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A REVIEW OF THE MULTIFACETED USEFULNESS OF *CELOSIA ARGENTEA* LINN

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ABSTRACT

In modern medicine today, medicinal plants have been the major source of drugs, playing vital role in drug development programme of the pharmaceutical industry and providing cure for man. In rural areas of developing countries, traditional healers gain more prominence in the use of plants of ethnobotanical origin for prophylaxis and cure of diseases. The growing awareness of the harmful side-effects of chemotherapy has made people to explore the time tested remedies from traditional alternative medicine. *Celosia argentea* (green vegetable) leaves containing phenols, flavonoids, saponins, alkaloids, tannin, carbohydrate, glycosides, protein, gum, mucilage and vitamins are eaten as vegetable in West Tropical Africa, used to relieve gastrointestinal disorders and are antipyretic, anti-inflammatory and antioxidative. This review however, consisting of literature search of journals and chapters in books aims at evaluating the medicinal uses, pharmacological actions and biological activities of celosia *argentea* Linn

KEYWORDS: *Celosia argentea*, medicinal, pharmacological, biological activity.

INTRODUCTION

Herbal medicine has been the basis of traditional medicine and has formed the root of modern pharmacology.[1] The World Health Organization (WHO) notes that of 119 plant- derived pharmaceutical medicines, about 74% are used in modern medicine in ways that correlated directly with their traditional uses as plant medicines by native cultures.[2] For a long time, plants have been a valuable source of natural products for maintaining human health, especially in the last decade with more intense studies devoted to natural therapies.[3]

Celosia argentea L. is an herbaceous plant which belongs to the family Amaranthacaceae and one of the leading leaf vegetables in south-western Nigeria, where it is known as 'sokoyòkòtò' in Yoruba language meaning 'make husbands fat and happy'.[4] It is also known as red 'soko' because it has red pigment on the leaves which differentiates it from the green 'soko'.[5] Red 'soko' imparts the anthocyanin- red colour into soup, making it less popular than green 'soko'.[4]

CELOSIA ARGENTEA LINN

Celosia argentea L is an erect annual herb up to 2 metres tall (Figure 1). The stem is ridged, glabrous and branches up to 25 per plant.[4] The leaves are alternate, simple, without stipules; petiole indistinctly demarcated; blade ovate to lanceolate-oblong or narrowly linear, up to 15 centimetres x 7 centimetres, tapering at base, acute to obtuse and shortly mucronate at apex, entire, glabrous and pinnately veined.[4] Inflorescence a dense, many flowered spike at first conical but becoming cylindrical up to 20 centimetres long, braceate, slivery to pink in ornamental forms completely or partly sterile and in many colours.[4] Flowers are small, bisexual, regular five merous, tepal free, narrowly elliptical-oblong, 6-10 millimetres long, stamen fused at base, ovary superior, 1-celled, style filiform up to 7 millimetres long, stigma 2-3,very short. Fruit is an ovoid to globose capsule 3-4 millimetres long circumscissile, few seeded with seeds being lenticular, 1- 1.5 millimetres long, black, shinning, shallowly reticulate.[4]

Fig: 1: The plant *(Celosia argentea* Linn).

BOTANICAL CLASSIFICATION

Celosia argentea L is scientifically classified to plantae kingdom. It is an angiosperm, eudicot and core eudicot. It belongs to the order Cryophyllales, of the family Amaranthaceae and sub family Amaranthoideae, genus *Celosia* and species *C. argentea* Linn. The full binomial name is *Celosia argentea* Linn.[6,7]

COMPOUNDS ISOLATED FROM *CELOSIA ARGENTEA* LINN

Composition of *Celosia argentea*Linn

The composition of *Celosia argentea* Linn per 100 grammes edible portion is: water 83.3g, energy 186 KiloJoules (44 Kcal), protein 4.7 grammes, fat 0.7 grammes, carbohydrate 7.3 grammes, fibre 1.8 grammes, Ca 260 mg, P 43mg, Fe 7.8mg.[4] Young leaves harvested 5-7 weeks after sowing have the best nutritional value and are especially rich in Fe, vitamin A, and Vitamin C. The leave contains phytic acid (120 mg/100 g) and oxalic acid (20 mg/100 g). The composition is strongly affected by environmental factors e.g. soil fertility, fertilizer application and age of plant.[4]

