American Journal of Microbiological Research, 2025, Vol. 13, No. 6, 143-148
Available online at http://pubs.sciepub.com/ajmr/13/6/4
Published by Science and Education Publishing
DOI:10.12691/ajmr-13-6-4

Consumption Perspectives of Traditional Cooked Corn-based Dough "Akpan" Wrapped in *Marantochloa cuspidata*, *Marantochloa purpurea* and *Marantochloa mannii* Leaves Collected in Togo: Nutritional Added Value and Potential Risks

Mamy EKLOU[1,*], Kodjo Djidjolé ETSE[3], Komlan Edjèdu SODJINOU[3], Moubarak MOUMOUNI[3], Benziwa Nathalie JOHNSON[3], Bayi Reine DOSSOU[2], Yaovi AMEYAPOH[1], Raoufou RADJI[3], Akossiwoa M-L QUASHIE[3]

[1]Laboratory of Microbiology and Food Quality Control (LAMICODA), University of Lomé 01 BP 1515 Lomé-Togo
[2]Higher School of Biological and Food Techniques (ESTBA), University of Lomé 01 BP 1515 Lomé-Togo
[3]Physiology-Horticulture-Biotechnology Team (PHOBIOT), Forestry Research Laboratory (LRF) -Climate Change Research Center (CRCC), University of Lomé 01 BP 1515 Lomé-Togo
*Corresponding author: eklouenyae@gmail.com

Received November 14, 2025; Revised December 16, 2025; Accepted December 22, 2025

Abstract The nutritional and phytochemical benefits that can be obtained from packaging corn-based foods using *Marantochloa* species are poorly documented scientifically. This paper therefore aims to determine the edibility and nutritional potential of *M. cuspidata*, *M. purpurea*, and *M. mannii* in the packaging of these foods in Greater Lomé. The properties of the leaves were analyzed using aqueous extraction. Their toxicity was assessed using human blood mononuclear cells (PBMC). The antioxidant potential of the leaves was assessed using DPPH (2,2-diphenyl-1-picrylhydrazyl). Total phenols were determined by spectrophotometry using the Folin-Ciocalteu colorimetric method. The toxicity of the three species is identical to that of the average tolerated negative control standard and significantly lower than that of the 100% DMSO positive control. All the aqueous extracts showed with DPPH inhibition percentages of 58.50 ± 3.31 for *M. purpurea*, 40.94 ± 28 for *M. mannii*, and 14.90 ± 8.17 for *M. cuspidata*, respectively. In addition to the insignificant presence of phenol, bioactive metabolites such as tannins, terpenes, phytosterols, and cardiac glycosides were identified. These results therefore show that the leaves studied have antimicrobial and anti-inflammatory properties. They help preserve the texture, color, and smell of packaged food, as well as its vitamin and lipid content. It is therefore necessary to promote the domestication of these species for the health, economic, and ecological well-being of the Togolese capital.

Keywords: *Corn-based foods, Marantochloa leaves, Food wrapping, Nutritional properties, Bioactive components, Species domestication*

Cite This Article: Mamy EKLOU, Kodjo Djidjolé ETSE, Komlan Edjèdu SODJINOU, Moubarak MOUMOUNI, Benziwa Nathalie JOHNSON, Bayi Reine DOSSOU, Yaovi AMEYAPOH, Raoufou RADJI, and Akossiwoa M-L QUASHIE, "Consumption Perspectives of Traditional Cooked Corn-based Dough "Akpan" Wrapped in *Marantochloa cuspidata*, *Marantochloa purpurea* and *Marantochloa mannii* Leaves Collected in Togo: Nutritional Added Value and Potential Risks." *American Journal of Microbiological Research*, vol. 13, no. 6 (2025): 143-148. doi: 10.12691/ajmr-13-6-4.

