

TOWARDS A BETTER UNDERSTANDING OF AN UPDATED ETHNOPHARMACOLOGY OF *CELOSIA ARGENTEA* L.

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ABSTRACT

Plant of genus *Celosia* (Amaranthaceae) is *Celosia argentea* L. is widely used in traditional medicine to cure many diseases such as jaundice, gonorrhoea, wounds, fever, inflammation, itching, mouth sores, and diarrhoea. A variety of phytoconstituents are isolated from the *C. argentea* which includes novel triterpenoid saponins, celosin E, celosin F and celosin G together with a known compound cristatin, betalains, nicotinic acid, celogenamide-A, celogentin A-D, H, J and K. Anti-inflammatory, immunostimulating, anticancer, hepatoprotective, antioxidant, wound healing, antidiabetic and antibacterial activities are reported in the extracts of this plant and its phytoconstituents. An overview and details of the ethnobotanical, phytochemical and pharmacological investigations on the *C. argentea* species is presented in this review.

Keywords: *Celosia*, *Celosia argentea* L., Celosin, Ethnomedicinal plant, Bioactive constituents.

INTRODUCTION

Plants are indispensable sources of medicine since time immemorial. Studies on natural product are aimed to determine medicinal values of plants by exploration of existing scientific knowledge, traditional uses and discovery of potential therapeutic agents. Phytochemicals are used as templates for lead optimization programs, which are intended to make safe and effective drugs [1]. In the developed countries, 25% of the medicinal drugs are based on plants and their derivatives [2]. Medicinal plants are the major components of all indigenous or alternative systems of medicine. Medicinal plants are sources and can be a good start for the discovery of new chemical compound [3,4]. A group of World Health Organization (WHO) experts, who met in Congo Brazzaville in 1976, sought to define traditional African medicine as the sum total of practices, measures, ingredients and procedures of all kinds whether material or not, which from time immemorial has enabled the African to guard against diseases, to alleviate his/her suffering and to cure him/herself [5].

The *Celosia* species is a small genus of edible and ornamental plants belonging to Amaranthaceae. The generic name is derived from the Greek word *kelos*, meaning "burned," and refers to the flame-like

flower heads. The flowers of the species are commonly known as wool-flowers, brain celosia or cockscombs, if the flower heads are crested by fasciation or Velvet flower (in Mexico). The plants are well known in East Africa's highlands and are used under their Swahili name, *mfungu* [6].

Amongst the different plants of the species, *C. argentea* is an important tropical leafy vegetable crop of high nutritional value [7]. An Indian origin, *C. argentea*, is a plant of tropical origin and known for its very brilliant colors and traditional uses [8]. *C. argentea* is commonly named as *semen celosiae*, celosia, silver cock's comb, cock's comb, quail grass, woolflower in English. In India locally named as *sitivara*, *vitunnaka*, *sunishannaka* (Sanskrit), *indivara*, *survali*, *safed murga* (Hindi), *annesoppu*, and *kannu hoo* (Kannada). Plant bears simple and spirally arranged leaves, often pinkish or white flowers while fruits are globular and seeds are black [9]. Genetic diversity of 16 populations of *C. argentea* and 6 populations of *Celosia cristata* L. was investigated in China using sequence-related amplified polymorphism [10]. There are more than seventy different species are identified and among all including *C. argentea* are routinely used as leafy vegetable [11]. The details of other species of *Celosia* are listed in Table 1.

Table 1: List of various other species of *Celosia* [12, 31]