Chemical constituents of *Celosia argentea* Linn

The chemical components of *Celosia argentea* L. include: 2-descarboxy-betandin; 3-methoxytyramine;4-O-β-D-apifuranosyl-(1→2-β-D-glucopyranosyl-2-hydroxy-6-methoxyacetophenone; amaranthin; betalimic acid; celogenamide A, celogentin A-D,H, J and K, celosin E, F, G, cristatain; dopamine; lyciumin A methylate; lyciumin C methylate; morodin; nicotinic acid; (S)-tryptophan.[4] Other chemical constituents of *Celosia argentea* L. also include: Acetic acid, tartaric acid, malic acid and citric acid, solanine, Alpha, β, gamachaconines, Minerals, protein and ascorbic acid, oxalic acid.[8] Some of these structures are shown in Figure 2.

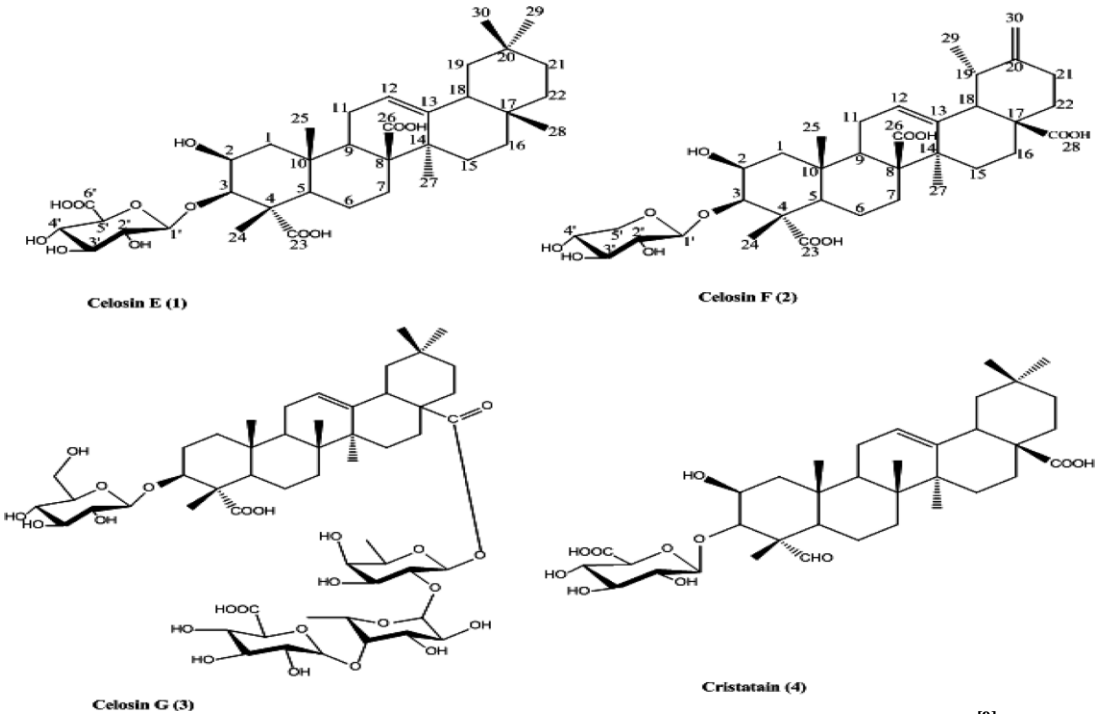

Fig. 2: Structures of some compounds isolated from seeds of *Celosia argentea*[9]

The phytochemical components of *Celosia argentea* L

Several works have been done by researchers to determine the phytochemical components of *Celosia argentea* L. These phytochemical components reported by Malomo *et al*.,[5] and Verma and Demla[10] are: phenols, flavonoids and saponins, alkaloids, tannin, carbohydrate, glycosides, protein, gum, mucilage and amino acid which gives it the antioxidant properties.

