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Review Article

PHYTOCHEMICAL AND PHARMACOLOGICAL OVERVIEW ON *CELOSIA CRISTATA* LINN

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ABSTRACT

Medicinal plants have been used basically in all cultures as a source of medicine. Medicinal plants play an important role in public health, especially in developed and developing countries, and leads to examination for therapeutic and pharmacological applications. Medicinal Plants have been used for thousands of years to flavor and conserve food, to treat different health issues, and to prevent diseases including epidemics. Active compounds produced during secondary metabolism usually possess the biological properties of plant species used throughout the globe for various purposes, including the treatment of infectious diseases. Based on the medicinal values, the *Celosia cristata* has been chosen for this review. *Celosia cristata* is a variety of species *Celosia argentea* (*Celosia argentea* var. *cristata*) plays an important role in traditional medicine to cure several disorders such as fever, diarrhea, mouth sores, itching, wounds, jaundice, gonorrhea, and inflammation. A variety of phytoconstituents are isolated from the *Celosia* species which includes triterpenoids, saponins, alkaloids, phenols, tannins, flavonoids, cardiac glycosides, steroids, phytosterols, and phlorotannins. The plant has potential pharmacological values screened for its various pharmacological activities, namely, anti-inflammatory, immune-stimulating, anticancer, hepatoprotective, antioxidant, wound healing, antidiabetic, antinociceptive effect, and antibacterial activities which are reported in the extracts of different parts of the plant. The objective of this study was to provide an overview of the ecology, phytoconstituents, pharmacology of *Celosia cristata* and to confess their therapeutic potentials, and secure an evidence base for further research works on *Celosia cristata*.

Keywords: Medicinal plants, *Celosia cristata*, Phytoconstituents, Pharmacological applications.

1. INTRODUCTION

The medicinal plant is an important element of endemic medical systems all over the world. The ethnobotany provides a wealthy means for natural drug research and development [1]. Traditional use of herbal medicines involves generous need, and this is true for many products that are accessible as "traditional herbal medicines". Herbal traditional methods have been refined through many skills of many generations. Herbal medicines are easily available, intact, reasonable, and without any adverse effects. Natural products have played an important role throughout the world in evaluating and averting various human diseases.

Medicinal plants contain organic compounds, known as phytochemicals (Phyto means plant in Greek), and are responsible for the defensive strength of the body. These bioactive substances encompass alkaloids, carbohydrates, flavonoids, steroids, tannins, and terpenoids. Today, millions of drugs are refined from medicinal plants. The World Health Organization (WHO) estimates that 80 % of the world's people presently use herbal medicine for primary health care.

Many researchers have found that phytochemicals have the potential to trigger the immune system, constrain toxic substances in the diet from becoming malignant, reduce inflammation, prevent DNA damage and induce DNA repair, reduce oxidative damage to cells, slow the growth rate of cancer cells, stimulate damaged cells to self-destroy (apoptosis) before they can reproduce, helps in controlling the intracellular signaling of hormones and gene expression, and activate insulin receptors. Templates for lead optimization programs are phyto-chemicals, which are intended to be safe and effective drugs [2]. Currently, there is a growing interest in investigating the phytochemical constituents of a medicinal plant and its pharmacological activity [3].

The family Amaranthaceae constitutes nearly 165 genera and 2,040 species and is treated to be the most species-rich lineage among the flowering plant order of Caryophyllales [3-4]. The Amaranthaceae consists of annual or perennial plants, herbs, also shrubs, small trees, and vines. It is a sophisticated family that can be identified from the tropics to cool temperate regions. The Nativity of the Amaranthaceae are tropical and subtropical areas of Central America, Africa, and Australia, whereas Chenopodiaceae occur mostly in arid to semiarid, saline, disturbed, and agricultural habitats of temperate and subtropical regions [5].

