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Unraveling The Medicinal Properties Of *Eleusine Coracana*: A Comprehensive Review Of Its Pharmacological Actions And Phytochemical Properties

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Abstract*: Eleusine Coracana, commonly known as Finger millet or Ragi in Uttarakhand. Belongs to species- E. Coracana, it is a Resilient and highly nutritious cereal crop cultivated predominantly in Africa and Asia (In India like Uttarakhand, Tamil Nadu and Karnataka states). This review aims to summarize the current state of knowledge on the pharmacological and phytochemical properties of Eleusine coracana. A comprehensive literature search was conducted, and relevant studies were analyzed to provide an overview of Eleusine Coracana medicinal properties, phytochemical constituents, and potential therapeutic applications. In Uttarakhand, Eleusine Coracana is particularly suited to the hilly terrain and challenging weather conditions, it is considered as most dominant kharif season crop in rainfed hills. It contains significant amounts of Phenolic compounds like Flavonoids and Tannins, Phytic acid, Saponins, Lignans, Triterpenoids, Alkaloids. These phytochemicals play a crucial role in Scavenging free radicals, Anti-Diabetic, Anti-Aging, Anti-Bacterial, Anti-lithiatic and Hepatoprotective properties. Moreover Eleusine Coracana is proven to modulate various biological pathways and enhance the body's defense mechanism. Future research on Eleusine coracana should focus on more clinical and preclinical trials to validate its health benefits and pharmacological activities and to understand the mechanism in molecular level underlying its therapeutic effects. Additionally, exploring its potential in developing functional food and nutraceuticals could open new avenues for its utilization in promoting health and preventing diseases.*
Keywords*: Eleusine coracana, Uttarakhand, Phytochemicals, Pharmacological.*

INTRODUCTION

Eluesine coracana L., often known locally as mandua or ragi, is a crop that is grown all over the world, including in different parts of India. *Eleusine Coracana* is primarily planted or produced in southern India and hilly regions of northern India such as Karnataka, Andhra Pradesh, Tamil Nadu, and primarily Uttarakhand. In certain regions of central and eastern Africa as well as India, *Eleusine Coracana* is one of the most significant staple food crops. In India, EC is the sixth most produced crop, behind bajra, sorghum, rice, wheat, and maize.[1]

Eleusine coracana, known globally as finger millet or ragi, is a crop of immense importance. In the world, it is valued for its resilience and ability to thrive in adverse climatic conditions, making it a critical food source in regions prone to drought.[2] This ancient grain plays a vital role in global food security, providing a nutritious and sustainable option for millions.

In India, *Eleusine Coracana* holds a prominent position in the diet, especially in rural communities. Renowned for its high calcium content and potential antidiabetic properties, it is an essential component of the Indian diet.[3] The grain's versatility and nutritional benefits make it a staple in various traditional dishes and recipes across the country.

In Uttarakhand, the significance of *Eleusine Coracana* is deeply embedded in tradition and culture. The region's unique agro-climatic conditions favor its cultivation, ensuring it remains a local dietary mainstay. Traditional uses in Uttarakhand include its incorporation into a variety of local dishes and beverages, appreciated not only for its health benefits but also for its long shelf life, which makes it a reliable food source.[4,5]

Pharmacognostically, EC is studied for its distinct botanical features, such as seed morphology and unique phytochemical constituents.[6,7] Pharmacologically, it is acknowledged for its therapeutic potential in managing conditions like diabetes, hypertension, and osteoporosis.[8,9] The phytochemical activities of EC, including antioxidants, polyphenols, and flavonoids, contribute significantly to its health-promoting properties. This exploration of pharmacognistical, pharmacological, and phytochemical activities underscores the immense potential of EC in both modern and traditional medicine, offering a natural and sustainable approach to health and well-being.

***Eleusine Coracana* domestication:**

Eleusine Coracana has a higher nutritional value than other common grains. These millets are used to make new bakery goods like bread, noodles, pasta, and vermicelli. Because it contains no gluten, those with celiac disease can safely consume it. Common millet processing techniques include milling, malting, popping, and decortication.[10,11]

Area and Production of *Eleusine Coracana* Cultivated in India and Around the World (2022–23):