1. Introduction

Corn is an essential grain that is integral to the cuisine, diet, and even the basic nutritional intake of the inhabitants of Lomé and other major urban centers in West Africa [1,2]. It is rich in carbohydrates (starch), fiber, and vitamins, and contributes to the production of minerals. The pantothenic acid (vitamin B5) in this food is part of a key coenzyme that enables the body to properly use synthesized food energy [3]. It also participates in the synthesis of steroid hormones, neurotransmitters, and hemoglobin. Folate (vitamin B9) is used to make all the cells in the body, including red blood cells. It plays an essential role in the production of DNA and RNA, in the functioning of the nervous and immune systems, and in the healing of injuries and wounds [4,5]. The cultural and gastronomic significance of this food is reflected in the daily diet of the inhabitants of Lomé, where it is processed and consumed in various forms: several varieties of porridge, paste, and flour [6]. Whether for breakfast, lunch, dinner, or even snacks, corn-based dishes are very popular and consumed in Greater Lomé by adults, children, the elderly, and pregnant women alike. However, for packaging used as a medium for processing or direct handling, especially when hot, it has been found that synthetic materials, mainly plastics, are more widely used [7]. In addition, this toxic form of packaging for corn-based foods is gradually replacing plant-based packaging such as *M. cuspidata, M. purpurea,* and *M. mannii*. In fact, apart from their containment and transport functions, the interesting properties of packaging leaves can enhance the nutritional quality of corn-based foods, provided that exchanges between packaging and products are effective [8]. Depending on the variety, *M. cuspidata, M. purpurea,* and *M. mannii* can contribute to the transfer of magnesium, potassium, and iron to the foods they wrap. These plant species can preserve the nutritional value of the wrapped food by stabilizing vitamins and extending their shelf life [9]. In the Togolese capital, as in other West African cities, the invasion of modern food practices is increasingly taking the place of the important role played by *M. cuspidata, M. purpurea,* and *M. mannii* in the packaging of corn-based foods due to their physical and phytochemical properties. As these plants are becoming more difficult to access, even in rural areas, their availability and high cost are increasingly steering users towards the use of plastic packaging. In this context, the research aims to determine the edibility and nutritional potential of *M. cuspidata, M. purpurea*, and *M. mannii* in the packaging of corn-based foods in Greater Lomé. These data could contribute to plan actions to promote the consumption of foods whose nutritional value could be significantly enhanced using these leaves. The focus will be on antioxidant activity, total phenol content, flavonoids, and then on identifying other compounds.

2. Materials and Methods

2.1. Study Area

Leaves material used for food wrapping was collected in May 2025 in forest galleries located on Akposso plateau (Wawa prefecture, Plateaux region in Togo).

Leaves aqueous extracts were prepared and analyzed in two research units in University of Lome: “Food Microbiology and Quality Control” Laboratory (for toxicity assay) and "Physiology, horticulture and biotechnology” research team (for bioactive components characterization and measurement).

2.2. Leaves Aqueous Extracts Production

In order to analyze the properties of the above mentionned leaves, an aqueous extraction was carried out. The aqueous extracts were obtained by a method adapted from that described by Azwanida (2015). The collected leaves samples of *Marantochloa cuspidata*, *Marantochloa purpurea* and *Marantochloa mannii* were washed with clean water and then cut into small pieces. The extraction was carried out by infusing 100 g of fresh leaves in 500 ml of boiling water for 15 minutes. The extract was then filtered through cotton and then through Whatman paper. Less diluted extract solutions ranging from 100 to 3.125 mg/ml was then obtained. These extracts were stored at -19 ℃.

2.3. Cellular Toxicity Evaluation on Human Peripheral Blood Mononucleated Cells (PBMCs)

Human Blood Cell Isolation

Human blood cells were used to assess the toxicity of these packaging leaves, according to the NF EN ISO 10993-5 standard. These are peripheral blood mononuclear cells (PBMCs). They were isolated by Ficoll density gradient centrifugation from venous blood samples of three (03) healthy volunteers, then cultured in RPMI 1640 media and incubated for 22 hours at 37 ℃ under 5% CO2 in a humid atmosphere (Katawa et al., 2015).