Native people in the tropical and subtropical countries, as well as a temperate climate, used Amaranthaceae species as medicinal plants for their numerous activities accepted in the present-day biological tests. Extracts from Amaranthaceae plants exhibit pharmacological activities such as antioxidant, antidiabetic, tonic, immune-stimulatory, antitumor, antibacterial, anti-inflammatory, antiosteoporosis, antiulcer, hypolipidemic, diuretic, larvicidal, antihypertensive, hypoglycemic, and analgesic activity.

Amaranthaceae family is analyzed by its diverse chemistry, including betalains, flavonoids, phenolic acids, essential oils, sesquiterpenes, diterpenes, and triterpenes. Triterpene, saponins are found to be present generously in Amaranthaceae family [6].

The *Celosia* species is a genus of edible and ornamental plants of the family Amaranthaceae. The generic name is derived from the Greek word kelos, meaning "burned," and refers to the flame-like flower heads. Wool-flowers, brain celosia, or cockscombs are the common name used for the flowers of the species if the flower heads are crested by fasciation or Velvet flower (in Mexico). In East Africa's highlands, the plants are very famous and are used under their Swahili name, mfungu [4].

1.1. Celosia cristata

It is a non-woody plant. It is widely seen in Africa, South America, India, and some parts of Asia [7]. The plant reaches a height of 2 to 5 feet. Leaves are arranged in an alternate, simple, and agitate or arrow-shaped. Margin and pinnate venation is seen in the leaf. They grow up to 2-4 inches in length and are greenish-purple or red. The flowers are mostly red. *Celosia cristata* was found to be having the capability of producing purplish or reddish pigment in the tissue culture system. Cyanidin, a kind of anthocyanin was found to be present [8]. The flower of *Celosia cristata* is shown in Fig. 1.

The geographic origins of *Celosia cristata* are unknown, although speculations include the dry slopes of Africa and India as well as dry stony regions of both North and South America. First, they are found in North America from the 18th century. Although reportedly Chinese herbalists used to stop bleeding, treat diseases of the blood, and infections of the urinary tract, there are no references to its use in any western herbals-modern or centuries-old, European or Native American.

Fig. 1: Flower and leaves of *Celosia cristata*

Celosia cristata is an annual herb, hairless entirely. The stem [9-12] is erect, thick, little branched, green or tinged with red, ridged, and flat near the upper part. The simple leaves are alternate, petiolate; the blade is long-elliptical to ovally lanceolate, 5-13 cm long, 2-6 cm wide, acuminate or attenuate at the apex, gradually narrow and decurrent at the base, and entire marginally. The spikes are flat, succulent, and crest-like. Numerous flowers are present in the down middle. The perianthial segments are light red to purplish red, yellowish-white, or yellow, elliptically ovate, pointed at the tip, 5 in number. The bract, bractlet, and perinatal segments are scarious. Each flower has five stamens whose filaments are joined together to form a cup at the base. The fruit has an egg-shaped utricle. The seed is kidney-shaped, black, and lustrous.

1.2. Cultivation

C. Cristata can grow of tropic origin. They can be grown in the summer months in a colder climate. The plants [13-14] being annual plants that grow for only about one-fourth of a year. The ideal temperature of the soil is 16°C for growth.

1.3. Propagation of herb

Seed sow early to mid-spring in a warm greenhouse. Germination takes place within 2 weeks. When large enough to handle, prick the seedlings out into individual pots and plant them out after the last expected frosts.

1.4. Traditional uses

Seeds were used as a demulcent; for painful micturition and dysentery. It is used medicinally in menorrhagia and as an astringent which is used to treat bloody stool, hemorrhoid bleeding, and diarrhea. The seed decoction is used to treat dysentery. The flowers [15-17] can be used as an astringent, styptic, depurative, uterine sedative, constipating, antibacterial, and corrective of urinary pigments, febrifuge, and exoteric. They can be used in the conditions of kapha and pitta, leprosy, burning sensation, skin diseases, diarrhea, dysentery, fever, headache, hemorrhoids, herpes, internal hemorrhage, leukorrhea, liver disorders, menorrhagia, ulcers, and wounds. Juice of leaves is beneficial for bilious sickness, a stimulant in pregnancy, bloodshot eyes, blurring of vision, cataracts, and hypertension.