Name of Species	Common names	Description and distribution
<i>C. cristata</i> L.	Cockscomb Chi Kuan (China)	Traditional medicine herb used for treatment of fatigue, atherosclerosis, leucorrhoea and osteoporosis. Its seeds have been used for removing "liver-heat" improving eyesight, clearing wind-heat and as an anti-inflammatory agent, as recorded in Dian Nan's Herbal. The chemical constituents of this plant include mainly flavonoids. Also used as ornamental plant.
<i>C. palmeri</i> S. Watson	Palmer's Cockscomb	Flowering plant, that is native to the lower Rio Grande Valley of Texas in the US as well as northeastern Mexico. It is a perennial shrub reaching a height of 0.3–1 m. Flowering takes place from summer to winter.
<i>C. nitida</i> Vahl	West Indian Cockscomb	It is a native perennial, glabrous herb in Texas and Florida, currently listed as an endangered species. It is also found in Central and South America. The plant can grow from 0.3 to 2.0 m height. Rootstock elongate, woody. Stems erect, branched from rootstock. Leaves are petiole, blade unlobed, deltate, ovate, rhombic to triangular-lanceolate, base abruptly narrowed, oblique, apex acute to acuminate. Flowers are tepals greenish, greenish white, or pinkish green, striate.
<i>C. plumosa</i> <i>C. trigyna</i> L.	Rocket Woolflower, Bukaragata, Mubalala	It is one of the cut-flower varieties of <i>Celosia</i> . It may grow up to 1 m in height and is considered a weed. During drought, it has been used as a source of food. The leaves are boiled like cabbage, and are known as <i>torchata</i> . It is also eaten as a vegetable in Africa.
<i>C. virgata</i> Jacq. Syn. <i>C. albahaca</i>	Albahaca	It is found in Puerto Rico and the Virgin Islands but not in the continental United States. It is a perennial subshrub.
<i>C. leptostachya</i> Benth.	Hausa (Nigeria); sokoyokota, Krio (Sierra Leone)	A straggly annual, reaching 0.7 m tall, of undergrowth and roadsides, recorded from Sierra Leone. In Nigeria the fruits and seeds are pounded up for topical application in cases of ophthalmia.
<i>C. isertii</i> C.C. Towns.	Fula-Fulfulde (Nigeria)	A straggling herb, reaching 3.0 m height. It grows stream-banks, damp sites, clearings and rarely in savanna. In Sierra Leone the leaves are boiled and applied hot for rheumatism. Traces of flavones have been reported in the entire plant from the Congo area. Recorded from Senegal to South Nigeria and Fernando Po, and in Cameroun across central Africa to Tanganyika, Zambia and Angola. The plant is

