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IN-DEPTH EXPLORATION AND ASSESSMENT OF THE PHARMACOLOGICAL AND MEDICINAL POTENTIAL OF *ELEUSINE CORACANA (LINN.) GAERTN*- "THE SUPER MILLET-A LITERARY REVIEW

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ABSTRACT

Ayurveda always approached health not only to cure diseases, but also to maintain health of a healthy individual. Science has given equal importance to preventative aspects along with curative approach. This approach can be substantiated by various references throughout the ayurvedic classics texts in various contexts like *Rtucharya*(seasonal regimens), *Dinacharya* (Daily regimens) *Janapadodhwamsa(*Chapter on epidemiology) *Rakshoghna karma*(Precautionary measures to combat infection /sickness) etc. One such important context is the mentioning of *trayopasthambha* or the three pillars of health, in which acharya has stressed the importance of application of *ahara* or food in health. This Health aspect of food is elaborated in various food groups mentioned. Among one such food group is *Trina dhanya or Kshudra dhanya* or millets. Among the most commonly available and used millets, finger millet is regarded as a superfood for its nutritional benefits in various parts of the country. This article is aimed to explore and understand the pharmacological, nutritional, and medicinal properties of *Raagi*/ Finger millet/ *Eleusine coracana (Linn.) Gaertn.*

KEYWORDS: *Raagi*, Nutraceuticals, Finger millet, Nutrition, Pharmacology, Millet, *Trina dhanya*, *traopasthambha*.

INTRODUCTION

Ayurveda has always given priority to conservation of health in the same way as to treating diseased condition. Throughout the classics, in many contexts this objective of science can be seen reflected through its approach towards prevention of diseases by conserving the health of the individual. In this regard, Ayurveda has included *ahara* as one measure to conserve health. *Ahara* is included by acharya under *trayopasthambha* or the three pillars of life that is essential to maintain the equilibrium of life.[1] This inclusion of *ahara* within the traopasthambha substantiates the importance and relevance of food as a factor that can navigate the health status of an individual. *Ahara* is not only the navigating factor towards health, but improper indulgence in *ahara* can lead to *santarpana janya vikara* which can be correlated to modern day lifestyle disorders.

Even though the term *Santarpana janya vyadhi* is literally translated to diseases caused due to over nutrition, the concept of *Santarpanajanya vyadhi/ vikara* can include a variety of non-communicable diseases and disorders that usually comes associated with sedentary lifestyle, improper sleep, intake of junk foods and finally inappropriate consumption of foods that contain nutritional benefits within. These non-communicable lifestyle provoked disorders/ diseases claim more than 41 million deaths per year and majority if the people that die belongs to the age group of below 50, and majority population belonging to low- and middle-income countries.[2]

Many of these *santarpana janya vikara* can be overcome by focusing on the selective consumption of foods that have nutritive and medicinal properties alike. Acharyas in the ancient texts have very elaborately explained about the medicinal and general pharmacological properties of various *ahara vargas* like *shuka dhanya, Shimbi dhanya, trina dhanya* etc.

In India, Millets have been consumed and encouraged to be grown in various seasons throughout the country, in the past century mainly used for their use as animal food, nutritive and medicinal usage. A Statistics conducted in 2013 stated that India is the largest producer of millet contributing more than 43.85% of total millet production of the world.[3] Millet basically refers to grasses like finger millet, foxtail millet, kodo millets, elephant grass etc. belonging to the Poaceae family under the group of monocotyledons. Millets are one of the major underrecognized crops yet being majorly important due to their resistance towards various pests and animal infestation and good adaptation to a large variety of climate, and yet

yielding a major amount of paddy. Millets are also preferred for their gluten free status making it suitable and perfect for all groups of people as a very healthy food alternative.

Among the millets, Finger millet constitute one of the most staple foods providing energy and calories to a majority of population belonging to the lower economic status. Among the various millet groups, finger millet ranks fourth in the world in terms of nutritional and health benefits.[4]

More focus of the health and scientific committee nowadays is on Nutraceuticals where both the concepts of nutrition and medicine can be clubbed together. In this regard millets, especially finger millet is one of the major staple foods than is regarded to have high nutritive potential due to the presence of major nutrients including niacin, thiamin, riboflavin etc. at the same time exhibiting medicinal pharmacological properties.

Nutraceuticals

Nutraceuticals is a branch of phytomedicine that originated by bridging the concepts of nutrition and pharmaceuticals, the term was coined in 1989 by Stephen DeFelice. According to him, nutraceuticals are any substances that is food or part of food that provides medical or health benefits including the prevention and treatment of medical diseases. The source of nutraceuticals can vary from a wide variety of substances from basic crops to genetically engineered food and herbal products. The nutraceutical sources basically include plant, animals and microbes.

