Chemists [AOAC]. (2005). Official methods of Analysis (14th ed.), Association of Official Analytical Chemists, Washington DC, 2005: 132-160.

Association of Official Analytical Chemists [AOAC]. (2007). Official methods of Analysis of AOAC International (OMA) (18th ed., Revision 2), 2007: 110-128.

Cakmak, I., McLaughlin, M. J., & White, P. (2017). Zinc for better crop production and human health. *Plant and Soil*, *411*, 1-4. doi:10.1007/s11104-016-3166-9

Ebrahimzadeh, M. A., Pourmorad, F., & Hafezi, S. (2008). Antioxidant activities of Iranian corn silk. *Turkish Journal of biology*, *32*(1), 43-49.

Eman, A. A. (2011). Evaluation of antioxidant and antibacterial activities of Egyptian Maydis stigma (Zea mays hairs) rich in some bioactive constituents. *The Journal of American Science*, *7*(4), 726-729. http://www.jofamericanscience.org/journals/am-sci/am0704/101_5383am0704_726_729.pdf.

Guil-Guerrero, J. L., Giménez-Giménez, A., Rodríguez-García, I., & Torija-Isasa, M. E. (1998). Nutritional composition of Sonchus species (S asperL, S oleraceusL and S tenerrimusL). *Journal of the Science of Food and Agriculture*, *76*(4), 628-632.

Ha, A. W., Kang, H. J., Kim, S. L., Kim, M. H., & Kim, W. K. (2018). Acute and subacute toxicity evaluation of corn silk extract. *Preventive Nutrition and Food Science*, *23*(1), 70-76. doi:10.3746/pnf.2018.23.1.70

Habtemariam, S. (1998). Extract of corn silk (stigma of Zea mays) inhibits the tumour necrosis factor-α- and bacterial lipopolysaccharide-induced cell adhesion and ICAM-1 expression. *Planta Medica*, *64*(4), 314-318. doi:10.1055/s-2006-957441

Hasanudin, K., Hashim, P., & Mustafa, S. (2012). Corn silk (Stigma maydis) in healthcare: a

phytochemical and pharmacological review. *Molecules*, *17*(8), 9697-9715. doi:10.3390/molecules17089697

Ishida, H., Suzuno, H., Sugiyama, N., Innami, S., Tadokoro, T., & Maekawa, A. (2000). Nutritive evaluation on chemical components of leaves, stalks and stems of sweet potatoes (Ipomoea batatas poir). *Food Chemistry*, *68*(3), 359-367. doi:10.1016/S0308-8146(99)00206-X

Izydorczyk, G., Sienkiewicz-Cholewa, U., Baśladyńska, S., Kocek, D., Mironiuk, M., & Chojnacka, K. (2020). New environmentally friendly bio-based micronutrient fertilizer by biosorption: From laboratory studies to the field. *Science of the Total Environment*, *710*, 136061. doi:10.1016/j.scitotenv.2019.136061

Juttukonda, L. J. & Skaar, E. P. (2017). Manganese and Nutritional Immunity. In J. F. Collins (Ed.), *Molecular, Genetic, and Nutritional Aspects of Major and Trace Minerals*. Elsevier (pp. 377-387). doi:10.1016/B978-0-12-802168-2.00031-2

Kalache, A., De Hoogh, A. I., Howlett, S. E., Kennedy, B., Eggersdorfer, M., Marsman, D. S., ... & Griffiths, J. C. (2019). Nutrition interventions for healthy ageing across the lifespan: a conference report. *European Journal of Nutrition*, *58*, 1-11. doi:10.1007/s00394-019-02027-z

Kim, S. L., & Jung, T. W. (2001). Maysin and other flavonoid contents in corn silks. *Korean J Breed*, *33*, 338-343.

Kurek, J. (2019). Introductory Chapter: Alkaloids - Their Importance in Nature and for Human Life. In J. Kurek (Ed.), *Alkaloids - Their Importance in Nature and Human Life*. doi:10.5772/intechopen.8540

Lee, E. Y., Kim, S. L., Kang, H. J., Kim, M. H., Ha, A. W., & Kim, W. K. (2016). High maysin corn silk extract reduces body weight and fat deposition in C57BL/6J mice fed high-fat diets. *Nutrition Research and Practice, 10*(6), 575-582. doi:10.4162/nrp.2016.10.6.575

Njoku, V. O., Obi, C., & Onyema, O. M. (2011). Phytochemical constituents of some selected medicinal plants. *African Journal of Biotechnology*, *10*(66), 15020-15024. doi:10.5897/AJB11.1948

Nurhanan, A. R., Wan Rosli, W., & Mohsin, S. (2012). Total polyphenol content and free radical scavenging activity of cornsilk (Zea mays hairs). *Sains Malays*, *41*(10), 1217-1221.