<i>C. bonnivairii</i> Schinz Syn. <i>C. pseudovirgata</i> Schinz. <i>C. globosa</i> Schinz.	often eaten as a vegetable or prepared in soups and sauces in West Africa. A glabrous herb attaining 1.0 m height, of the forest, roadsides and cultivated land. Recorded in S Nigeria and W Cameroun, and also occurring in Zaïre. No usage is recorded in the Region. In Zaïre it is taken as a vegetable, and used in fishing.
<i>C. loandensis</i> Baker	A straggling herb to about 0.70 m length, of forest undergrowth, clearings and in cultivated land, recorded in S Nigeria and W Cameroun, and in central Africa from Cameroun to Zaïre and Uganda. The leaves are eaten as a vegetable in Zaïre It is glabrous rambler, the numerous elongate panicle-bearing branches springing at right angles from a main branch. Leaves petioled; blade, ovate-lanceolate.
<i>C. chenopodiifolia</i> Baker	It is annual herb, with one to several stems from the base, long and slender branches; stem and branches striate, glabrous. In Zambia it is found by a roadside. Leaves elliptic or rhomboid-lanceolate, and shortly petiolate. Seeds are lenticular, 1mm in diameter, black in colour and moderately shiny.
<i>C. staticodes</i> Hiern <i>C. stuhlmanniana</i> Schinz	An herb grows 0.6-0.9 m height; the stem and nerves of the leaves more or less pubescent. Spreading branched perennial herb grows up to 9 m height. Stem and branches striate, glabrous more or less furnished with brownish multicellular hairs. Seeds are lenticular, 1-1.25 mm in diameter, black in colour and shiny. Distributed in the Zambia, Tanzania and Uganada.
<i>C. vanderystii</i> Schinz	Erect annual herb, attaining 0.1-0.4 m. tall, simple or with a few to numerous long, ascending branches; stem and branches slender, striate, glabrous or with short. Seeds are lenticular, black, shiny, 1.25 mm in diameter. Apparently it grows always in light sandy or loamy soil, along roads and tracks.
<i>C. schweinfurthiana</i> Schinz	Perennial branched herb, frequently somewhat woody below, vary variable in habit. Seeds lenticular, black, very shiny, feebly reticulate with flat areolae. It is a forest plant distributed in Mozambique; it also occurs in a wider range of habitats as a weed of cultivation, in coastal scrub and on rocky hill slopes.
<i>C. pandurata</i> Baker	It grows 0.6–1.0 m height, sparsely branched above. Stem and branches slender, striate, more or less densely furnished throughout with characteristic whitish or yellowish multicellular hairs. Seeds rotund-quadrate, strongly compressed, black, shiny with 1 mm wide.
<i>C. odorata</i> T.Cooke, <i>C. taitoensis</i> Hayata, <i>C. triuncinella</i> Schinz, <i>C. spicata</i> L., <i>C. angustifolia</i> Schinz, <i>C. anthelminthica</i> Asch, <i>C. bakeri</i> C.C.Towns., <i>C. baronii</i> Cavaco, <i>C. benguellensis</i> C.C.Towns., <i>C. boivinii</i> Hook.f., <i>C. brasiliensis</i> Moq., <i>C. brevispicata</i> C.C.Towns., <i>C. chiapensis</i> Brandege, <i>C. corymbifera</i> Didr., <i>C. elegantissima</i> Hauman, <i>C. expansifolia</i> C.C.Towns., <i>C. fadenorum</i> C.C.Towns., <i>C. floribunda</i> A.Gray, <i>C. grandifolia</i> Moq., <i>C. hastata</i> Lopr., <i>C. humbertiana</i> Cavaco, <i>C. longifolia</i> Mart., <i>C. madagascariensis</i> Poir., <i>C. micrantha</i> Baker, <i>C. monosperma</i> Rose., <i>C. nervosa</i> C.C.Towns., <i>C. orcuttii</i> Greenm., <i>C. patentiloba</i> C.C.Towns., <i>C. persicaria</i> Schinz., <i>C. polygonoides</i> Retz., <i>C. polystachia</i> (Forssk.) C.C.Towns., <i>C. pulchella</i> Moq., <i>C. richardsiae</i> C.C.Towns., <i>C. salicifolia</i> Lopr. <i>C. spicata</i> Spreng., and <i>C. virgata</i> Jacq.	

*the other species of *Celosia* are listed since these species have been identified but there is lack of information regarding their description and distribution.

Distribution and description

C. argentea plant is known worldwide, its use for food is geographically much more limited. The plant is common in West Africa, from Sierra Leone to Nigeria. It is also known in Ethiopia, Somalia, Kenya, other parts of East Africa, Mexico and Central Africa. *C. argentea* is an important cultivated vegetable in the rainforest zone of Nigeria, Benin, Cameroon, Gabon, and Togo. The wild form (sometimes referred to as *C. trigyna*) is a potherb throughout the savanna area of tropical Africa. *C. argentea* grows as a weed during rainy season throughout India and other tropical regions of the world mainly Sri Lanka, Yeman, Indonesia, America and West Indies [13].

Table 2: Taxonomy of *C. argentea* L. [13]

Kingdom	Plantae
Super division	Spermatophyte
Division	Magnoliophyta
Class	Magnoliopsida
Order	Caryophyllales
Family	Amaranthaceae
Genus	<i>Celosia</i>
Species	<i>Argentia</i>

Table 3: The morphological features of *C. argentea* L. [12,13]

Part	Macroscopic features
Leaves	Alternate, linear to lanceolate, entire and to 5cm long
Flowers	Small, in dense erect spikes up to 8 cm long, white to purple, without petals
Fruits	Membranaceous, utricles, seeds shining black and about 1.5 mm in diameter
Seeds	Small (between 1-5 millimeters) and round, with a black or reddish-black exterior and a thin, brittle outer skin

Celosia species have been designated as a quantitative short-day plant, alternate entire or rarely lobed leaves. *C. argentea* is an erect, coarse, simple, branched, smooth annual herb, normally about 0.5 to

1.5 m in height but sometimes much taller. It has few branches, at least until it approaches the time for flowering. The leaves are alternate entire or rarely lobed, light green. They are typically 2 X 6cm, although those on flowering shoots are slightly longer. Even the green foliage may contain large amounts of betalain pigments. The often brilliantly colored flowers are borne in dense heads. Most occur in spikes, and stand like spears in the garden bed. But certain cultivated forms have compact or feathery clusters due to fasciation. *C. argentea* flowers yield large numbers of seeds that are about 1 mm in diameter and are normally black in colour. The Cockscomb flower blooms from late summer through late fall. *C. argentea* plant is an annual dicotyledon [13,14,15].

