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Review Article

Nutritional and Biological Importance of the Weed *Echinochloacolona*: A Review

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Abstract: *Echinochloacolona* is a cosmopolitan weed common in gardens, roadsides, disturbed sites, waste areas, wetlands, and pastures. It is capable of invading natural areas, where it is being classified as the prime environmental weeds. It has high fibre contain which is essential for diabetes, cardio vascular-related disorders and for the patient who are suffering from constipation. *E. colona* also can be given to the celiac disease patient as an alternative gluten free diet. It has a low glycemic index and phyto-toxic effects. It shows high antimicrobial, antioxidant and plays a significant role in phyto-remediation. This minor millet which is famous as a predominant weed might act a long with a combination of the preventive medicines for an effective therapeutic strategy against the most common disorders such as diabetes and cardiovascular complications. It can also be used for prevention of starvation in under-developed and developing country.

Keywords: Jungle Rice, *Echinochloacolona*, Weed, Nutritional, Biological

1. Introduction

Echinochloa species are usually described as noxious weeds in several economically important crops around the world. Among them, *Echinochloacolona* is recognised as the world's most dangerous grass weed in many summer crop sand vegetable in more than 60 countries [1]. In the West Indies, It was first published in 1814 in Cuba. By the 1880s, *E. colona* species became a general weed in St CroixIsland, St Thomas, Puerto Rico, Jamaica, and Cuba. It is a type of wild grass originating from tropical Asia. It was used to be classified as a species of *Panicum*. It is the wild fore father of the cultivated cereal crop *Echinochloafrumentacea*, sawamillet [5]. Some taxonomists declared the two taxa as one species, in which case the domesticated forms may also be referred to as *E. colona.*

Domain: Eukaryota
Kingdom: Plantae
Phylum: Spermatophyta
Subphylum: Angiospermae
Class: Monocotyledonae
Order: Cyperales
Family: Poaceae
Genus: Echinochloa
Species: *Echinochloacolona*

Figure 1. *Taxonomic Tree.*

1.1. Vernacular Names

Jungle-rice, barnyard grass, pigeon millet, short millet, millet rice, swamp rice, arrocillo (Spanish), pastodelarroz (Spanish), zacatedeagua (Spanish); cancao (Chinese), wangbai (Chinese), capimarroz (Portuguese), ble`duDekkan (French), bashaft (Arabic), Bangladesh: alighasha; khudeyshayama; shymaghas. India: borur; hama; jangli swank; janguli; sanwa; shama millet; sawa; samo. Srilanka: adipul; gira-tana. Indonesia: jajagoan leutik; padibu rung.

1.2. Description

Jungle rice (*Echinochloacolona*) is a year-long (occasionally perennial) grass, 0.3-1m high. It is green to purple, tufted and shortly stoloniferous. It is a valuable fodder relished by all classes of bovine animals, notably dairy animals and water buffaloes [3].

Structure: a tufted, erect to spreading and semi-prostrate, annual graminoid; up to 16in. (60cm) tall or more.

Roots: Fibrous roots.

Branching: culms are freely branching at the base and lower nodes.

Culms /blades /sheath*:* culms 8-16in. (20-60 cm) or more high, glabrous or nodes pubescent.

Blades 2-4 in. (5-10 cm) or rarely up to 6 in. (15 cm) long, 0.1-0.4 in. 3-9, or more wide, glabrous, margins sparsely scabrous; soft, rather thin, lax; commonly with purple transverse bands or blotching. Sheath open, compressed.

Collar / ligule / auricle: collar smooth and glabrous. No ligule and auricles.

Inflorescence: Inflorescence is a terminal panicle with widely spaced, appressed or spreading branches of spike-like racemes, branches single or occasionally paired at the nodes. These primary branches unbranched, panicle mostly 0.03-0.15 m long, branches 0.01-0.02 (hardly 0.03 m) long; axis and branches glabrousor with some hairs; spikelets subsessile, paired, and densely arranged from branch base along one side of the flattened rach is in 2-4 rows.