Table 1: Represent the Geographical presentation of *Eleusine Coracana*

Common Name	Finger Millet
Scientific Names	*Eleusine Coracana*
Vernacular Names	Ragi, Mandua
Area in Worlds (Millions ha)	15.48
Production in worlds (Millions tons)	3.42
Centre of origin	Highlands of Uganda and Ethiopia
Major Countries	India, Nepal and Sri Lanka
Area in India (Millions ha)	1.07
Production in India (Millions tons)	17.32
Major States	Uttarakhand, Karnataka, Tamil Nadu
Uses	Grown for food grain and Beverages making

Taxonomical Classification :

Table 2: Taxonomical Classification

Order	Poales
Clade	Angiosperms
Genus	Eleusine
Family	Poaceae
Species	E. Coracana
Kingdom	Plantae

Figure 1: Arial part of *Eleusine Coracana*

The subfamily of Chloridoideae comprises approximately 1360 species, in about 150 genera worldwide. Ayyangar describe the different types of fingers on the finger millet head.[12,13] Variation in grain shape helps distinguish closely related species. Different head shapes have also been described and defined the *Eleusine Coracana* subspecies coracana as that which ‘‘includes all cultivated finger millets.[14,15]

Vernacular Name :

Table 3: Vernacular Name

German	Fingerhirse
English	Korakcan
French	Millet African
Nepali	Kodo
Hindi	Ragi

Figure 2: *Eleusine coracana* seeds

PHYTOCHEMICAL PROPERTIES OF *EC*

Phenolic Compounds:

Phenolic compounds are one of the major classes of phytochemicals present in *Eleusine Coracana*. These compounds are known for their antioxidant, anti-inflammatory, and anticancer properties.[16]

Phenolic Acids:

Eleusine Coracana is rich in various phenolic acids, including ferulic acid, p-coumaric acid, vanillic acid, and caffeic acid. These phenolic acids have been shown to possess potent antioxidant and anti-inflammatory activities, as well as potential protective effects against chronic diseases such as cancer, cardiovascular diseases, and neurodegenerative disorders.[17,18]

Flavonoids:

Eleusine Coracana contains several flavonoids, such as quercetin, luteolin, apigenin, and their glycosides. Flavonoids are known for their strong antioxidant and free radical scavenging abilities, as well as their potential to modulate various cellular signaling pathways involved in inflammation, cell proliferation, and apoptosis.[19]

Tannins:

Tannins are a class of polyphenolic compounds that are abundant in Eleusine Coracana. The predominant tannins found in Eleusine Coracana are condensed tannins (proanthocyanidins). Tannins exhibit antioxidant, antimicrobial, and protein-binding properties, which may contribute to their potential health benefits, including anti-inflammatory, anticancer, and cardioprotective effects.[20]

Phytosterols:

Eleusine Coracana is a good source of phytosterols, particularly β-sitosterol, campesterol, and stigmasterol. Phytosterols are structurally similar to cholesterol and have been shown to compete with cholesterol for absorption in the intestine, thereby reducing cholesterol levels in the body. Additionally, phytosterols have been associated with potential anticancer and anti- inflammatory properties.[21,22]

Carotenoids:

Eleusine Coracana contains various carotenoid pigments, such as lutein, zeaxanthin, and β- carotene. These carotenoids are known for their antioxidant properties and their potential to protect against age-related macular degeneration and other eye-related disorders. Additionally, β-carotene can be converted to vitamin A in the body, which is essential for various physiological functions, including vision, immune function, and cell growth.[23]

Vitamins and Minerals:

Eleusine Coracana is a good source of various vitamins and minerals, including vitamin E (tocopherols and tocotrienols), calcium, iron, zinc, and phosphorus. These micronutrients play crucial roles in various physiological processes, such as antioxidant defense, bone health, immune function, and metabolic regulation.[24,25]

Glycosides:

Eleusine Coracana contains various glycosides, including flavonoid glycosides (like vitexin and orientin) and phenolic glycosides (like feruloyl arabinoxylans). These glycosides have been associated with antioxidant, anti-inflammatory, and antimicrobial activities, as well as potential protective effects against chronic diseases.[26]

Phytic Acid:

Eleusine Coracana is a good source of phytic acid (inositol hexaphosphate), which is known for its antioxidant, anticancer, and cholesterol-lowering properties. Phytic acid can also act as a chelator, binding to minerals and potentially enhancing their bioavailability.