Traditional uses

The whole plant of *C. argentea* is known for its usage in the treatment of diarrhea, piles, bleeding nose, disinfectant, inflammation, haematological and gynaecologic disorders [16]. In India, the plant is well known for treatment of mouth sores, blood diseases and used as an aphrodisiac [17,18,19]. The seed paste of *C. argentea* used to cure ovarian and uterine diseases [20,21]. It is widely used in Indian folk medicine for the treatment of diabetes mellitus [22].

In China, *C. argentea* is well known for cold, gastrointestinal diseases, rheumatoid arthritis [23] and as fertility regulating agent [24]. The traditional Yao communities of China use the stem, leaf, flower and seed of *C. argentea* for the treatment of hemorrhoids, leucorrhoea, profuse uterine bleeding [25]. In USA, midwifery, rural Honduras practice *C. argentea* for encouraging lactation and its decoction for hemorrhage [26]. In Riau province, Sumatra (Indonesia) antibacterial assay of extracts of 114 species were tested and *C. argentea* was found to have activity against cough and jaundice [27]. In Vietnam, *C. argentea* plant is used as hemostatic herb [28]. In screening of Taiwanese crude flower extract of *C. argentea* was found antibacterial effect against *Streptococcus mutans* [29], and also flowers of the plant are used against snakebite [30]. The leaves and flowers are used as edible and are grown for such use in Africa and Southeast Asia [31].

Food and nutritional value

From the ancient days Celosia and its species are used as a one of the major vegetable as parallel with as its therapeutic effect for various disorders. The plants from *Celosia* including *C. argentea* have nutritional value is more-or-less comparable to that of other dark-green leaves, higher content of minerals, provitamin A, good sources for vitamins A and C. The leaves are containing considerable protein and calcium as well as phosphorus and iron. A survey reported that, the plant rich with nutritional value and it has been listed the following constituents water 84 g, calories 44, protein 4.7 g, fat 0.7 g, carbohydrate 8 g, fiber 1.8 g, calcium 0.26mg, phosphorus 0.43g, and iron 0.078g (measured per 100 g edible leaf portion) [32].

Betalains from *Celosia* plants used in traditional Chinese medicine like *Celosia* sp. were tested for their feasibility to colour food, but yet are used only locally [33]. *C. argentea* is annual leaf vegetable; it grows widespread as a native or naturalized wildflower, and is cultivated as a nutritious leafy green vegetable. It is traditional fare in the countries of Central and West Africa, and is one of the leading leafy green vegetables in Nigeria, where it is known as 'soko yokoto', meaning "make husbands fat and happy". These leaves, young stems and young inflorescences are used for stew, as they soften up readily in cooking. The leaves also have a soft texture and a mild spinach-like taste. They are also pepped up with such things as hot pepper, garlic, fresh lime, and red palm oil and eaten as a side dish. In Nigeria, Benin, and Congo, to name just three countries, the fresh young leaves are a common item of diet. They are primarily eaten in a dish and soup prepared from various other vegetable greens. To such dishes celosia leaves certainly contribute their share of nutrients, including calcium, phosphorus, iron, and vitamins, as well as little protein [13].

Forage and ornamental uses

At least occasionally the plants are chopped and used as feed for chickens. The literature also revealed that it being employed as forage for cattle. The foliage is, however, thought to accumulate oxalate [13].