Spikelets / glumes / lemma / palea: Spikelets have one terminal perfect floret with a sterile floret below, with two glumes. Spikelets 0.00254 m long, 0.001-0.0015 m wide, ovate to elliptic, awnless but sharp-pointed, weakly hispid-scabrous on the veins; subsessile; disarticulating below the glumes. First glume acute, thick, triangular, 0.001-0.0015 m long, about half as long as spikelet, 3-5 veined; second glume and sterile lemma equal, acute to acuminate, usually hispid-scabrous to glabrate, faintly veined, veins weakly hispid-scabrous; sterile lemma 5-veined. Fertile lemma plano convex, elliptic, smooth and shiny, abruptly sharp-pointed or cuspidate, margins in rolled below over palea with the apex of palea not enclosed. Palea flat, surface texture similar to fertile lemma.

Seeds: caryopsis 0.0018 m long, elliptic, acute [4].

1.3. Habitat

E. colona, a summer weed species, is native to tropical and subtropical Asia. It is now wide spread in the warm regions of Asia, Africa, and Australia, commonly at low altitudes between 30 N and 30 S. It is the most shared and important weed of rice in Latin America, and South and South-East Asian countries including India, Nepal, Philippines, and Pakistan. *E. colona* was first listed in 1924 as a casual neophyte in the flora of the Czech Republic and Sweden. In Egypt, it has been documented as one of the most dominant weed species in summer crops, fallow lands, and orchards. *E. colona* is usually found throughout the west coast and southern states of the USA from Virginia to Missouri, south to Florida and Texas, and South-East California. It is often considered as an annual dominant grass weed of summer crops in Kenya, Japan, and Malaysia and is too ranked among the important weed species in Colombia and SriLanka. In Australia, *E. colona* is considered as the most common grassy weed associated with summer fallows in grain cropping systems. It is widely naturalised in northern, north-western, south-western, south-eastern, and eastern parts including Queensland, New SouthWales, Kimberly, Pilbara, Victoria, Australian Capital Territory, Northern Territory, and Christmas Island [1].

1.4. Distribution and Preferred Climate

Echinochloacolona thrives in the temporarily wet site in environments receiving 15-47 in. (40-120 cm) of precipitation. *Echinochloacolona* requires high soil moisture to enable establishment. It is adapted to full sunlight or partial shady conditions. It can be seen at elevations from sea level to 6562 ft. (0-2000 m). Although, it seemingly has some limitations on how wet a site can be. In some research it can be found that increased flood depth (0-3.2 in. (0-8cm)) decreased both plant numbers and also its biomass, and increased flood duration (2, 4, 7 days out of 7) reduced plant numbers, yet, not its biomass. Jungle rice is a full sunlight species that cannot grow in the shade [3].

1.5. Folk Uses

In India, During Navaratri Samak Chaval (*Echinochloacolona*) is a good replacement for rice eaters. In classical India fast it is restricted to eat rice, and hence it becomes the beneficial and health-giving replacement of rice. It provides the nutrition and energy that rice does [5]. *E. colona* uses as a highly appetising fodder that is relished by animals and is thought to be one of the best for agegrasses. It is found very common in many countries in South-East Asia is to pull off whole plants out of rice fields, where it is considered as a weed. The composed substance is then given as food to ruminants. Farmers in Myanmar appraise *E. colona* to be the best grass for feeding to milking animals. The contents of phosphorus and calcium were sufficient for cattle requirements. During famines, humans eat the seeds. Some forms of this plant are cultivated in tropical Africa and Asia for the grain, which is used for food Sawa (*E. colona*) is grown in India, Nepal and Sikkim. Primitive races of sawa grown in India differ from wild *E. colona* only in the tardy disarticulation of their spikelets at maturity. In Java, young

shoots of barnyard millets are considered as a nutritious vegetable. Also, the seed of *E. colona* is used as a feed for caged birds. In Rajasthan, India, the seeds are boiled in water and used as a replacement for rice. The seeds are also ground into flour, sometimes being mixed with maize or blackgram, and made in to bread or porridge.

Figure 2. *Parts of Echinochloacolona.*

2. Aims and Objective

Now a days people become so health conscious and deeply believe in one phrase Prevention is better than cure, and it should be, because according to WHO, *the number of people with diabetes has risen from 108 million in 1980 to 422 million in 2014*. Not only diabetes but also other degenerative diseases like Cancer and Heart disease are also very common.