2. CHEMICAL CONSTITUENTS OF *C. CRISTATA*

The extracts of *Celosia cristata* contain flavonoids, mucilages, phenolic compounds and tannins, saponins, triterpenoids, alkaloids, carbohydrates, proteins, amino acids, gums, and steroids [18-22]. The plant contained choline esters of hyaluronic acid, betanin, and several sterols. The inflorescence contained amarantin, isoamarantin, celosianin, and isocelosianin. The seeds contain 10.1-12.8 % of protein and yield 7.2-7.9 % fatty oil. Six compounds were isolated from the ethanolic extract of *C. Cristata*, and identified as 4-hydroxyphenyl alcohol, kaempferol, quercetin, β-sitosterol, 2-hydroxy octadecanoic acid, and stigmasterol [23]. Isoflavone, cristatein (5-hydroxy-6-hy-droxymethyl-7,20-dime-thoxyisoflavone, 2), and five known flavonoids were also identified. Five saponins, cristatain , celosin A, celosin B, celosin C, and celosin D were obtained from the seeds of *Celosia cristata*. Triterpenoid saponin and semenoside A are isolated from semen of *Celosia cristata*. Two glycoproteins, CCP-25, and CCP-27, were purified from the leaves of *Celosia cristata*. The compounds isolated from *C. Cristata* were p-hydroxyphenyl ethanol, kaempferol, quercetin, cristatain, celosin A, celosin B, celosin, celosin, sphingosine, β-sitosterol, stearic acid, stigmasterol, daucosterol, palmitic acid, and n-hexacosanoic acid [24-28].