Recently there has been a remarkable increase in the demand for *Celosia* cut flowers, particularly since the introduction of new cultivars from Japan. From 1992 to 1993 there was a 35% increase in the sale of cut *Celosia* flowers in the Netherlands, representing a total of more than 20 million flowering stems. The main variety grown for cut flowers was *C. plumosa*. [15]. African families plant

Celosia as a vegetable not as an ornamental, but let a few plants grow to flowering to get seed. Its use as an ornamental is hardly known in Africa. However it is among the most popular choices for bedding and border plants, tall backgrounds, edging, pot and container production. In addition, they are easy to dry, being merely hung upside down in a dark, dry place for several weeks. In this form they retain their form and color and can be incorporated into dry bouquets and everlasting flower arrangements [13].

Cultivation

C. argentea in India mainly cultivated in Tirunelveli and also it is wildly grow as weed. Even though it is African origin, *Celosia* is known as a foodstuff in Indonesia and even in India. Furthermore, in the future it might become cultivated, especially in the hot and malnourished regions of the equatorial zone. It can be planted well in humid areas and it grows in the wet season. As *C. argentea* is a simple plant needs moderate soil moisture for its proper growth [13]. *C. argentea* was cultivated for cut flower production in Israel, and the local environmental conditions in the Arad area are suitable for their growth [34].

Phytochemical constituents

A variety of interesting but limited compounds have been isolated and identified from the plants of *C. argentea* which includes phenolics, steroids, diterpenes, and flavonoids. The recent investigations shows that, three novel triterpenoid saponins, celosin E, celosin F and celosin G together with a known compound cristatain, were isolated from the seeds and characterized using extensive nuclear magnetic resonance (NMR) and mass spectroscopy (MS) technique. These three novel triterpenoid saponins and cristatain shows the antitumor and anti-inflammatory activities by *in vitro* screenings [35]. Phytochemical analysis of *C. argentea* reveals betalains [36], nicotinic acid, celogenamide A [37], celogentin A–D, Celogentin-H, celogentin-J [38] and celogentin -K [39], moroidin [40]. The inflorescence of *C. argentea* has been studied for the removal of methylene blue from waste water as cheap and eco-friendly biosorbents. Inflorescence of *C. argentea* along with stem of *Cicer aritinum* and cob of *Zea maize* was used in the batch adsorption study with variation of amount of adsorbent, concentration, temperature and pH. There is promising interest in the *C. argentea* for its active phytochemical constituents, for its potential pharmacological activities. The herb *C. argentea* having both primary and secondary metabolites as explained below and also expressed in Table 4 and 5.

Table 4: Details of primary metabolite constituents of *C. argentea* L. [36,37,38,41]

Name of Primary Metabolites	Primary Metabolite constituents	Part of the plant
Carbohydrates	Sucrose	Seeds
Lipids	Fatty acids, waxes, glycerides, phospholipids, sterols, vitamins A, D, E and K, β -sitosterol, palmitic acid, oleanolic acid stigmasterol, daucosterol	Whole plant
Amino Acids, Peptides and Protein	Bicyclic peptides: celogentins A, B, C, D, E, F, G, H, and J; moroidin Cyclic peptide: Celogenamide A, Celogentin K	Seed
Betalain	Betacyanins: Amaranthin, Isoamaranthin, Betalamic acid, Miraxanthin V (Dopaamine-BX), (S)-Tryptophan, (S)-Tryptophan-BX, 3-methoxytyramine-BX and yellow betaxanthins	Flower, inflorescences

Table 5: Details of secondary metabolite constituents of *C. argentea* L. [38, 42-48]