Quantitative analysis of *Celosia argentea* Linn

The Quantitative elemental analysis of *Celosia argentea* Linn leaves was conducted by Markandeya *et al.*[11] They observed that the plant exhibits good quantity of micronutrients like Mg, Ca, S, P, K and Fe and toxic elementals show their concentrations below permissible limit and therefore concluded that the plant can be used as supplementary food for deficiency of minerals like iron (Fe), magnesium (Mg) and calcium (Ca).

Medicinal uses of *Celosia argentea* L

The leaves are eaten as vegetable in West Tropical Africa where it is considered an excellent pot herb and slightly bitter spinach alternate, rich in protein and vitamins. The stems and leaves bruised and applied as poultice is used for infected sores, wounds and skin eruptions.[12] Poultice of leaves, smeared in honey, is used as cooling application to inflamed areas and painful affections such as buboes and abscesses. Leave concussions are used to relieve gastrointestinal disorders and are antipyretic. Seeds when in decoction or finely powdered, are considered antidiarrhoeal or aphrodisiac. Whole plant is used for antidote in snake poison while root is used for abdominal colic, gonorrhea and eczema.[12]

The seeds are prescribed for haemorrhagic conditions including menorrhagia, haematuria, haematemsis, haemoptysis, epistaxis, acute retinal heamorrhage and bleeding haemorrhoids.[13] *Celosia argentea L.* has sometimes been useful for treatment of disorders like excessive menstruation and leucorrhea.[13] *Celosia argentea* is also used in traditional medicine for sores, ulcers, and skin eruptions.[14]

Pharmacological uses and Phytochemistry of *Celosia argentea* Linn

Pharmacological and health benefits of the plant are: anti-oxidant, anti-diarrhoeal, Anti-diabetic, nutritive, bile juice increase and use as blood Tonic.[8]

Pharmacognostic and phytochemical evaluation of whole plant of *Celosia argentea* was done by Priyanka *et al.*,[15] who observed that the microscopy of the leaves showed the thick, cylindrical and collateral vascular strand. The mesophyll tissue consists of adaxial band of vertically oblong cylindrical palisade cells, fan shaped and sandy balls crystals of calcium oxalate and anomocytic stomata. The stem shows unique vascular system sometimes called "anomalous type". Roots showed presence of primary concentric and secondary radial vascular bundle with distinct medullary rays running through the vascular bundles. The preliminary phytochemical screening indicated the presence of carbohydrates, glycosides, flavonoids, tannins and steroids in the aerial parts, seed and root extracts which were confirmed by chromatography. They concluded that the pharmacognostic and phytochemical data could serve as a base for building the official monograph of the drug required for identification, isolation, synthesis of a new drug development in an ethanopharmacological research. Rajni *et al.*,[16] also conducted the pharmacognostic and phytochemical investigation of the (Plant root, leaf and stem) *Celosia argentea* Linn. Report showed: glycoside, tannin, saponin, protein, sugar, alkaloid, flavonoid are more in the leaf than stem and root and carbohydrate is more in the root than leaf and stem. They concluded that the morphological character, histochemical study, percentage extractives, fluorescence, and ash analysis of the plant is helpful for standardization of drug. The standardization of whole plant of *Celosia argentea* Linn was done by Verma and Demla.[10] They reported that fluorescence analysis and phyto-chemical investigations reveal the presence of carbohydrates, amino acids, glycosides, saponins, alkaloids, flavonoids, phenolic compound and tannins in different extracts. The ethanol and chloroform extracts showed presence of alkaloids while water extract did not, but Gbadamosi *et al*.[17] showed that ethanolic extract of plant shows absence of flavonoid. The use of *Celosia argentea* Linn aqueous flower extract as a natural indicator in acid base titration was studied by Rajendra *et al.*,[18] who observed that the equivalence points obtained by the flower extract was coincident with the equivalence points obtained by standard indicators expected in weak acid vs weak base. They therefore concluded that it may be beneficial to use *Celosia argentea* L. aqueous flower extract as an indicator in all types of acid base titrations because of its economy, simplicity and availability. The phytochemical screening and corrosion inhibitive behavior of m ethanolic leaf extract of *Celosia argentea* plant extracts on mild steel in industrial water medium was studied by Kumar and Mohana.[19] They reported that the Inhibition Efficiency (%) of *Celosia argentea* extracts increased with increasing concentration and decreased with temperature. and that *Celosia argentea* is efficient, eco-friendly and low-cost corrosion inhibitors for mild steel in industrial water medium. Kumar *et al.*,[20] also did a phytochemical screening for *Celosia argentea* plant using different extraction medium and came up with the following result: Aqueous extract shows presence of alkaloids, carbohydrates, glycosides, tannins, protein, amino acids, steroids. Methanolic extract shows presence of alkaloids, carbohydrates, glycosides, tannins, protein, amino acids, and steroids. Chloroform extract shows presence of carbohydrates, tannins and petroleum ether extract shows presence of alkaloids, carbohydrates, glycosides, protein and amino acids. They also reported that major active constituents are present in methanolic and aqueous extract. Physicochemical and phytochemical studies by Patel *et al.*,[21] using the seeds

of *Celosia argentea* Linn showed that considerable amount of total ash was observed in seed, the different extracts analyzed gave different yields with the aqueous extract giving the highest yield and the presence of alkaloids, tannins, saponin, amino acid, flavonoids, steroids, glycosides and carbohydrates. They concluded that the study scientifically validates the use of plants in traditional medicine and phytochemical data will be helpful for the standardization and quality control of precious indigenous drug and also pharmaceutical industries. Urmila *et al.*,[22] also worked on the physicochemical and preliminary phytochemical analysis of *Celosia argentea* Linn plant using the plant leaves. The phytochemical evaluation revealed the presence of glycosides, saponins, phytosterols, phenolic compounds, flavonoids, tannins, carbohydrates and triterpenoids. They observed that the extracts from the plants could be seen as a good source for useful drugs. The effects of paraquat on genetic diversity and protein profiles of six varieties of *Celosia* in South-Western Nigeria was studied by Akinloye *et al.*,[23] and the results showed a decrease in the growth of plants, altered DNA configuration, decreased relative mobilities, modified gene sequence as well as broad band similarities in paraquat treated group when compared to the control group. This study therefore suggests that paraquat possesses lethal effect on plants and also helpful in providing efficient strategies for sustainable management of genetic resources of *Celosia*. Mostafa *et al.*,[24] demonstrated that mutation can be induced in *Celosia* using Dimethyl Sulphate and Identification of S Genetic Variation by ISSR Markers. They reported that the concentration of 3000 ppm increased significantly the number of leaves, concentration of anthocyanin in the leaves and inflorescences in both generation and the concentration of phenols in the M_2-generation and therefore, concluded that dimethyl sulphate could be suitable for inducing genetic variability in the natural gene pool of *Celosia*. It is also appropriate to induce valuable mutants. Pang *et al.*,[25] isolated three new oleanane-type triterpenoid saponins named celosins H, I, and J were isolated from the seeds of *Celosia argentea* L. and reported that celosins H-J could be used as chemical markers for the quality control of *Celosia argentea* seeds. Wang *et al.*,[26] studied the HPLC fingerprints in seed of *Celosia argentea* and reported that the chemical constituents of *Celosia argentea* vary with different habitats so selection of material habitat is very important for quality control of *Celosia argentea* and the fingerprint with high individuality and specificity could be applied in the identification and quality control of the material of *Celosia argentea*.

BIOLOGICAL ACTIVITIES OF *CELOSIA ARGENTEA*

Anti-metastatic and immunomodulating activities

Studies conducted by Hayakawa *et al*.,[27] on the anti-metastatic and immunomodulating properties of the water extract from *Celosia argentea* seeds showed that administration of *Celosia argentea* seed extracts for 7 days before tumor inoculation significantly inhibited liver metastasis caused by intraportal injection of colon 26-L5 carcinoma cells in a dose-dependent manner and also production of maximal levels of IL-12 and interferon (IFN)-gamma in serum were achieved at 2-3 and 6 hour, respectively. They concluded that this may provide a basis for the inhibition of cancer metastasis.