Celosia cristata contains an essential phytochemical compound namely flavonoids. Total flavonoid contents were determined using the aluminum colorimetric method with slight modification [15]. Cochliophilin A (5-hydroxy-6,7-methylenedioxyflavone) and a isoflavone, cristatein (5-hydroxy-6-hydroxymethyl-7,2′-dimethoxyisoflavone) are present in *Celosia cristata*. Glycoproteins obtained from the plant leaves are CCP-25 and CCP-27 at the flowering stage [16]. Pure Celosianins like Celosianin I, Celosianin II and their C-15 epimers are isolated from *Celosia cristata* inflorescence [17]. 4-hydroxy phenethylalcohol, kaempferol, quercetin, β-sitosteol, 2-hydroxy octadecenoic acid, stigmasterol were also identified. Saponins such as cristatin, celosin A, celosin B, celosin C, and celosin D are present in plant seeds. The total phenolic content (TPC) was determined using Folin-Ciocalteu's reagent [18]. Antiviral protein CCP-27 isolated from leaves of *Celosia cristata*. The ammonium sulfate fractionation method is used for isolation purposes. The gel filtration chromatography method is used for further purification of proteins [19]. Phytochemical screening of steams, leaves and roots yielded starch, protein, tannin, flavonoids, saponins, fat, sugar, proteins. The total ash content of steams, leaves, and roots is 16.2 %, 16 %, and 12.6 %; from which insoluble ash content is 6.3 %, 6.5 %, and 5.6 % respectively. The study suggested that protein and flavonoid content is higher in leaf while carbohydrate content is higher in the root. Therefore, this plant is used as a vegetable in most Tribes. A variety phyto-constitutents 43a,51a-b are isolated from the *Celosia cristata* which includes flavonoids-Isoflavones and latlancuayin; glycosides; phenols-Lutin, epigallocatechin, gallic acid, caffeic acid, rosmarinic acid, quercetin; tannins; triterpenoid saponins -celosin A-G, celosin I-II, and celosin H-J together with a known compound cristatain; Cycpeptide-morodin, celogentin A-K and celogenamide A; betalains-2-descarboxy betandin, amaranthin, isoamaranthin, betalimic acid, miraxanthin V, (*S*)-Tryptophan, (*S*)-Tryptophan-BX, 3- methoxy-tyramine-BX; lyciumin-A methylate; lyciumin- C methylate; Fatty acid-arachic acid, arachidonic acid, linolenic acid, hexadecanoic acid, palmitoleic acid, octadecanoic acid, octadecanoic monoenoic acid, oleinic acid, linoleic acid; solanine; β-sitosterol; betaxanthins; and β-gamachaconines. This plant is a good source of minerals because of their higher amount such as Ca-178.08 mg, P-38.01 mg, K - 62.34 mg, Na - 35.25 mg, Mg - 39.64 mg, Fe - 15.25 mg, Zn - 7.25 mg, and Cu - 3.75 mg per 100 g of sample with a trace amount of Cr, Mn, Ni, and Pb. The phytochemical contents extracted is depended on medium and condition such as - aqueous extract shows the presence of alkaloids, carbohydrates, glycosides, tannins, protein, amino acids, steroids; methanolic extract shows the presence of alkaloids, carbohydrates, glycosides, tannins, protein, amino acids, and steroids; while Chloroform extract shows the presence of carbohydrates, tannins, and petroleum ether extract show presence of alkaloids, carbohydrates, glycosides, protein, and amino acids. A new three bicyclic moroidin type peptides, Celogentin A, B, and Celogentin C antimiotic along with moroidin, were extracted in methanol from the seeds of *Celosia cristata*. The celogentin C is four times more potent for inhibitory activity than moroidin. Moroidin is isolated from the seeds of *Celosia cristata* in methanol, which is a unique bicyclic peptide originally isolated from *Laportea moroides* (Labiatae), remarkably inhibits the tubulin polymerization and studied their microtubule activity [29]. Betaxanthins are the conjugation products of betalamic acid with different amino acids or amines; in *Celosia cristata* varieties, three ammonium conjugates of betalamic acid with dopamine (miraxanthin-V or dopamine-betaxanthin, B1), 3-methoxytyramine (3-methoxytyramine-betaxanthin, B2), and (*S*)-tryptophan [(*S*)-tryptophan-betaxanthin, B3]. These betaxanthins were isolated in aqueous methanol from *Celosia cristata* (yellow and orange-red fluorescence genotypes) besides the known betalamic acid and amaranthine /isoamaranthine (A1/A2). They are used as colorant properties in foods [30]. The amaranthin, a characteristic pigment is characterized from the extract of red inflorescences of common cockscomb (*Celosia argentea* var. *cristata*) were compared and proved to be qualitatively identical to those extracted from the orange-red inflorescence of feathered amaranth (*Celosia cristata*). It is fragmented into two parts in the mass spectrum as betanin and betanidin [31]. Comparative analyses of the pigments of yellow and orange inflorescences of *C. argentea var. cristata* (common cockscomb) and *Celosia argentea var. plumosa* (feathered amaranth) gave identical betalain patterns with the presence of three betaxanthins, two of them being new structures [32]. A new cyclic 17-membered nonapeptide, celogenamide A, has been isolated along with lyclumins A and C methylates from the methanol extract of seeds of *Celosia cristata*, and the structure including absolute stereochemistry was determined by chemical means and using extensive 2D NMR and LC-MS methods [33].

3. PHARMACOLOGICAL EFFECTS

3.1. Hemostatic effect

The mice were given a decoction of flowers of *Celosia cristata* with the dosage of 17g/kg after 5 days and compared with a control group. It showed that the bleeding time was shortened. After 7 days rabbits were given the same decoction [34] with the dosage of 1.7g/kg. It was observed that the coagulation time, prothrombin time, and plasma recovery were shortened, and the euglobulin lysis time was markedly shortened in comparison with the control.