Secondary Metabolites	Secondary Metabolite constituents	Part of the plant
Phenols and Phenolic acid	1-(4-O- β -glucopyranosyl-3-methoxyphenyl) propan-2-ene (citrusin C), 3-O- β -glucopyranosyl-1H-indole (indican), (7E)-6,9-dihydromegastigma-7-ene-3-one-9-O- β -glucopyranoside, (3Z)-hexenyl-1-O-(6-O- β -rhamnopyranosyl- β -glucopyranoside), (3Z)-hexenyl-1-O- β -Dglucopyranoside and trans-ferulic acid	Leaves
Phenolic glycosides	4-O- β -D-apifuranosyl-(1 \rightarrow 2)-b-D-glucopyranosyl-2-hydroxy-6-methoxyacetophenone, eugenyl-O- β -D-glucopyranoside, sucrose, quercetin-3-O- β -D-glucopyranoside, isorhamnetin-3-O- β -D-glucopyranoside, rhamnatin-3-O- β -D-glucopyranoside, isorhamnetin-3-O- β -L-rhamnopyranosyl-(1 \rightarrow 2)- β -D-glucopyranoside, β -sitosterol, stigmasterol, and stigmasterol-3-O- β -D-glucopyranoside	Whole herb
Flavonoids	Isoflavones: 5-Methoxy-6,7-methylenedioxy-2'-hydroxyisoflavone and 2'-methoxy derivative: tlatlancauyin	Aerial parts
Diterpenes	Gibberellic acid	Seed
Steroids	Cristatain, saponins, Celosin A, B, C, D and celosin E, celosin F, celosin G	Seed

Primary Metabolites

Primary metabolites are the substances responsible for development, growth and reproduction in living organisms. These make energy available for anabolism and catabolism. Carbohydrates, lipids [41], proteins [37, 38], vitamins and betalains [36] are the often found in herbs (Table 4).

Secondary Metabolites

Phenols and Phenolic acid

Phenols and phenolic acids are the secondary metabolites which are synthesized from carbohydrates in plants. Plant phenolics are a structurally diverse set of compounds responsible for organoleptic properties of plants. These are found to possess a wide range of therapeutic activity. They occur in plants in the form of simple phenolic acids or as complex structures associated with the oxygenated heterocyclic ring, such as benzoic acid derivatives, stilbenes, tannins, lignans, anthocyanins, flavonoids and coumarins [42].

The six compounds including Eugenyl O- β -D-glucopyranoside (citrusin C) were isolated from the leaves of *C. argentea* which shows Tyrosinase inhibitory and superoxide scavenging activity. The six compounds (Table-VI) isolated from the leaves of *C. argentea* showed good skin depigmentation effect [43]. A phenolic glycoside, 4-O- β -D-glucopyranosyl-2-hydroxy-6-methoxyacetophenone along with ten known compounds (Table 5), were isolated from the plant *C. argentea* [44].

Flavonoids

Flavonoids, another important class of phenolics featuring the linkage of two benzene rings by a chain of 3 carbon atoms, so as to form pyran or pyrone ring, play predominant role in plant physiology and serve as light screens, antioxidants, enzyme inhibitors, precursors of toxic substances and pigments [42, 45]. Flavonoids play an important role in a plant as a defense and signaling compounds in reproduction, pathogenesis and symbiosis. The two isoflavones, 5-Methoxy-6,7-methylenedioxy-2'-hydroxyisoflavone and its 2'-methoxy derivative: tlatlancuayin were isolated from aerial parts of *C. argentea* [46].

Diterpenes

Diterpenes, C₂₀ are a group of compounds that consists of 4 five carbon (C₅) units called isoprene. These compounds are well known for their pharmacological, toxicological activities and bitter taste. Gibberellic acid is a simple gibberellin, a tetracyclic diterpene acid and acts as plant hormone. Similar effect was observed for promoted seedling by oligogalacturonic acids [38].

Steroids

Sterols, structurally comprised of perhydrocyclopenta-(O) phenanthrene ring system, are widely distributed in higher plants [42]. Phytosteroids represents a wide range of polarities especially, in account of its existence of polar, non-polar conjugates and the possibility of charged forms. Steroids contain a specific arrangement of four cycloalkane rings that are joined to each other. Steroidal saponins are close with triterpenoid saponins and broadly distributed in secondary metabolites of plant. Steroidal saponins (Table-VI), Cristatain, with four other saponins, Celosin A, B, C, and D were isolated from the seeds of *C. cristata* [47,48].

Pharmacological activity

In the recent years, the use of herbal products has been increasing in developing countries. Plants have always been an attractive source of drugs. On the other hand, intricate ways of molecular interactions and bioactivity mechanisms of the extracts or their bioactive constituents provide a challenge to the scientists [49]. The *C. argentea* displays a wide range of pharmacological activities. A brief overview of their activities has been presented here.