Nutraceuticals can be an effective inclusion for both prevention as well as treatment of health disorders due to the presence of various phytochemical and essential nutrients.

Classification of nutraceuticals

Based on the effect/utility of nutraceuticals, they can be classified into mainly 2.

POTENTIAL NUTRACEUTICALS

Established nutraceuticals

A potential nutraceutical is one that holds a promising nature of having a health benefit or medicinal action along with being a nutritional food. An established nutraceutical is one that has been established of its nutraceutical potential by enough clinical trials and data.

Hence this study is essential to understand and explore the nutraceutical potential of *Raagi*/Finger millet by deep understanding of its pharmacological properties, actions, and activity.

AIMS AND OBJECTIVES

Aim of the article is to explore and understand in detail the pharmacological, nutritional, and medicinal properties along with the nutraceutical potential of *Raagi* (*Eleusine coracana (Linn*) *Gaertn* and in-turn substantiate its inclusion in daily diet cycle to promote and preserve health.

MATERIALS AND METHODS

Relevant information regarding the drug with special emphasis on its pharmacological properties and actions were referred to and collected from all available sources of *Samhitas* and *Nighantus*. All the available information on the drugs was collected from online peer reviewed articles and offline sources. The botanical name, family, pharmacological properties of the drug was collected and cross-referenced for the study. Proven pharmacological activities of the drug were collected from various research articles published in indexed scientific journals.

Botanical Name : *Eleusine coracana (Linn.) Gaertn /Cynosurus coracanus Linn*.

Family : Poaceae

Table 1: Botanical name, Family and Part used.[5]

Drug	Sanskrit name	Botanical name	Family	Part used
Raagi/ Finger millet	Nrityakundala Nartaka, raagi	*Eleusine coracana (Linn.) Gaertn,*	Poaceae	Grains

Vernacular names[6]

English : Finger millet

Sanskrit : *Raagi, Nrityakundalah, Nartakah, Madhulika*

Hindi- *Maandava, Maruva, Raagi*

Kannada –*Raagi*

Malayalam – *Panchapullu, Muttari, Raagi*

Synonyms with their interpretation[7]

Nartaka – Erect stem with lateral flattened branches that are wavy in nature.

Nrytyakundalah – nature of the stem is erect and branched.

Bahupatraka – leaves are long, flattened and numerous.

Bhuchara – Found in clusters along the ground.

Guchakanisha–the inflorescence at the tip of the stem resembles the tail hairs.

Table 2: Habit & Morphological Characteristics.[8]

Habitat	Cultivated throughout south India in areas up to elevation of 1500ft.
Habit	Erect, Stout, Annual grass 60-120cm in height
Root	Root, Fibrous, well branched up to 25cm long, 3.5cm thick, tapering
Stem	Laterally flattened tillering tufted stems
Leaf	5-7mm broad with sheath and ligule of hairs far over topping the stem
Inflorescence	Spike,5-7 frequently incurved spikelet 3-6 flowered congested
Seeds	Each spikelet contains 4-7 seeds. Seeds nearly globose, somewhat flattened. Dark reddish brown to white in color

Table 3: Organoleptic characteristics.[9]

External characters	Well branched, gradually tapering, root hairs present
Size	Up to 25cm long, 3.5mm in thickness
color	Creamy white, rough and dirty
Fracture	Brittle, fibrous, Centre hollow
Taste	Earthen taste
Odor	No Characteristic odor

Table 4: Pharmacological properties of Finger millet.[10]

Drug	Rasa	Guna	Virya	Vipaka
Raagi	Tikta, Madhura (Nighantu Ratnakara) Tikta, Madhura, Kashaya (Raja Nighantu)	Laghu, Snigdha	Sheeta	Madhura

Pharmacological property or *rasa panchaka* of a drug gives us an insight into the property of the drug and explains or helps to understand the action potential and action mechanism exhibited by the drug. *Acharya vagbhata* has clearly stated the need for understanding of the *Rasa, Guna, Virya and Vipaka* of the drug, since the action can always be brought about by the virtue of any of these said pharmacological properties of the drug and that would provide a deep understanding on the mechanism of action put forward by the drug.