Toxicity assessment

These assays were performed on peripheral blood mononuclear cells (PBMCs) following the method of Kamiloglu et al. (2020) based on trypan blue and 3-[4,5-dimethylthiazol-2-yl]-2,5-diphenyltetrazolium bromide (MTT) staining techniques. Peripheral blood mononuclear cells from three voluntary adults consenting donors were isolated by Ficoll density gradient centrifugation using the method of Katawa et al. (2015). After counting, the isolated cells were cultured in the presence of the *M. cuspidata*, *M. purpurea* and *M. mannii* extracts in 96-well culture plates containing the same culture medium. 100 µl of cell suspension containing 2×10^5 cells was therefore, distributed in each well. Then 100 µl of each concentration of leaves extracts were added to the corresponding wells, each concentration constituting a separate treatment. Dimethyl sulfoxide (DMSO) at 10 and 100 and the culture medium (RMPI 1640 medium supplemented) were used as positive and negative controls, respectively. After incubation for 22 hours at 37 ℃ under 5% CO_2 in a humid atmosphere, the different stainings were performed. The coloring with trypan blue allowed to determine the mortality rate (dead cells are colored blue). MTT (3-[4,5-dimethylthiazol-2-yl]-2,5-diphenyltetrazolium bromide) staining is useful to assess cell viability which depends on the intensity of insoluble purple formazan produced by active dehydrogenase in living cells.

2.4. Antioxidant Activity and Bioactive Content of Leaves Extracts

Antioxidant activity

The antioxidant potential of the extracts of *Marantochloa cuspidata, Marantochloa purpurea and Marantochloa mannii* was evaluated using the DPPH (2,2-diphenyl-1-picrylhydrazyl) stable free radical scavenging test according to the method implemented by Merhoudj and Zaid (2023). The DPPH test is based on the ability of antioxidants to reduce the DPPH free radical, resulting in a decrease in violet absorbance at 515 nm and a yellow discoloration towards yellow, proportional to the antioxidant activity. A 0.00478% (w/v) DPPH solution was prepared in ethanol and stored in the dark. 100 µL of each extract was then added to 3 mL of this DPPH solution. A control was prepared by replacing the extract with distilled water. After incubation for 30 minutes in the dark, the absorbance (OD) of the mixtures was measured at 523 nm using a spectrophotometer, with the blank consisting of ethanol supplemented with the extract, but without DPPH. Antioxidant activity was expressed as percentage inhibition, according to the formula proposed by Matkowski et al. (2008).

Determination of Total Phenol Concentration

Total phenols were determined spectrophotometrically using the Folin-Ciocalteu reagent colorimetric method, as described by Merhoudj and Zaid (2023). In hemolysis tubes, 400 µL the 3 extracts were mixed with 2 mL of 10% (v/v) Folin-Ciocalteu reagent. After standing for 5 minutes, 1600 µL of 7.5% (w/v) sodium carbonate (Na_2CO_3) solution was added to the mixture. The tubes were shaken and left in the dark for 30 minutes to allow the colored complex to form. The absorbance was then measured at 765 nm using a spectrophotometer whose blank was prepared under the same conditions by replacing the leaves extracts with distilled water. The concentration of total phenol is expressed in mg of gallic acid equivalent.

Identification of other bioactive components

Tannins, terpenes, phytosterols, terpenoids, cardiac glycoside and saponins were detected in the aqueous extracts using the method described by Melila et al. (2021) presented in Table 1. To do this, the appropriate reagent is added to hemolysis tubes containing a volume of extract and the coloration is observed. If the latter is characteristic, then the desired metabolite is present in the extract.

Table 1. Detection methods of some bioactive components in aqueous extract

Desired metabolite	Reagents	Operating mode	Coloration type
Catechin tannins	Iron chloride $FeCl_3$	1 ml of extract + 1 ml de $FeCl_3$	Blue, blue-black or black coloring
General tannins	Lead acetate	3 ml of extract + 1 ml of reagent	Whitish coloring
Terpenoides	Chloroform + sulfuric acid	1ml of extract + 0,5 ml of chloroform + 0,7 ml of HCl	Green-blue coloring
Cardiac glycosides		1 ml of extract + 2 ml of chloroform + 1 ml of HCl	Brown-red coloring
Phytosterol + terpenes	sulfuric acid	1 ml d'extract + 1 ml HCl	Golden yellow coloring
Saponins	-	Strong agitation of the extract	Appearance of persistant foam

Source: Melila et al (2021)

2.5. Statistical Analysis

The various data collected were processed using Excel 2013 spreadsheet software. Histograms of the means were plotted using GraphPad software as well as data analysis. The latter were subjected to the Shapiro-Wilk normality test at the 5% threshold. Statistical comparisons between the different treatments were carried out using ANOVA analysis of variance for distributed and mixed data and the Kruskal-Walis test for non-distributed data.