Immunological activity

The Celosian, one of the chemical constituent of *C. argentea* shows immunostimulating activity. Celosian is an acidic polysaccharide

from the seeds of this plant. Celosian found to be a potent antihepatotoxic agent for chemical and immunological liver injury models in animals. Celosian is an immunostimulating agent because a study shows that it induced production of tumor necrosis factor-alpha (TNF-alpha), interleukin-1 beta (IL-1 beta), nitric oxide (NO) and gamma interferon (IFN-gamma) on various in-vitro experimental methods [50].

Anti-inflammatory activity

The in vivo study investigated that, the flavonoid fraction from alcoholic extract of the leaves of *C. argentea* for anti-inflammatory activity in animal models like carrageenan induced rat paw edema acute inflammatory and cotton pellet induced chronic inflammatory methods [51]. Further a study revealed the triterpenoid saponins were isolated from the seeds of *C. argentea* and named as celosin E, celosin F, celosin G, and cristatain. These active constituents are screened for their anti-inflammatory activity by in vitro methods [52].

Anti-cancer activity

The triterpenoid saponins were isolated from the seeds of *C. argentea* and named as celosin E, celosin F, celosin G, and cristatain. These active constituents are screened for their anti-cancer activity by in vitro methods [53].

Hepatoprotective activity

A study shows that hepatoprotective activity of 70% ethanolic extract of *C. argentea* seeds was against carbon tetrachloride (CCl₄) induced hepatic damage in rats. The study also investigated extract caused a significant reduction in lipid peroxidation (TBARS) and an elevation in antioxidant defence parameters as compared to CCl₄ treated control rats [14].

Potential antioxidant activity

Celosia argentea reported to contain high amount of plant phenolic was evaluated for its ability to scavenge the harmful radicals generated by *in-vitro* methods. The work was done with three extracts of *C. argentea* namely, aerial part extract, seed extract and root extract. The plant is reported to be rich in phenols; the total phenolic for the seed extract was significant compared for all the three extracts. The study investigated that the ability to scavenge the generated harmful radicals was more for the seed extract followed by the aerial parts extract. However the antioxidant potential for the root extract was found to be negligible. Hence, it could be stated that seed extract of *C. argentea* could help protect the damage due to harmful free radicals by scavenging and suppressing them possibly due to its abundant polyphenols [53].

Antimitotic activity

The moroidin, a bicyclic peptide from the seeds of *C. argentea*, shows that it strongly inhibit the polymerization of tubulin [40].

Antibacterial activity

A study shows that, crude alcoholic extract of *Datura alba* and *C. argentea* leaves were evaluated against pathogens isolated from infected burn patients. The disc-diffusion method showed significant zone of lysis against all the pathogens studied and the results are comparable to the conventional antibiotic cream namely Silver Sulphadiazine. On comparing the efficiency of the two extracts, extract of *Datura alba* exhibited more than 50% increase in antibacterial activity compared to *C. argentea* [54,55].

Wound healing activity

The healing efficacy of alcohol extract of *C. argentea* in an ointment formulated (10 % w/w) using a rat burn wound model. This result confirmed that, a salutary action of the *C. argentea* extract on wound healing, and also suggested that this may be due to mitogenic and motogenic promotion of dermal fibroblasts [56]. *C. argentea* is considered as one of wound healing medicinal plant in India along with various medicinal plants like, *Aloe vera*, *Azadirachta indica*, *Carica papaya*, *Cinnamomum zeylanicum*, *Curcuma longa*, *Ocimum sanctum*, *Nelumbo nucifera*, and others [41].

Anti-diabetic activity

The ethanolic extract of *C. argentea* shows that, significant hypoglycaemic action in streptozotocin induced diabetic rats [57].