Pharmacological actions

Assessment and understanding of the pharmacological actions of the drug "*Raagi*" helps us to explore the pharmacological potential and the mechanisms through which the pharmacological action is put forward. *Dhatu* is a representation of the basic growth element of the body and on understanding of the effect of the drug on dhatu, it exhibits *Tarpana* action (Nourishive) along with actions like *balya, vrishya*. The pharmacological actions on dhatu.

Table 5: Pharmacological actions.[11]

Site of action	Effect of the drug
Action on *Eka dosha*	*Pittahara*
Action on *Dwi-Dosha*	*Pittaraktahara*
Action on *Tridosha*	*Tridoshahara*
Action on Dhatu	*Tarpana, raktadusti hara*
Action on body	*BalyaVrishya*

Table 6: Proved Pharmacological activity.

Antioxidant activity-[12]
Anticarcinogenic activity–[13]
Antidiabetogenic–[14]
Antihyperlipidemic–[15]
Cardio-protective activity–[15]
Antimicrobial activity[16]
Anti-viral[17]

Phytochemical constituents[18]

On analysis of the phytochemical constituents present in the drug, *Raagi i*s known to contain a large group of phytochemical constituents whose functional properties include actions like Antioxidant, Antifungal, Antimicrobial, detoxifying agents etc. Important phytochemical constituents of the drug are enlisted in Table 7.

Table 7: Chemical constituents present.

Tannins
Steroids
Flavonoids
Quercetin
Polyphenols
Alkaloids
Terpenoids
Cardiac glucosides
Ligans
Phytoestrogens
Phytocyanin

On analysis of chemical constituents present in Raagi, it is evident that the drug is saturated with potent phytochemical constituents like steroids, flavonoids, alkaloids, phytoestrogens etc. Many of the chemical constituents that are found to be present is rich in medicinal properties in addition to nutritional properties. Ex: Flavonoids are phytochemical compounds with potential medicinal applications. They exhibit various properties like Anti-cancer property, Antioxidant property, Anti-inflammatory property, Antiviral property,

neuroprotective actions, cardio-protective activity etc(19). the analysis of all these phytochemical compounds within the drug opens up and helps us to understand various potent medicinal activities exhibited by the drug and potential of its therapeutic application in various conditions.

Table 8: Nutritional composition.[20]

Nutrients	Percentage present
Calcium	0.38%
Dietary fiber	18%
Phytates	0.48%
Proteins	6-13%
Carbohydrates	65-75%

Table 9: Mineral and Vitamin constitution of Finger millet.[21]

NUTRIENTS	Composition(mg/100grms)
Calcium	344 mg/100grms
Phosperous	283 mg/100grms
Iron	3.9 mg/100grms
Magnesium	137 mg/100grms
Sodium	11 mg/100grms
Potassium	408 mg/100grms
Copper	0.47 mg/100grms
Manganeese	5.49 mg/100grms
Zinc	2.3 mg/100grms
Thiamine	0.42 mg/100grms
Riboflavin	0.19 mg/100grms
Niacin	1.1 mg/100grms

DISCUSSION

Millets are food sources that offer a good nutritional security since they are enriched with macro_and micronutrients. In comparison to the daily options of foods, millets are considered as a reliable and usable cereal due to the absence of gluten and rich presence of dietary fibre, mineral and B-complex vitamins. Among the different varieties, finger millet is enriched with various phtochemical compounds like Tannins, flavonoids, polyphenols, phyto-estrogens, alkaloids, steroids etc. Among these phytochemical compounds, important phytochemical compounds like flavonoids, polyphenols, phyto-estrogens, tannins attributes to various pharmacological actions like Antioxidant activity, immune-modulatory activity etc.[22] The phytochemical compounds along with macro and micronutrients like vitamins, minerals, essential fatty acids also help protect the body against various age-related degenerative diseases rather than being effective against nutritional deficiency disorders.[23]

Millets in general are therapeutically potent against various age- onset degenerative diseases. Dail induction of millets into diet reduces the risk of cardiovascular diseases, cancer, diabetes, reduces blood pressure, increased muscle function, improved muscular and neural activity and provide protection against various degenerative diseases like metabolic diseases, Parkinson's disease.[24][25]

In context of finger millet, Finger millet has the highest level of calcium (300-350mg/100g) and the gluten free nature of it makes finger millet a high energy cereal that could replace the mainstream major cereals. Looking at the nutritional profile of finger millet, it contains 72.7g/100g carbohydrates, 3.6g/100g of Dietary fibre, 7.3grms /100g of Proteins and the ratio of Carbohdrates to dietary fibre denoted as CHO / DF Ratio equals 20.19 which is lesser than the most commonly used grains denoted in table 10.