Okwu, D. E., & Josiah, C. (2006). Evaluation of the chemical composition of two Nigerian medicinal plants. *African Journal of Biotechnology, 5*(4), 357-361. doi:10.4314/ajb.v5i4.

Pearson, D. (1976). *The chemical analysis of food* (7th ed.). Churchill Livingstons.

Potiron, C. O., Passe-Coutrin, N., Toro, F., Delvasto, S., Bilba, K. et al. (2010). Sugar cane bagasse fibres reinforced cement composites: Thermal considerations. *Composites Part A: Applied Science and Manufacturing*, *41*(4), 549-556.

Rainakari, A. I., Rita, H., Putkonen, T., & Pastell, H. (2016). New dietary fibre content results for cereals in the Nordic countries using AOAC 2011.25 method. *Journal of Food Composition and Analysis*, *51,* 1-8. doi:10.1016/j.jfca.2016.06.001

Ramula, P. & Rao, P. U. (2003). Dietary fibre content of fruits and leafy vegetables. *Nutrition News, 24*(3), 1-6.

Read, J. M., Bridgen, J. R., Cummings, D. A., Ho, A., & Jewell, C. P. (2020). Novel coronavirus 2019-nCoV: early estimation of epidemiological parameters and epidemic predictions. *medRxiv, 2020*. doi:10.1101/2020.01.23.20018549

Shi, S., Li, S., Li, W., & Xu, H. (2019). Corn silk tea for hypertension: A systematic review and meta-analysis of randomized controlled trials. *Evidence-based Complementary and Alternative Medicine, 2019*, 2915498. doi:10.1155/2019/2915498

Siddique, M. A. B. & Brunton, N. (2019). Food Glycoalkaloids: Distribution, Structure, Cytotoxicity, Extraction, and Biological Activity. In J. Kurek (Ed.), *Alkaloids-Their*

Importance in Nature and Human Life. IntechOpen.

Simpson, H. L., & Campbell, B. J. (2015). Dietary fibre–microbiota interactions. *Alimentary Pharmacology & Therapeutics*, *42*(2), 158-179.

Sodipo, O. A., Akanji, M. A., Kolawole, F. B., & Odutuga, A. A. (1991). Saponin is the active antifungal principle in Garcinia kola, heckle seed. *Biosci. Res. Commun*, *3*, 171.

Soetan, K. O., Oyekunle, M. A., Aiyelaagbe, O. O., & Fafunso, M. A. (2006). Evaluation of the antimicrobial activity of saponins extract of Sorghum Bicolor L. Moench. *African Journal of Biotechnology*, *5*(23), 2405-2407. doi:10.4314/ajb.v5i23.56024

Tiwari, P., Kumar, B., Kaur, M., Kaur, G., & Kaur, H. (2011). Phytochemical screening and extraction: a review. *Internationale Pharmaceutica Sciencia*, *1*(1), 98-106.

Velazquez, D. V. O., Xavier, H. S., Batista, J. E. M., & de Castro-Chaves, C. (2005). Zea mays L. extracts modify glomerular function and potassium urinary excretion in conscious rats. *Phytomedicine*, *12*(5), 363-369.

Wan Rosli, W., Nurhanan, A. R., Solihah, M. A., & Mohsin, S. S. J. (2011). Cornsilk improves nutrient content and physical characteristics of beef patties. *Sains Malaysiana*, *40*(2), 155-161.

Winiarska-Mieczan, A., Kwiatkowska, K., Kwiecień, M., Baranowska-Wójcik, E., Wójcik, G., & Krusiński, R. (2019). Analysis of the intake of sodium with cereal products by the population of Poland. *Food Additives & Contaminants: Part A*, *36*(6), 884-892. doi:10.1080/19440049.2019.1605209

Wise, A. (1995). Phytate and zinc bioavailability. *International Journal of Food Sciences and Nutrition*, *46*(1), 53-63. doi:10.3109/09637489509003386

World Health Organization. (2012). Effect of Reduced Sodium Intake on Blood Pressure, Renal Function, Blood Lipids and Other Potential Adverse Effects, World Health Organization, Geneva, Switzerland. ISBN 978 92 4 150491 1.

World Health Organization. (2017). Cardiovascular diseases (CVDs): Fact Sheet 2017, Geneva, Switzerland. https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds)