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Phytochemical evaluation and pharmacological potential of *Celosia cristata* L.

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ABSTRACT

Celosia cristata (family Amaranthaceae), has significant medicinal value with rich phytochemical composition and is used traditionally across cultures, it treats various ailments due to its diverse bioactive compounds (sterols, tannins, saponins, and flavonoids). It demonstrates pharmacological capability: anti-inflammatory, hepatoprotective and antiviral effects. The methanolic extracts of *C. cristata* flower contains alkaloids, tannins, carbohydrate, saponins, terpenoids, phenols, flavonoids, and steroids. These bioactive phytochemical compounds in methanolic extracts, supports its traditional medicinal use for various ailments. The abundant presence of phytochemicals in *C. cristata* flowers suggests their potential application in pharmaceutical industries for drug development. These findings provide a scientific basis for the traditional medicinal use of *C. cristata* in managing ailments and disorders.

Keywords: Anti-inflammatory, Bioactive compounds, *Celosia cristata*, Hepatoprotective, phytochemical screening, phytochemicals

1. INTRODUCTION

Celosia, has around 60 species, grown in Southern Hemisphere (35). The term Celosia originates from the Greek term "kelos," signifying "burned," alluding to flower heads that bear a resemblance to flames (9). Due to its vibrant and attractive inflorescence, it is widely used as an ornamental plant. In Asia, Africa and South America, its tender leaves, inflorescences, and seedlings are consumed as part of their culinary properties (44). The green leaves have sweet taste when added into soups (28).Conventional medicine employs various Celosia species to treat pyrexia, diarrhea, canker sore, wound, irritation, and infections (3,22). Various cytological, biometric and molecular analyses indicate that *C. cristata* and *C. argentea*are distinct species, with *C. argentea* serving as the direct precursor of *C. cristata*(30). The flower heads of *Celosia cristata* offer a natural dye. Extracting the unique pigments (betalains) present in flowers enables the dyeing of fabrics, papers, and food products (46). Its phytochemical analysis revealed that Celosia plants contains saponins, sterols, alkaloids, phenolic compounds, tannins, betalains, flavonoids, glycosides,

Figure 1. Photograph of *Celosia cristata*

triterpenoids etc. These compounds are linked to a range of health benefits, such as reducing inflammation, boosting the immune system, preventing cancer, supporting liver health, combating oxidative stress, aiding in tissue healing, regulating blood sugar levels, alleviating pain and exerting antimicrobial effects(17,43).This paper focuses on the phytochemical screening of methanolic extract of *C. cristata flower*.

2. BOTANY, CLASSIFICATION AND MORPHOLOGY

BOTANICAL CLASSIFICATION

Kingdom Plantae
Class Magnoliopsida
Order Caryophyllales
Family Amaranthaceae
Genus Celosia
Species Cristata (21)

DISTRIBUTION : Africa, Asia [India, Indonesia, China (32)]

MORPHOLOGY

Plant Parts	Features	Characteristics
Leaf	Colour	Greenish purple
	Size	Length-2-10 cm and width- 1-5 cm
	Shape	Elliptic – lanceolate
	Venation	Pinnate
	Taste	Bitter
	Odour	Characteristic
	Arrangement	Alternate
	Margin	Smooth to wavy
	Leaf Apex	Acuminate or attenuate
	Leaf Base	Gradually narrow and decurren
Stem	Colour	Greenish purple
	Length	20-40 inches
	Texture	Slightly hairy
Flowers	Shape	Cockscomb
	Colour	Pink, yellow, orange
	Bract, Bractlet, and Perianthial Segments	Scarious
	Stamens	Five
	Perianthial segments	Five

3. TRADITIONAL MEDICINAL USES

*Celosia cristata*is used in traditional medicine in India, Africa, and China, to treat diverse array of ailments. This plant have significant role in traditional healing practices [vomiting blood, abnormal uterine bleeding, and hemorrhoids to soothing conditions like chronic diarrhea, eye inflammation, and dizziness(47)]. It is also used to treat digestive disorders, painful menstruation, and provide relief for eye inflammation, demulcent, alexiteric and astringent properties. In Chinese medicine, its seeds alleviates blood heat, enhances vision and reduce inflammation. In folk medicine it is*C. cristata* remedy for hypertension, palsy, cataracts, diabetesand atherosclerosisedtc.(40). It has potential in addressing fatigue and atherosclerosis concerns (27).