3. Results

3.1. Toxicity Assessment

Mortality rate

Figure 1 shows the results of toxicity assessment from the cell mortality point of view. Indeed, the PBMCs' mortality rate when treated with all the three species aqueous extracts varies from 0 to 18%. Analysis of the results using the Kruskal-Walis test reveals, on the one hand, that these rates are statistically identical to that of the medium (negative control), whose mortality rate was 5%, and on the other hand, these rates are significantly lower compared to that of the positive control DMSO 100% (78.5%). Furthermore, no dose-dependent effect was observed.

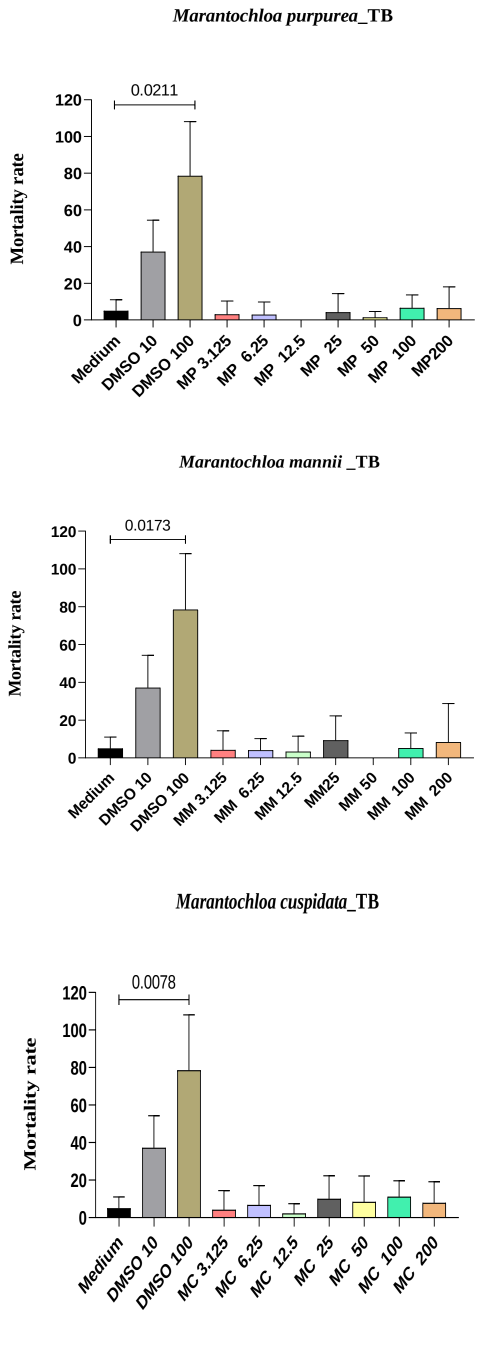

Figure 1. rtality rate of PBMCs treated with *M. purpurea*, *M. mannii* and *M. cuspidata* aqueous extracts

Viability rate

Cell viability was assessed by measuring cellular metabolic activity as a function of absorbance as illustrated in Figure 2. The results indicate a decrease in cell viability compared to the medium for all the three species aqueous extract tested with variability depending on the species and the concentration of the extract. For each species, the analysis of variance of the different concentrations compared to the medium reveals significant differences with p-values varying between 0.05 and 0.001, with the exception of a few concentrations

The aqueous extracts of the leaves extract studied, at some concentrations, could contain substances that inhibit cell multiplication.