Wound healing activities

The work of Priya *et al*.,[14] demonstrated a salutary (health giving) action of the *Celosia argentea* extract on wound healing by using an ointment formulated on alcohol extract of *Celosia argentea* leaves. Their result showed that wound closure occurred earlier in the treated rats (15 days versus 30 in the untreated group) and also collagen and hexsoamine content of the granulation tissue increased at a faster rate in the treated wounds.

Anti-diabetic activity

Vetrichelvan *et al.*,[28] demonstrated the anti-diabetic activity of alcoholic extract of *Celosia argentea* Linn seeds in rats and reported that chronic administration of the extract significantly reduced the blood glucose in alloxan-induced diabetic rats for two weeks and also prevented a decrease in their body weight. Their results suggested that the extract possesses anti-diabetic activity in alloxan-induced diabetic rats. The ethanolic extract of *C. argentea* root lowered blood glucose in basal conditions and after a heavy glucose load in normal rats, reduced the increase of blood sugar found in diabetic rats (73.43% at 250 mg/kg and 80.20% at 500 mg/kg body weight on 15th day), reduced the increased levels of cholesterol, triglycerides and urea, decreased level of proteins and liver glycogen in streptozotocin-induced diabetic animals and inhibited the body weight reduction induced by streptozotocin administration.[29]

Antidiarrhoeal activity

The Antidiarrhoeal activity of alcoholic extract of *Celosia argentea* leaves in experimentally induced diarrhoea in rats was studied by Sharma *et al*.,[30] and they observed that the extract produced dose related anti-diarrhoeal effect against castor oil induced diarrhoea, charcoal meal test and PGE_2 induced diarrhoea.

Antimicrobial activity

In the study of Gbadamosi *et al.*,[17] conducted a study using ethanolic extract of *Celosia argentea* root on microorganisms (bacteria) and reported that the extract showed significant antimicrobial activity especially against *E. coli* and *S. aureus* in addition to their nutritional and phytochemical components. The phytochemical analysis conducted on the plant root showed that it contains no flavonoid and therefore, they concluded that the roots could be useful as cheap source of herbal drugs, food supplements and fodders for livestocks instead of discarding them as waste. Gnanamani *et al.*,[31] used disc-diffusion method to study the effect of *Celosia argentea* Linn on eight burn pathogens and the result showed that there was

significant zone of lysis against all the pathogens studied and the results are comparable to the conventional antibiotic cream called Silver Sulphadiazine (SSD).

Antifungal activity

Fungal study using plant seed oil n- hexane extract of *Celosia argentea* was studied by Diéméléou *et al.*,[32] who observed that *Celosia argentea* seed oil showed antifungal activity against Aspergillus fumigatus, Candida tropicalis and Trichophyton mentagrophytes with minimal inhibitory concentration of 50% and therefore concluded that these characteristics should be exploited for possible applications in the food supplement, pharmaceutical and cosmetic industries.

IgE antibody suppression activity

The work of Imaoka *et al.*,[33] on effects of *Celosia argentea* and *Cucurbit amoschata* extracts on anti-DNP IgE antibody production in mice showed that Anti-DNP IgE production was markedly suppressed but IgG responses were not affected. It was also found that mitogenic activity occurred in *Celosia argentea* extract dose dependently in vitro. They concluded that these results suggest that *Celosia argentea* extract may be more useful than *Perilla frutescens* extract (PFE) for the suppression of IgE antibody in certain allergic disorders.