4. CHEMICAL COMPOSITION OF *C. CRISTATA*

Table 1. Chemical composition of *C. cristala*

#	Plant Part	Chemical Analysis Method	Chemical Constituents	Activity	Ref
1	Seeds	ESI-MS and GCMS technique	Saponin – celosin A, B, Cand D, Polysaccharide-CP1-1,Oleanane-type, Triterpenoid Saponins-Celosin K. L and M	Hepatoprotective	16,40, 47
		Spectral analyses	Celosialdehyde, β-sitosterol stearic acid, palmitic acid oleanolic acid, cochliophilin A, tyrosol, 1,3-dilinolein, 1,2-dilinolein, linoleic acid, kaempferol, quercetin, polygonocinol, hydroxybenzoic acid, protocatechualdehyde, protocatechuic acid, caffeic acid, ferulic acid, rutin, celosin H, celosin I, celosin J	Dysentery, Sexual dysfunction, mucous secretion, piles, Blood in urine, diarrhea, urinary tract infections, wounds, diabetes, dysuria, liver-heat, improving eyesight, and as an antiphlogistic agent, demulcent	16,50
2	Flowers	RP HPLC, Silica gel column chromatograpghy	Amarantin,Isoamarantin, Celosianin, Isocelosianin, Celosianin I and II, Alkaloid, Phenols, Tannins, Phytosterols, glycosides, flavonoids, Tannins, terpenoid and their C-15 epimers	Styptic, tranquillizer, constipation, antibacterial, antipyretic and alexiteric, leprosy, skin diseases, headache, wounds, Astringent	2,5,10
3	Leaves	UHPLC DAD	Rutin, (−) epigallocatechin gallate,catechin chlorogenic acid, gallic acid and (−) epigallocatechin	Dysentery, menstrual bleeding, inflammation and	18,19

				worms. Leaves juice used for bilious sickness, blurring of vision, cataract, pregnancy blood shot eyes and hypertension	

5. RECENT RESEARCHES

Recent researches have studied *Celosia cristata*s biology and cultivation practices (1). These aimed to elucidate the genetic underpinnings responsible for the diverse flower in different *C. cristsata* cultivars and unveiled the fundamental genetic mechanisms for array of floral hues within the species (24). Utilizing advanced molecular techniques (genome sequencing and gene expression analysis) have pinpointed key genes in pigment production pathways. Moreover, advancements in cultivation methods have developed *Celosia cristata* varieties, improving ornamental features (larger blooms, prolonged flowering seasons, and resistance to diseases). These have significantly increased the production of *Celosia cristata*(15,45). Beyond its beauty, Cockscomb (*Celosia cristata*) is being studied for potential medicinal uses. Modern research is investigating its components to understand its health benefits and their mechanisms of action.

6. PHARMACOLOGICAL ACTIVITIES

The pharmacological profile of *Celosia cristata* reveals a diverse array of bioactivities attributed to its various phytochemical components. This plant has been extensively researched due to its potential therapeutic applications. In this section, we explore the notable pharmacological effects of *Celosia cristata*, emphasizing its hepatoprotective, adipogenic, antihelmintic, antiviral, antioxidant, antidiabetic, cytotoxic, antinociceptive, antidepressant, hemostatic, antimicrobial, neurodegenerative, immune-stimulatory, and atherosclerosis-modulating activities, as well as its nutritional value.

6.1. Hepatoprotective effects: Researchers have identified several compounds in *Celosia cristata* seeds, including the four saponins i.e. celosin A, B, C and D aa well novel saponin cristatain (20). The saponin cristatain has remarkable antihepatotoxic effects against tetrachloroethane (CCl4) and N,N-dimethylmethanamide (DMF) induced liver damage in mice. This was indicated by reduction in levels of aspartate aminotransferase (AST), alanine aminotransferase (ALT) and alkaline phosphatase (ALP) in the serum, alongside histopathological evaluations than control (48).That extracts from *Celosia cristata* flowers effectively counteracted oxidative liver damage caused by tert-butyl hydrogen peroxide(13).

6.2. Adipogenic effects: The *Celosia cristata* flower extract showed potent inhibition of adipogenesis in human adipose tissue progenitor cells (CD34+/CD31-) *in-vitro*. Using a carefully isolated progenitor cell population, two experiments were done to assess the extract's impact during different phases. In first one progenitor cell were

cultured for 10 days in differentiation medium (with and without extract) while in second one cells were cultured for 48 h (with and without extract) followed by 10 days incubation (4).

6.3. Antihelmintic effects: The anthelmintic activity was assessed using the methanol extract of *Celosia cristata* flowers on adult Indian earthworms (*Pheritima posthuma*). The methanolic extract its flowers showed significant wormicidal effects at both lower (25 mg/ml) and higher (100 mg/ml) concentrations. The observed effect was correlated with the existence of glycosides, sterols and flavonoid in flower extract(14,38).

6.4. Antiviral effects: During its flowering phase, *Celosia cristata* produces potent antiviral agents, notably CCP-27, a glycoprotein. Purified CCP-27 exhibits resistance against sunhemp rosette virus and demonstrates both DNase and RNase activities. Its DNase activity involves cleaving supercoiled DNA in two steps, while gel electrophoresis confirms its distinct RNase activity, suggesting potential as an antiviral agent similar to other ribonucleolytic proteins (25).

6.5. Antioxidant effects: *C. cristata* leaves contain CCP-25 and CCP-27glycoproteins, confirmed for their antiviral properties via HPLC analysis. Additionally, these glycoproteins showed potent antioxidant abilities, inhibiting redox enzymes and phenylalanine ammonia lyase. Moreover, its ethanol extract effectively reduces the intracellular superoxide anion production and inhibits hyaluronidase and elastase activity, making it valuable for skincare due to its moisturizing and anti-aging effects (12).

6.6. Antidiabetic effects: To assess the potential antidiabetic effects, methanolic extract from *Celosia argentia var. cristata*, male albino rats were segregated into various groupings: diabetic control, normal control, and diabetic rats treated with doses of 250 and 750 mg/kg body weight of *C. cristata* extract, along with a group treated with 5 mg/kg body weight of glibenclamide. Following a 21-day observation period, the results indicated a notable decrease in blood glucose concentrations 103.33±17.47 mg/dl for the 250 and 750 mg/kg body weight doses of Celosia extract, and 85.00±5.19 mg/dl for glibenclamide (compared to 104.33±10.40 mg/dl). However, the precise chemical mechanism of action and the specific secondary metabolites responsible for these effects remain unclear (6,7).

6.7. Cytotoxic effects: Moroidin, a cyclopeptide from *Celosia cristata* seeds, disrupts microtubule dynamics by inhibiting tubulin polymerization (11). It demonstrates cytotoxic effects on tumorcells like A549 lung cancer cells, impacting polymerization of microtubule and reducing levels of β-tubulin protein. Molecular docking shows significant binding affinity for the site of action of vinca alkaloids on tubulin. Moroidin halts cell progression in the G2/M phase and triggers cell death via the AKT activation and intrinsic mitochondrial pathway. Additionally, it inhibits the migratory and invasive properties of A549 cells at non-toxic dose (29,49).

Table 2. Summary of various pharmacological activities of *C. cristata*

#	**Pharmacological activity**	**Activity**	**Ref**
1.	Hepatoprotective effect	Semenoside A, a saponin extracted from *C. cristata* showed an effective hepatoprotective activity.	13,48
2.	Adipogenic effect	*Celosia cristata* extract induces a more potent reduction of lipid content. Celosia cristata extract induces a more potent reduction of lipid content. *C. cristata* showed significant reduction in lipid accumulation and downregulation of key adipogenic genes (PRARγ2, C/EBPα) and markers.	44
3.	Antihelmintic effect	*C. cristata* showed potent anthelmintic activity	14, 38
4.	Antiviral effect	*C. cristata* CCP-27(antiviral protein) showed to possess strong ribonuclease activity against *Torula* yeast rRNA.	25
5.	Antioxidant effect	*C. cristata* antiviral proteins (CCP-25 and CCP-27) indicated as strong antioxidants.	12
6.	Antidiabetic effect	*C. cristata* extract showed significantly reduction in the levels of the serum enzymes and increased the level of CAT and SOD.	*6,7*
7.	Cytotoxic effect	Celosia cristata showed 18% of inhibition with the concentration of 20 µg/mL against HCT116 cell lines.	39, 49
8.	Antinociceptive	*C. cristata* showed significant antinociceptive effect which is associated with both central and peripheral mechanisms	34
9.	Antidepressant activity	It significantly decreased the overall immobility duration in both test paradigms.	8
10.	Hemostatic effect	*C. cristata* showed reductions in PRT, CT, and PT, while mice exhibited a decrease in BT	23
11.	Antimicrobial activity	The C. *cristata*AgNPs showed an effective antimicrobial activity against IS-3, IS-4, IS-6, and IS-7 as compared to a positive control (ciprofloxacin).	36, 37
12.	Neurodegenerative disease	The crude extract of *Celosia argentea var. cristata* possesses inhibitory activity against tyrosinase, acetylcholine estrase and butrylcholineestrase enzymes.	39
13.	Immunostimulatory effect	*C. cristata* polysaccharide stimulated the immune mediators and macrophages through TLR4- dependent signaling.	31
14.	Immunoglobulin nephropathy	Bioactive compounds such as stigmasterol, luteolin, β-sitosterol showed potential therapeutic agents against IgAN.	26
15.	Atherosclerosis activity	(−)-Celosine treatment there was reduction in the expression of MPO.	41
16.	Nutritional value	*C. cristata* demonstrated as potential source of nutrition.	33

6.8. Antinociceptive: The analgesic properties of methanolic extract derived from the *Celosia cristata* plant were assessed using various pain models in mice, including both chemical (formalin, glutamate, and acetic acid-induced nociception test) and thermal (tail immersion test and hot plate) paradigms at different doses. The study explored the interaction of methylene blue and glibenclamide with opioid receptors, the cGMP pathway, and affected the ATP-sensitive potassium channel, alongside the suppression of peripheral mediators like prostaglandins, cyclooxygenase, lipoxygenase, NMDA, and non-NMDA receptors (34).

6.9. Antidepressant activity: The ethanol extracts from its leaves and fruits exhibited potent antidepressant effects in Albino mice, as evidenced by reduced immobility time in the tail suspension test, forced swim test (FST), and Porsolt swim test (PST). These extracts significantly decreased the overall immobility duration in both test paradigms. The antidepressant properties of these extracts were likely attributed to their polyphenolic constituents, including flavonoids and catechin (8).

6.10. Hemostatic effects: The hemostatic properties of *C. cristata* were studied in rabbits and mice. Both groups of animals received a dosage of 1.7g of plant extract per kg of body weight, and various parameters including prothrombin time (PT), coagulation time (CT), plasma recovery time (PRT), and bleeding time (BT) were evaluated. Compared to the control group, rabbits showed reductions in PRT, CT, and PT, while mice exhibited a decrease in BT (23).