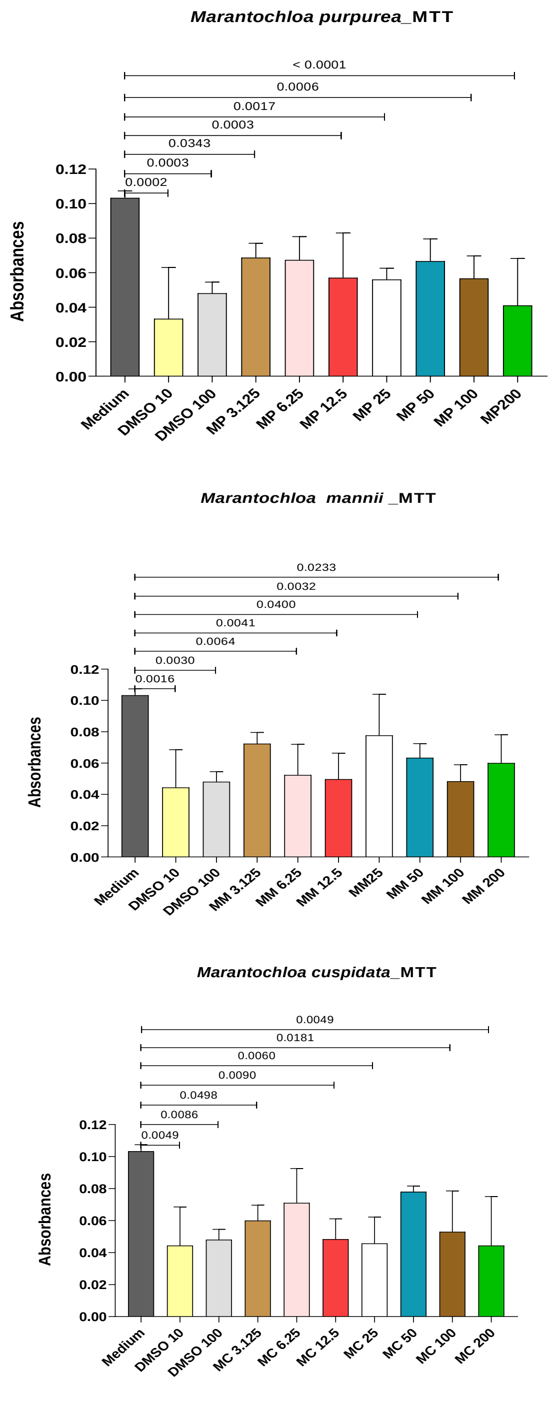

Figure 2. ability rate (measured by absorbances) of PBMCs treated with *M. purpurea*, *M. mannii* and *M. cuspidata* aqueous extracts

3.2. Antioxidant Activity

All the aqueous extracts showed antioxidant activity with a percentage of DPPH inhibition of respectively 58,50 ± 3,31 for *M. purpurea*, 40,94 ± 28 for *M. mannii* and 14,90 ± 8,17 for *M. cuspidata*. Aqueous extract from dried *M. mannii* leaves inhibited 2.55% of DPPH while *Marantochloa purpurea* and *Marantochloa cuspidata* recorded 0% inhibition. This difference was not significant at the 5% level (Table 2). Although the last value is very different from the previous ones, statistical analysis reveals that these three percentages are not significantly different.

Table 2. Percentage inhibition of DPPH standing for antioxidant activity of aqueous leaves extracts

Feuilles d'emballage	% d'inhibition DPPH
M. purpurea	58,50 ±3,31 a
M. mannii	40,94 ±28 a
M. cuspidata	14,90 ±8,17 a

Results are presented as mean ± standard deviation, means with the same letters are statistically identical

3.3. Contents of Some Bioactive Metabolites

As illustrated by Table 3, all the leaves extracts reveal similar and non-significantly different values for total phenols concentration.

Fresh leaves prepared extracts were also tested for the presence or not of some other bioactive metabolites.

Table 3. Total phenols contents of M. purpurea, M. mannii and M. cuspidata

Leaves extracts	Phenols concentration (mg Eq. gallic acid / g
M. purpurea	132,90 ±3,78 a
M. mannii	110,90 ±24,49 a
M. cuspidata	97,21 ±2,53 a

Results are presented as mean ±standard deviation, mean with the same letters are statistically identical

Table 4 indicates that all the samples assessed for the purpose contain general tannins, phytosterol + terpenes, cardiac glycosides and saponins.

Table 4. Identification of some other bioactive metabolites

Metabolite	Fresh leaves extracts		
	M. purpurea	*M. mannii*	*M. cuspidata*
Catechin tannins	-	-	-
General Tannins	+	+	+
Terpenoids	-	-	-
Phytosterol + terpenes	+	+	+
Cardiac glycosides	+	+	+
Saponins	+	+	+

(+) Means detection of metabolite; (-) means non detection of metabolite

4. Discussion

The mortality rates obtained indicate that aqueous extracts of the leaves of the species studied are not toxic to human peripheral blood mononuclear cells. A similar study carried out in Benin using the toxicity assessment method based on the lethal concentration (LC50), the value of which was determined using the review of S. Hu et al. [10] revealed the non-toxicity of many plant species used as packaging [11]. Indeed, these authors report that no toxic effect of crude aqueous extracts obtained by centrifugation of the leaves of *Tectona grandis*, *Musa sapientum*, *Manihot esculenta* and *Thalia geniculata*, used as food packaging in Benin, was observed on brine shrimp larvae (*Artemia salina* LEACH). Similarly, the technique using MTT staining, Y. Kanga et al. [12] showed that the ethanolic extract of *Hunteria eburnea*, a medicinal plant, had no toxic effects on fetal human fibroblast cells. Regarding cell viability, the results show that aqueous extracts of the species studied lead to a decrease in cell proliferation, revealing a cytostatic effect of the extracts at certain concentrations. This result, although contradictory to the previous conclusion, is similar to that of Y. Kanga et al. [12] who observed, after MTT staining, a slight decrease in the viability of dividing cells in the presence of ethanolic extract of *Hunteria eburnea* compared to confluent cells. Indeed, the authors, studying 15 Mexican plants, noted that methanolic extracts of *H. inuloides, J. dioica, J. spicigera, P. peltatum* and *P. obtusifolium* induced the proliferation of Vero cells while the other extracts induced a reduction in cell viability between concentrations of 250 and 500 µg/ml on these same cells. On the other hand, extracts of *K. daigremontiana, A. adstringens, S. mexicanum, J. spicigera, L. tridentata* and *M. tenuiflora* induced the proliferation of PBMC cells while the other extracts induced a reduction in viability at concentrations of 250 and 500 µg/ml. It therefore appears that aqueous extracts of *M. mannii*, *M. leucantha*, *M. purpurea, M. cuspidata*, *M. alnifolia* and *S. prionogonium* are not toxic to peripheral blood mononuclear cells [13]. However, they may contain substances that inhibit the division and/or multiplication of the same cells.

In terms of nutritional benefits, the phenols present in *M. cuspidata*, *M. purpurea*, and *M. mannii* are natural antioxidants that protect the vitamins in the corn-based foods they package from oxidation [14]. The presence of phenols also shows that these three plant species enhance the safety and preservation of the corn foods they package by acting as antimicrobials [15]. This reduces the risk of toxicity and infection for consumers [16]. In addition, the migration of phenols to corn-based foods in Lomé transfers anti-inflammatory and cell-protective properties to the food [17]. For example, packaging a dough made from corn with *M. cuspidata*, *M. purpurea*, and *M. mannii* reduces the consumer's chances of exposure to chronic inflammatory diseases.

Another benefit of these leaves in corn-based foods is that they preserve their color, aroma, and freshness, thereby increasing the acceptability, palatability, and even desirability of the food [8]. The tannins in these leaves also preserve vitamins and lipids [18]. Terpenes reinforce their ability to protect consumers of packaged foods against microbial attacks [19,20]. Phytosterols and saponins reduce cholesterol absorption and therefore play a crucial role in stabilizing fats [21]. Finally, cardiac glycosides, in low doses, can stabilize corn-based foods and give them cardiotonic effects.

In general, not only can *M. cuspidata*, *M. purpurea*, and *M. mannii* indirectly strengthen the protection of natural ecosystems through the significant reduction of the ecological effects of plastic waste, but they also constitute an important lever for economic development [22]. Indeed, the more these species are valued and promoted in terms of use, the less public health problems will affect the populations of Greater Lomé due to the regular consumption of corn-based foods in this city. Furthermore, it should be noted that this health benefit may, in the long term, contribute to boosting the country's economic growth, which will be able to fully reap its economic dividends due to its young population [23]. However, for the research results to be widely applicable, animal testing is needed to study acute and subchronic toxicity. Here, particular emphasis should be placed on food intake, the animals' reaction before and after intake, the appearance of their feces, their physiological condition (weight of certain organs such as the liver and kidneys), and even their lifespan.