Table 10: CHO/DF ratio of Commonly used grains in comparison to finger millet.[26]

Grains used	Carbohydrates (g/100g)	Dietary Fibre (g/ 100g)	CHO/DF Ratio
Rice	79g	0.2g	395
Wheat	76.2g	2.7g	28.22
Barley	73g	1.2g	60.83
Sorghum	72.4g	1.3g	55.69
Bajra	67.1g	1.2g	55.92
Raagi	72.7g	3.6g	20.19

Dietary fibre is seen highest in Raagi (3.6g/100g) in comparison to commonly consumed cereals and paddy like rice and wheat. Dietary fibre exerts their beneficial action by their swelling properties and increasing the transit time in small intestine thereby reducing the rate of release and absorption of glucose and subsequently proving to be helpful in various diabetes. Dietary fibre also binds with bile salts promoting the excretion of cholesterol and food toxins in the gut.[27]

On analysis and understanding of the nutritional composition and properties of the drug, it is evident that the drug is a store house for various nutrients that possesses immunomodulator, antioxidant properties. The presence of these chemical constituents and nutrients makes it effective for consumption in various physco-somatic disorders /lifestyle disorders. Pharmacological activity assessment of the drug makes it clear that the drug has multiple pharmacological actions like antioxidant property, antimicrobial property, Antihypertensive, Anti hyperlipidemicetc. Which are effective against numerous lifestyle disorders.

Morphological assessment in combination with the understanding of chemical constituents ensures the presence of Tannins in the outer layer of *Raagi* which protects the crop against fungal invasion.[30]

Pharmacological assessment of the drug was conducted on various levels of the drug including its pharmacological properties, karma or action, pharmacological activities conducted and proven, chemical constituents present, nutritional profile. On assessment of the Pharmacological property of the drug, it was evident that *Raagi/Madhulika* possesses *Tikta, Madhura and Kashaya rasa, Laghu snigdha Guna, Sita virya and Madhura Vipaka*. *The Madhura rasa, Madhura vipaka* and *Snigdha guna* of the drug substantiates the nutritive potential of the drug which is reflected by its *Vrishya and Balya* action. The Laghu guna could be related to the easy to digest property of the millet. The laghu guna along with its nutritive properties also could also be the substantiating reason for prevalence of its usage in children. The *Tikta, Kashaya* rasa of the drug on the other helps to overcome the aggravated *pitta*. Madhura vipaka ensures various actions like vatapittahara action, sukrala property, easy evacuation of bowels and urine. Overall understanding of the pharmacological properties of Madhulika makes it evident regarding its nutritive potential and suitability to be included as a daily cereal due to its easy availability and easy to digest property.

The substantiating factor for including *Raagi* under the concept of Nutraceuticals is the abundant presence of essential macro and micronutrients like calcium, proteins, carbohydrates, phenolic compounds etc and also to the high levels of calcium and dietary fire in comparison to commonly used paddy. The dietary fibres, tannins, polyphenols are proved to have antioxidant properties.[28][29] It also has been proved that finger millet is also useful and effective in management of various physiological disorders such as diabetes mellitus, hypertension, vascular F*ragil*ity, hypercholesterolemia etc all of which can be included under the group of lifestyle disorders along with it has been mentioned its ability to improve gastrointestinal health.[31][32]

Food source is now considered as one of the inevitable sources for the onset of various infections and malignancy. A recent study with the seed purified extract of finger millet revealed that the grain contains a bifunctional complex of Alpha-amylase-trypsin and trypsin simultaneously. Both of these protease inhibitors are multifunctional proteins that are effective in various biological processes like redness, infection, apoptosis, tumour invasion,

cancer metastasis etc, hence proving its significant role in human health and disease management.[33]

CONCLUSION

In the current era, public health is deteriorating due to various factors like increased microbial infections. Less immune health status, indulgence in unhealthy foods, lifestyle diseases. All these factors make way to various diseases that become chronic over time due to long term indulgence. even though many a times, food is least considered and prioritized to be a mode of approach to overcome such health disorders, various food products including paddy, cereals, pulses that are abundant and readily available has exhibited potential to better the immune status and overall health due to the abundance of nutrients present within them. Foods with both nourishive and medicinal properties is a major weapon that can be utilized for combating various lifestyle and health disorders. These underutilized and underrecognized grasses are a powerhouse of various potent chemical constituents, nutrients and vitamins that could very well serve as the lead towards the development of various novel agents for incurable health disorders in the future, So the present review sheds light on nutritive, medicinal and biosynthetic potential of *Raagi* to be included under the concept of a nutraceutical and day to day food.

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