The diverse array of phytochemicals present in Eleusine Coracana contributes to its potential health benefits and has attracted significant research interest. However, it's important to note that the bioavailability and bioactivity of these phytochemicals can be influenced by various factors, such as processing methods, cooking techniques, and interactions with other food components. Ongoing research aims to further elucidate the specific mechanisms of action and potential applications of these bioactive compounds in functional foods, nutraceuticals, and pharmaceuticals.[27]

Phytochemicals present in *Eleusine Coracana*

Table 4: Showing the Phytochemicals compound present in *Eleusine Coracana*

S.NO.	POLYPHENOLS	AMINO ACIDS	VITAMINS	MINERALS
1	Quercetin	Valine	Vitamin B	Ca (0.33%)
2	Vanillic	Methionine	Ascorbic Acid	P (0.24%)
3	Syringic	Isoleucine	Riboflavin	K (0.43%)
4	Ferulic	Tyrosine	Niacin	Na (0.02%)
5	p-hydroxy benzoic	Glycine	Thiamin	Mg (0.11%)

Hexane, ethyl acetate and ethanol extraction of seeds, demonstrated the presence of terpenoids, alkaloids, phenols, and steroids, tannins, phenols, cardiac glycosides, balsams.[28]

Hexane extracts of three distinct cultivar of *Eleusine Coracana* also the presence of tannins alkaloids, terpenoids.[29]

The oil content of this grain is determined to be 0.74% consisting of oleic acid (47.16%), linoleic acid (24.79%) and palmitic acid (23.07%).[30] *Eleusine coracana* powdered seed aqueous extract showing the presence of proteins, carbohydrates, alkaloids, reducing sugars, tannins, phenols, flavonoids, terpenoids, and saponins.[31]

In addition, *Eleusine Coracana* contains vitamins, B vitamins, ascorbic acid, thiamin, riboflavin, and niacin (Amir et al; 2016). The polyphenols found in EC, include quercetin, vanillic, syringic, ferulic, p-hydroxy benzoic, p-coumaric, and gallic and protocatechuic acids are present in ragi seed coat.[32]

Eleusine Coracana contains minerals such as Ca (0.33%), P (0.24%), K (0.43%), Na (0.02%) Mg (0.11%) Fe (46.0%) Mn (7.5%) Zn (15.0%).[33,34]

PHARMACOLOGICAL PROPERTIES OF *EC*

Eleusine coracana (finger millet) is a nutrient-rich cereal that possesses numerous bioactive phytochemicals responsible for its wide-ranging pharmacological and therapeutic properties. The phytochemicals in *Eleusine Coracana* include phenolic compounds, flavonoids, tannins, alkaloids, saponins, and phytosterols, which exhibit potent antioxidant, anti-diabetic, anti-inflammatory, antimicrobial, and anti-urolithiasis effects.

Antioxidant Properties:

Phenolic acids and flavonoids such as ferulic acid, gallic acid, caffeic acid, quercetin, and catechin present in Eleusine Coracana act as powerful antioxidants. These compounds scavenge free radicals, chelate metal ions, and inhibit lipid peroxidation, thereby protecting cells from oxidative damage.[35,36]

Anti-Diabetic Properties:

The high content of polyphenols and dietary fiber in Eleusine Coracana slows down the digestion and absorption of carbohydrates, resulting in lower postprandial blood glucose levels. Studies have shown that Eleusine Coracana extract inhibits α-amylase and α-glucosidase enzymes, indicating its potential for managing type 2 diabetes.[37,38]

Anti-Inflammatory and Analgesic Properties:

Eleusine Coracana contains phytochemicals like flavonoids and alkaloids that exhibit anti-inflammatory effects by inhibiting the production of pro-inflammatory mediators such as prostaglandins and nitric oxide. These compounds have been observed to reduce edema and inflammation in experimental models.[39]

Anti-Urolithiasis Properties:

Recent in vitro studies have demonstrated that ethanolic extracts of Eleusine Coracana inhibit calcium oxalate nucleation and aggregation, key processes in kidney stone formation. This activity is attributed to its flavonoids, tannins, and phenolic acids, which can chelate calcium ions and prevent crystal growth.[40]

Antimicrobial Properties:

Eleusine Coracana contains antimicrobial phytochemicals such as tannins, alkaloids, and phenolic compounds that show inhibitory effects against bacterial strains like *E. coli*, *Staphylococcus aureus*, and

Pseudomonas aeruginosa. These properties make Eleusine Coracana useful in traditional medicine for treating infections.[41]

Other Properties:

Hypocholesterolemia effect: Phytosterols like β-sitosterol in *Eleusine Coracana* reduce intestinal cholesterol absorption.

Neuroprotective effects: Antioxidant phytochemicals help mitigate oxidative stress in neuronal cells.