3.2. Hepatoprotective effects

The hepatoprotective activity of semenoside A with an oral dose of 1.0, 2.0, and 4.0 mg/kg, respectively, were observed by CCl4-induced hepatotoxicity in mice. The results showed that it had significant hepatoprotective effects. Cristatain saponin showed the significant hepatoprotective effect on CCl4 and N, N-dimethylformamide-induced hepatotoxicity in mice, which were observed by significant decreases in the values of aspartate aminotransferase (AST), alanine aminotransferase (ALT), and alkaline phosphatase (ALP) of serum and histopathological examinations compared to controls [35].

3.3. Cytotoxic effects

The cytotoxicity [36] of water and organic solvent extracts was determined in the fibroblast cells Cos7 and four cancer cell lines: HeLa, HepG2, SK-Hep1, and LS 174T. IC_{50} of the water extracts against cancer cell lines is compared.

3.4. Antioxidant effects

Celosia cristata ethanol extract had antioxidant activity [37] in a dose-dependent manner in 1-diphenyl-2-picryl-hydroxyl (DPPH) radical scavenging. Ethanol extract had antioxidant activity in a dose-dependent manner. Silica dose-dependently increased the intracellular ROS generation in RAW 264.7 cells. *Celosia cristata* ethanol extract showed anti-aging effects, the hyaluronidase inhibitory effects, and elastase activity inhibitory effects were relatively strong which suggests the *Celosia cristata* ethanol extract has hydration and anti-wrinkle property.

3.5. Adipogenic effect

The *in vitro* capacity of a *Celosia cristata* extracts to impact the adipogenic potential of native human adipose tissue progenitor cells. Native adipose tissue [38] progenitor cells were isolated by depletion approaches from human subcutaneous adipose tissues. Cell culture conditions were used to assess the effect of *Celosia cristata* extract on the commitment and differentiation of progenitor cells. Results showed that *Celosia cristata* extract reduces the lipid content of progenitor cells undergoing differentiation.

3.6. Antimicrobial and anthelmintic effects

The antimicrobial properties [39] of ethanolic, methanolic, and other solvent extracts of *Celosia cristata* were evaluated against microorganisms, *Staphylococcus aureus*, *Bacillus subtilis*, *Salmonella typhimurium*, *Escherichia coli*, *Pseudomonas aeruginosa,* and *Candida albicans.* The minimal inhibitory concentration values of the extracts against animal pathogenic bacteria and yeast were assessed using the broth microdilution methods. Results obtained that the different extracts differed clearly in their antimicrobial activities.

3.7. Antidiabetic effect

The effect of the methanolic extract of *Celosia cristata* leaves on blood glucose level, superoxide dismutase (SOD), catalase (CAT), ALT, AST, ALP activities, and malondialdehyde (MDA) level was examined in diabetic rats. The results obtained a significant increase in serum AST, ALP, and ALT activities and a reduction in SOD and CAT activities compared with normal control groups.

3.8. Antinociceptive effect

Methanol extract of the whole plant of *Celosia cristata* was used to evaluate the antinociceptive activity. The antinociceptive effect of *C. Cristata* was carried out in thermal (hot plate and tail immersion test) and chemical (acetic acid, formalin, and glutamate-induced nociception test) pain models in mice at various doses. Central and peripheral mechanisms are associated with *Celosia cristata* showing significant antinociceptive effect [40].

3.9. Other pharmacological effects

Celosia cristata was considered as one of the herbal therapy [41-44] acting as an antitussive. Choline esters of hyaluronic acid from the plant, when fed to rats showed the antiulcer and gastroprotective effect. The plant prevented fluoride toxicity, the food supplemented with calcium can reduce the effect of high fluorine, and the food supplemented with both calcium and *Celosia cristata* extracts is better.

4. CONCLUSION

Celosia cristata possessed a wide range of therapeutic activities which were proved that this plant has a potential regenerator capacity of various cells, antiproliferative activity, antimicrobial potentiality, adipogenic potentiality, and cytotoxic potential. The wide range of therapeutic potentialities of *Celosia cristata* is mainly due to the presence of various bioactive molecules in flowers, roots, stems, leaves, and herbs.

Conflict of interest

None declared

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