Immunostimulating Activity

The immunostimulating activity of Celosian, an antihepatotoxic polysaccharide isolated from *Celosia argentea* was studied by Koji *et al*.[34] Celosian induced tumor necrosis factor-α (TNF-α) production in mice, production of interleukin-1β (IL-1β) and nitric oxide (NO) in macrophage cell line J774.1 in a concentration-dependent manner (1 to 1000 μg/ml), IL-1β secretion in human mono-nuclear cells and also enhanced gamma interferon (IFN-γ) production activity of concanavalin A (Con A) in mice spleen cells. However, Celosian alone did not significantly influence IFN-γ production. They concluded that Celosian is an immunostimulating agent in addition to its antihepatotoxic effects.

Hepatoprotective activity

Phytochemical screening and hepatoprotective activity of ethanolic extract of *Celosia argentea* plant was conducted by Haribabu *et al.*[35] They observed that the plant extract (ECA) at the dose of 250 mg/kg and 500 mg/kg, showed a remarkable hepatoprotective activity against paracetamol induced hepatotoxicity as judged from the serum marker enzyme. Two new triterpenoid saponins celosin I (1) and celosin II (2) were isolated from the seeds of *Celosia argentea* Linn exhibited significant hepatoprotective effect on carbon tetrachloride-induced and *N,N*-dimethylformamide-induced hepatotoxicity in mice.[36] There effect of aqueous extract of plant seed Celosian, an acidic polysaccharide, was studied by Hase *et al.*,[37] and they observed that Celosian inhibited the elevation of serum enzyme (GPT, GOT, LDH) and bilirubin levels on carbon tetrachloride (CC1(4))-induced liver injuries in rat and also protected against recombinant human TNF-alpha (rhTNF-alpha)-induced liver injury in D-galactosamine sensitized mice. They concluded that Celosian is an active component in protection against chemical and immunological hepatitis and the activity was found to be dose- dependent.

Antitumor and Anti- inflammatory activities

Anti- inflammatory activity of an isolated flavonoid fraction from *Celosia argentea* Linn leaves was studied by Bhujbal *et al*.[38] The results of the study revealed this flavonoid possesses significant anti-inflammatory properties when investigated by employing carrageenan induced rat paw edema and cotton pellet induced chronic inflammatory models. The study showed significant dose dependent anti-inflammatory activities in both models. The result supported the traditional use of this plant in some painful inflammatory conditions.

Qingbin *et al.*,[9] reported three new triterpenoid saponins, named celosin E (1), celosin F (2) and celosin G (3), together with a known compound cristatain (4), which were isolated from the seeds of *Celosia argentea* L. and were noted to have antitumor and anti-inflammatory activities which was tested in vitro. The chemical structures of these compounds are displayed in figure 2.

Antiurolithiatic activity

Antiurolithiatic activity of ethanolic extract of *Celosia argentea* (seed) in rats was evaluated by Joshi *et al.*[39] The result of the study showed that groups treated with 250 kg and 500 kg of *Celosia argentea* extract showed significant anti urolithiatic activity compared with the standard and *Celosia argentea* demonstrated a potent prophylactic effect on formation of kidney stone confirming the folklore about its antiurolithiasis activity.

Antimitotic activity

The study of Kobayashi *et al.*,[40] reported that celogentins A-C, antimitotic bicyclic peptide from the seeds of *Celosia argentea* inhibited polymerization of tubulin. Hence seed extract of *Celosia argentea* L. possesses antimitotic activity. Its inhibitory mechanism was likely to be associated with activation of macrophages. Antimitotic activity of moroidin, a bicyclic peptide from the seeds of *Celosia argentea* was studied by Morita *et al.*,[41] and the result showed that moroidin, from the seeds of *Celosia argentea* Linn strongly inhibited the polymerization of tubulin. Ma *et al.*,[42] reported the total synthesis of antimitotic and bicyclicpeptide, Celogentin C and the antitumor screening showed that Celogentin C inhibited the growth of some cancer cell line. Stigmasterol isolated from the Methanol extract of the plant *Celosia argentea* showed moderate inhibitory activities against SGC-7901 and BEL-7404 cells.[43]