5. Conclusion

Corn-based foods come in many varieties and are deeply rooted in the daily food culture of the inhabitants of Greater Lomé, but their packaging made from plant species for transport or consumption is tending to disappear as a result of the use of plastics. However, these leaves have nutritional and phytochemical properties that can protect and preserve food and improve consumer health. These properties have been documented for *M. cuspidata*, *M. purpurea*, and *M. mannii*, and the research aimed to determine them in order to consider promoting corn-based foods packaged in these leaves. The results of the analyses showed that the leaves contain antioxidants, phenols, tannins, terpenes, phytosterols, and cardiac glycosides. These compounds generally protect the vitamin content of corn-based foods, preserve their freshness, and give them a pleasant smell. They also contain antioxidants that can act against microbial attacks, fungi, and yeasts. They therefore contribute to a significant reduction in the risk of food poisoning and inflammation. In addition, they can improve the fixation of certain minerals in food in small doses, thus benefiting consumer health. It is therefore important to promote the widespread cultivation of these plants in order to improve the quality of food packaging in Greater Lomé and, in turn, protect natural ecosystems from degradation, reduce public health expenditure, and increase the benefits of the demographic dividend.

ACKNOWLEDGEMENT

The authors would like to thank Ms. Fékandine Victoire Douti supervised by Dr. Gnatoulma Katawa, for their great support in toxicity assessment in collected leaves' extracts.

References

[1] GEDIL Melaku, MENGESHA Wende, ILESANMI Oluyinka, et MENKIR Abebe. (2024). Advances in Genetic Enhancement of

Nutritional Quality of Tropical Maize in West and Central Africa. *Agriculture*, *14*(4).

[2] SÁNCHEZ-NUÑO Yaír A., ZERMEÑO-RUIZ Martín, VÁZQUEZ-PAULINO Olga D., NUÑO Karla, et VILLARRUEL-LÓPEZ Angélica. (2024). Bioactive Compounds from Pigmented Corn (Zea mays L.) and Their Effect on Health. *Biomolecules*, *14*(3).

[3] ANASTASSAKIS Konstantinos. (2022). Vit B5 (pantothenic acid). In *Androgenetic alopecia from A to Z: vol. 2 drugs, herbs, nutrition and supplements* (pp. 309-313). Springer.

[4] FRIGERIO Barbara, BIZZONI Claudia, JANSEN Gerrit, LEAMON Christopher P., PETERS Godefridus J., LOW Philip S., MATHERLY Larry H., et FIGINI Mariangela. (2019). Folate receptors and transporters: biological role and diagnostic/therapeutic targets in cancer and other diseases. *Journal of Experimental & Clinical Cancer Research*, *38*(1), 125.

[5] XU Jingwen, LI Yonghui, et WANG Weiqun. (2019). Corn. In *Bioactive factors and processing technology for cereal foods* (pp. 33-53). Springer.

[6] TOUMOUDAGOU N'OUENI Penagui, ZINSOU-KLASSOU Kossiwa, et CHENAL Jérôme. (2024). State of Food and Nutritional Security of Urban Households in Grand Lome: Approach by Measuring Household Indicators. *Foods*, *13*(21).

[7] ARSHAD Muhammad Tayyab, HASSAN Sajid, SHEHZADI Robab, SANI Malik Amanullah, IKRAM Ali, MAQSOOD Sammra, AHMAD Aneeq, HUSSAIN Mehreen Faqeer, ABDULLAH Zunair, et GNEDEKA Kodjo Théodore. (2025b). Emerging Trends in Sustainable Packaging of Food Products: An Updated Review. *Journal of Natural Fibers*, *22*(1), 2505608.

[8] PATERNINA-SIERRA Katherine, ACEVEDO-CORREA Diofanor, DÍAZ-CASTILLO Fredyc, MERCADO-CAMARGO Jairo, et ÚRSULA-ORTEGA Jefferson José. (2025). Phenolic profile, antioxidant activity, and active compounds of ethanolic extract and essential oil of Calathea lutea leaves. *Quality Assurance and Safety of Crops & Foods*, *17*(4), 133-178.

[9] LINATOC Alona, OWEN Susan M., et DALIMIN Mohd Noh. (2023). Occurrence of volatile organic compounds and extrafloral nectaries in tropical rainforest species in Danum Valley Conservation Area, Sabah, Malaysia. *Journal of Sustainable Natural Resources*, *4*(2), 9-21.