Anti-cancer potential: Polyphenols like quercetin and ferulic acid induce apoptosis in certain cancer cell lines.[42]

Eleusine Coracana exhibits several pharmacological properties, including:

Table 5: Showing the Pharmacological activities of *Eleusine Coracana*

S.No.	ACTIVITY	PART USED	USES
1	Hypoglycaemic	Seeds	Reduces blood sugar level
2	Hypocholesterolaemia	Seeds	Lowers cholesterol levels
3	Antioxidant	Seeds	Protect against oxidative stress
4	Anti-inflammatory	Seeds	Reduces inflammation
5	Anti-microbial	Seeds	Exhibits antibacterial properties
6	Neuroprotective	Seeds	May help protect against neurodegenerative disease
7	Cardioprotective	Seeds	Helps protect against heart disease
8	Gastroprotective	Seeds	prevents ulcers
9	Immunomodulatory	Seeds	Regulates the immune system
10	Wound healing	Seeds	Accelerates wound healing
11	Anti-anxiety	Seeds	May help reduce anxiety
12	Anti-diarrhoeal	Seeds	Helps manage diarrhoea
13	Anti-Ulcerative	Seeds	Prevents and treats ulcer
14	Anti-Lithiatic	Seeds	Improve Kidney function

MODERN APPLICATIONS OF *ELEUSINE CORACANA*

Eleusine coracana has gained renewed attention in recent years due to its exceptional nutritional profile and therapeutic potential. Beyond traditional dietary uses, modern research and product development have highlighted its applicability in the fields of **functional foods**, **pharmaceuticals**, **nutraceuticals**, and **cosmeceuticals**. These modern applications are largely attributed to its high content of dietary fiber, calcium, resistant starch, polyphenols, and essential amino acids.

Functional Foods and Health Beverages:

Eleusine Coracana is widely used in the development of functional foods, particularly for individuals with diabetes, cardiovascular diseases, and gluten intolerance. Its low glycemic index and high fiber content make it suitable for diabetic diets. Ready-to-eat products, breakfast cereals, energy bars, and probiotic-based beverages using *Eleusine Coracana* are gaining popularity as health-promoting alternatives to conventional cereal-based products.[43,44]

Nutraceutical Formulations:

The high antioxidant potential due to polyphenols such as ferulic acid, catechin, and quercetin has led to the incorporation of *Eleusine Coracana* extracts into nutraceutical capsules and powders. These formulations are used to manage oxidative stress, metabolic syndrome, and aging-related disorders.[45,46]

Gluten-Free and Allergen-Free Products:

As *Eleusine Coracana* is naturally gluten-free, it serves as an ideal grain for gluten-sensitive individuals and celiac patients. It is being used in the formulation of gluten-free breads, cookies, noodles, and snack items for both clinical nutrition and commercial markets.[47]

Infant and Geriatric Nutrition:

Due to its high calcium content (~344 mg/100 g) and easy digestibility, *Eleusine Coracana* is widely used in the preparation of infant formulas, porridges, and weaning foods. It is also being formulated into soft, nutrient-dense foods for the elderly to help manage osteoporosis and malnutrition.[48]

Cosmetic and Skincare Formulations:

The antioxidant and antimicrobial properties of phenolic compounds in *Eleusine Coracana* have potential in cosmeceutical products such as anti-aging creams, herbal soaps, and skin-lightening agents, although this area remains under active exploration.[49,50]

CONCLUSION

Eleusine coracana holds substantial promise as a functional food and medicinal plant. Its diverse phytochemical composition, including polyphenols, flavonoids, alkaloids, and glycosides, contributes to its wide range of pharmacological effects. The plant may be used to prevent and treat a number of chronic illnesses due to its antibacterial, antioxidant, anti-inflammatory, anti-cancer, and neuroprotective qualities.. However, more research, particularly clinical studies, is necessary to fully understand the mechanisms of action of its bioactive compounds and to validate its therapeutic efficacy in humans. The rich phytochemical and nutritional profile of *Eleusine coracana* makes it a versatile grain in modern applications. From diabetic-friendly foods to bone-health supplements and dermatological products, it is increasingly being explored in the food, pharmaceutical, and cosmetic industries.

Future research should focus on exploring the full spectrum of *Eleusine Coracana* pharmacological actions, including its potential synergy with other medicinal plants and pharmaceuticals. Additionally, standardized extraction methods and formulation of bioactive compounds into bioavailable and effective therapeutic products will be crucial in translating its traditional use into modern medicine.

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