6.11. Antimicrobial activity: Researcher investigated the antimicrobial effects of Ag nanoparticles synthesized using *C. cristata* leaf extract. The biogenically synthesized AgNPs showed enhanced efficacy against various bacterial strains compared to chemically synthesized ones. Specifically, they exhibited greater effectiveness against otorhinolaryngological isolates like *Alcaligens faecalis* and *Staphylococcus sciuri*. The study highlights the potential of its leaves in synthesizing AgNPs with antibacterial properties, particularly against strains associated with ear, nose and throat infections (36,37).

6.12. Neurodegenerative disease: The methanolic extract in aqueous solution from *C. argentea var. cristata* displayed a moderate level of tyrosinase inhibitory property, exhibiting 63.6% inhibition. This inhibitory effect on tyrosinase may be linked to the existence of flavonoid and phenolic compounds in the extract. Additionally, the extract of *C. cristata* demonstrated notable enzyme inhibitory activity against BChE (68.2 %) and AChE (80.3 %)(39).

6.13. Immunostimulatory effects: The immune system modulatory properties of a polysaccharide-enriched crude fraction from *C. cristata* flowers (CCP) were investigated on murine macrophages. Treatment with CCP activated macrophages through TLR4-dependent pathways, leading to the immune mediator's production like i-NOS, COX.2, IL.6, and TNFα (31).

6.14. Immunoglobulin nephropathy: Abdur *et al.*(26) reported that *Celosia cristata* compounds like stigmasterol and luteolin provide relief for IgA nephropathy (IgAN). Through compound-target gene-pathway networks, they identified these compounds as promising therapeutic agents influencing target genes linked to IgAN pathology. Microarray analysis showed upregulation of FOS, JUN and EGFR, and downregulation of AKT1 in IgAN patients(26).

6.15. Atherosclerosis activity: Docking experiments conducted with Myeloperoxidase (MPO), the primary target in anti-atherosclerosis therapy, demonstrated that celosine, extracted from *Celosia cristata*, exhibits encouraging anti-atherosclerosis properties. *In-vivo* trials conducted on a rat model of atherosclerosis confirmed that treatment with (−)-Celosine significantly enhanced vascular function in a dose-dependent manner. Concurrently, alterations in MPO and MMP-9 expression were observed, although there was no notable impact on Lp-PLA2 expression. Supplementary investigations utilized

Knowledge Discovery in Database (KDD) methodologies to forecast potential pharmaceutical targets, with MD simulation ensuring the reliability of docking outcomes. Moreover, a thorough examination of the interaction between Celosine and MPO residues indicated potential avenues for modification, underscoring its promising therapeutic pathways for atherosclerosis prevention (41).

6.16. Nutritional value: *Celosia cristata* is potential reservoir of betalain pigment, this provides vibrant hues of its inflorescences. Renowned for its potent antioxidant and anti-inflammatory properties, this pigment holds promise as beneficial food ingredient, offering many health advantages. The blossoms of *C. cristata* are revered as rich source of physiologically nutraceutical and active components, boasting significant antioxidant and pharmacological attributes. Abundant in various vitamins such as A, B, C and E with E (tocopherol) notably concentrated, these flowers are a treasure of nutrition. Additionally, substantial levels of potassium along with essential amino acids and fatty acids further underscore the nutritional richness of *C. cristata*(33).

7. CONCLUSIONS

Celosia cristata has remarkable therapeutic potential, offers combination of traditional medicinal uses and promising scientific evidence for its diverse pharmacological activities. Its potential to treat anti-inflammatory, antioxidant properties, cancer treatment and liver protection. While further research is needed to fully unlock its potential, *Celosia cristata* is testament to the power of nature's pharmacy and a beacon of hope for holistic healthcare solutions.

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