Antioxidant activities

Subba, B. and Basnet [44] studied the antimicrobial and antioxidant activity of some indigenous plants of nepal and reported that the ethanol extract of whole plant (*C. argentea)* showed promising antimicrobial activity against tested microorganisms (S. aureus, K. pneumonia, P. vulgaris, E. coli) and moderate antioxidant activity. When the invitro-antioxidant study of methanolic extract of *Celosia argentea leaves* was studied by Urmila *et al*.,[22] they observed that plant leaf exhibited invitro antioxidant activity in DPPH, NO and H_2O_2 radical scavenging activities models and concluded that the phytochemical constituents present in the plant extract may be responsible for showing the anti-oxidant properties. Malomo *et al*.,[5] conducted an *in vitro* and *in vivo* antioxidant activity of the aqueous extract of *Celosia argentea* leaves and reported that 10 mg/ml of the extract inhibited linoleic acid oxidation by 67.57%. The highest reducing power was 100 mg/ml as against 10 mg/ml for ascorbic acid. In addition, 2 mg/ml of the extract produced a membrane stabilizing activity of 63.49% as against 77.46% for indomethacin. Phytochemical screening had revealed the presence of alkaloids, saponins, cardiac glycosides, cardenolides, phenolics, and flavonoids. Other results indicated that the aqueous extract of *Celosia argentea* leaves attenuated Cd-induced oxidative stress in the animals, with the best result at 400 mg/kg body weight. Tannin was not detected in aqueous extract used in this study but was detected in ethanolic extracts of the works of Verma, and Demla;[10] Gbadamosi *et al*.[17] The antioxidant activity of selected Nigeria green leafy vegetables was conducted by Odukoya *et al*.,[45] Who reported that *Celosia argentea* Linn showed the highest antioxidant activity (68.41±0.78) of all the plants studied and also contains ascorbic acid (108.48±0.14), total phenols (216.85±2.11) and therefore concluded that high consumption of vegetables containing phenolic antioxidants may slow down the process of degenerative diseases.

Wang *et al*.,[46] reported a novel *Celosia argentea* saponins compounds extracted from *Celosia argentea* L., namely *Celosia argentea* C and *Celosia argentea* D and showed that in animal experiments, these new compounds might be developed for the medicaments capable of preventing and treating hepatic diseases, cardiovascular and cerebrovascular diseases, metabolic diseases, dementia, depression or anxiety.

Pro-oxidant and haemagglutination activities

The boiled, cold, and methanolic extract of *Celosia argentea* showed pro-oxidant effect and also the cytoprotective effect showed that it demonstrated a very low haemagglutination titer value. These results indicated correlation between the antioxidant properties and the haemagglutination values of the plant extract.[47]

Manganese-hyperaccumulator property

Liu *et al*.,[48] studied the manganese-hyperaccumulator properties of *Celosia argentea* Linn and found out that it exhibits the basic characteristics of a manganese-hyperaccumulator and shows a great tolerance to manganese and concluded that this species has great potential to remediate manganese contaminated soil cheaply and can also aid the studies of manganese uptake, translocation, speciation, distribution and detoxification in plants.

CONCLUSIONS AND FURTHER DIRECTIONS

A number of chemical compounds including oleanane-type triterpenoid saponins (celosin H, I and J), cristatain, celosin E, celosin F, celosin G have been isolated from *Celosia argentea.* Phenols, flavonoids, saponins, alkaloids, glycosides, as well as micronutrients like Mg, Ca, S, P, K and Fe have been identified from the plant. Some of these compounds elicit antioxidant and chemoprotective properties. Its rich medicinal uses have also been demonstrated whileutilizing its other properties namely: antifungal, antidiarrhoeal, antidiabetic, nutritive, wound healing and antimetastatic properties. Concerning the antimetastatic property, the moderate inhibitory activities against SGC-7901 and BEL-7404 cells was shown by one of its isolates, Stigmasterol is significant. The use of the flower extract as natural indicator in acid base titration is also worthy of note. The potentials identified in the various isolates from *Celosia argentea* calls for more studies aimed at elucidating the various pathways by which the compounds work. This will help in opening up more areas of application of this plant for medical and diagnostic use.

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