[10] HU Shengsi, HAN Lu, YU Chenfeng, PAN Leiqing, et TU Kang. (2025). A Review on Replacing Food Packaging Plastics with Nature-Inspired Bio-Based Materials. *Foods*, *14*(10), 1661. https://pmc.ncbi.nlm.nih.gov/articles/PMC12110880/

[11] ANDRADE Mariana A., BARBOSA Cássia H., RIBEIRO-SANTOS Regiane, TOMÉ Sidney, FERNANDO Ana L., SILVA Ana S., et VILARINHO Fernanda. (2025). Emerging Trends in Active Packaging for Food: A Six-Year Review. *Foods*, *14*(15).

[12] KANGA Yao, CAMARA Djeneb, COULIBALY Kiyinlma, BENE Kouadio, et ZIRIHI Guédé Noël. (2018). Biosciences and Plant Biology. *Int. J. Curr. Res. Biosci. Plant Biol*, *5*(4), 47-52.

[13] OBONGA Wilfred O., NNADI Charles O., CHIMA Chinonye C., OKAFOR Sunday N., et OMEJE Edwin O. (2019). In-vitro antioxidant and in vivo anti-inflammatory potentials of Marantochloa leucantha (Marantaceae) extracts and fractions. *Dhaka University Journal of Pharmaceutical Sciences*, *18*(2), 233-240.

[14] MCLENNAN Matthew R., et GANZHORN Jörg U. (2017). Nutritional characteristics of wild and cultivated foods for chimpanzees (Pan troglodytes) in agricultural landscapes. *International Journal of Primatology*, *38*(2), 122-150.

[15] ODOEMELAM Emmanuel I, UGORJI Chimaobi O, EZEMA Benjamin E, AGBO Matthias O, NNADI Charles O, ORJIOCHA Samuel I, OKONKWO Vivian I, NWAFOR Felix I, UGWU Gladys N, et CHUKWUMA Michael O. (2024). Estimation of Total Phenolics, Total Flavonoids Content and In Vitro Antioxidant Activities of Extract and Fractions of Asplenium platyneuron (Carl Linnaeus). *Tropical Journal of Natural Product Research*, *8*(3).

[16] DELGADO Amélia, GONÇALVES Sandra, et ROMANO Anabela. (2023). Mediterranean Diet: The Role of Phenolic Compounds from Aromatic Plant Foods. *Foods*, *12*(4).

[17] DEMBIŃSKA Katarzyna, SHINDE Ambika H., PEJCHALOVÁ Marcela, RICHERT Agnieszka, et SWIONTEK BRZEZINSKA Maria. (2025). The Application of Natural Phenolic Substances as Antimicrobial Agents in Agriculture and Food Industry. *Foods*, *14*(11), 1893.

[18] PAN Junkun, LI Chengheng, LIU Jiechao, JIAO Zhonggao, ZHANG Qiang, LV Zhenzhen, YANG Wenbo, CHEN Dalei, et LIU Hui. (2024). Polysaccharide-Based Packaging Coatings and Films with Phenolic Compounds in Preservation of Fruits and Vegetables—A Review. *Foods*, *13*(23).

[19] BASAVEGOWDA Nagaraj, et BAEK Kwang-Hyun. (2021). Synergistic Antioxidant and Antibacterial Advantages of Essential Oils for Food Packaging Applications. *Biomolecules*, *11*(9).

[20] MEHMOOD Arif, AZIZ Tariq, AL-ASMARI Fahad, SHAMI Ashwag, HAIYING Cui, XU Jinlong, et LIN Lin. (2025). Insight Into the Recent Advances in the Development of Antimicrobial Edible Films for Food Packaging. *Packaging Technology and Science*, *38*(6), 487-509.

[21] ARSHAD Muhammad Tayyab, ALI M. K. M., MAQSOOD Sammra, IKRAM Ali, HOSSAIN Md Sakhawot, ALJAMEEL A. I., AL-FARGA Ammar, et GNEDEKA Kodjo Théodore. (2025a). Dietary Phytochemicals in Cardiovascular Disease Prevention and Management: A Comprehensive Review. *Food Science & Nutrition*, *13*(9), e70872.

[22] KALINA S., KAPILAN R., WICKRAMASINGHE Indira, et NAVARATNE S. B. (2024). Potential use of plant leaves and sheath as food packaging materials in tackling plastic pollution: A Review. *Ceylon Journal of Science*, *53*(1).

[23] CILLIERS Jakkie. (2025). Harnessing and advancing Africa's future demographic dividend. *Netherlands Scientific Council for Government Policy (WRR), WP*, 1-62.