CONCLUSION

The following manifestations can be made on the basis of this comprehensive perusal of literature, that the plant *C. argentea* is being used traditionally, due to their immense therapeutic potential to treat/cure various diseases. It is a rich source of bioactive compounds like, phenolics and triterpenes are present in plant and exhibit with wide range of health benefits. A large number of studies suggested that, the genus *Celosia* having plenty of identified species but there is

lack of particular medicinal and phytochemical investigations for them. Many studies demonstrated significant Anti-inflammatory, immunostimulating, anticancer, hepatoprotective, antioxidant, wound healing, antidiabetic and antibacterial activities. These pharmacological activities and identified compounds provide solid scientific evidence for some of the traditional therapeutical claims of *C. argentea*. A variety of phytoconstituents has been isolated from the different parts of *C. argentea*. However, among all the species of *Celosia*, only a few species including *C. argentea* have been explored exhaustively for their chemical constituents and pharmacological activities. Thus, there remains a tremendous scope for further scientific exploration of this genus, as well as *C. argentea* to establish their therapeutic efficacy and commercial exploitation [Fig.1].

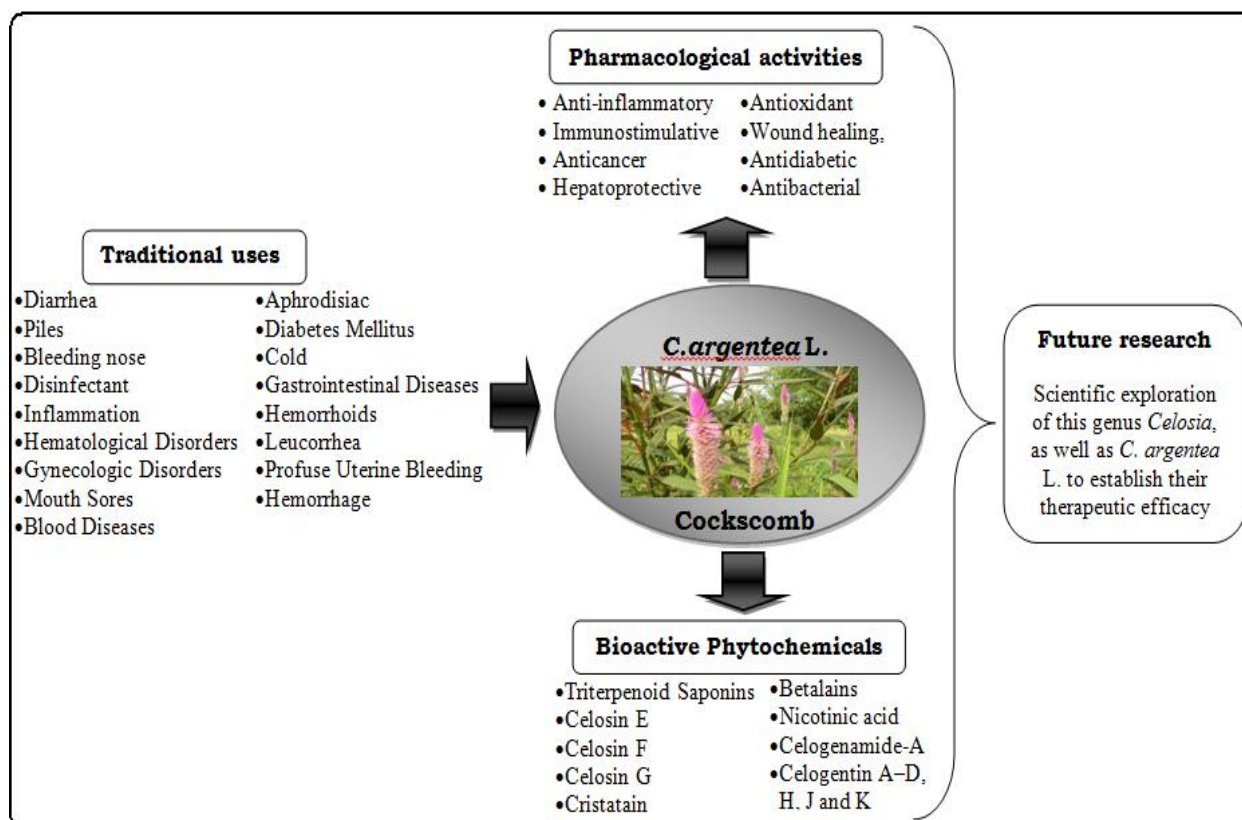


Fig. 1: Research of *C. argentea* L. past, present and future

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