This review emphasises the use of *E. colona*, neglected minor millet which has long-term beneficial effects on degenerative diseases and can prevent them. It is also very inexpensive, useful for under-developed and developing countries.

This review also encourages researcher and technologist to enhance utility and commercial value of this grain and also superior varieties of the recipe to meet those demands.

Besides that, it will be a clear documentation about jungle rice which helps to provide first-hand information to the future research workers who are willing to carry out research activities on this rice.

Figure 3. *Barnyard millet–echinochloacolona.*

Table 1. *Nutritive value of jungle rice.*

Serving [1]	100g (uncooked)
Calories	171g
Total fat	1g
Cholesterol	0mg
Sodium	10mg
Potassium	0mg
Total carbohydrates	36g
Dietary fibre	2g
Sugar	0g
Protein	3g
VitaminA[1]	2%
VitaminC[1]	1%
Calcium[1]	5%
Iron[1]	10%

Percent daily values are based on a 2000 calorie diet [1]

3. Review of Literature

3.1. Biological Importance

Gomaa *et. al.* (2012) have shown that the Dichloromethane (CH_2Cl_2) fraction of *E. colona* Methanol (MeOH) extract and the isolated compound tricin have significant phytotoxic effects on the germination and seed ling growth of weeds. So, they might be potentially useful as a bioherbicide for weed control in agriculture which should be investigated further in the field for their practical application [6].

Ajaib *et. al.* (2013) were carried out Antimicrobial and antioxidant activities of plants *Echinochloacolona.* The results revealed that the extracts of plants were active against Gram-positive bacteria, *i.e. Staphylococcus aureus* and *Streptococcus pneumonia* and Gram-negative bacteria, *i.e. Escherichia coli* and *Pseudomonas aeruginosa* as well as the fungal strains *Aspergillus oryzae* and *Aspergillus niger.* The most significant results were obtained from the methanolic and petroleum ether extracts of *E. colona, i.e.* 24±2.64 mm and 23±2.64 mm against *S. aureus*, respectively [5].

The total antioxidant activity was assessed by using five basic approaches, which are, the free radicals cavenging capacity determined by 2,2'-Azino-bis(3-ethyl benzothiazoline)-6-sulphonic acid (ABTS) method; ferric reducing antioxidant power (FRAP) assay, metal chelating assay, total phenolic contents (TPC) and flavonoid contents.

The results showed that the methanolic extracts of *E. colona* plants possessed significant antioxidant activity. The results also indicated that methanolic extract of *E. colona* had total phenol and flavonoid contents, *i.e.* 734.25 and 7774.54 mg/ml [5].

Another study also carried out where antioxidant activities of different fractions made by *E. colona* extract showed reducing power which was found to be increased with increasing concentration. However, these studies proved the higher antioxidant potency of chloroform fraction comparing other [7].

3.2. Nutritional Importance as a Functional Food

An investigation was done to determine the optimum condition for processing of barnyard millets (*E. colona*) and its incorporative effect on invivo glycemic response in normal and type 2 diabetic women. The millets were subjected to cold water soaking, hot water soaking and steaming and the effect of processing was noted. The physical, functional, nutritional, cooking characteristics and invivo glycemic response were determined for developed products. The result indicated that the pre-treatment of and barnyard millet grains had significant influence on dehulling yield and nutritional composition. The millet flour blend incorporation was acceptable at 20% for noodle, 30% for rusk, dosa, and chapati with significant improvement in quality regarding physical, nutritional, cooking and sensory parameters. Since the incorporation of millet flour blend reduces the GI and GL of refined foods significantly, it paves the way for recommending the developed products to diabetic subjects and persons suffering from degenerative diseases as a tasty functional food [11].

Incorporation of barnyard millet flour blend (*E. colona* flour) and soyflour improved the quality of noodle regarding nutrient density, glycemic response, stable gruelloss, and taste [9].

Another study was undertaken on 2014 to increase and formulate the cookies and to determine the optimal level incorporation of Refined Wheat Flour (RWF) and Barnyard Millet Bran (BMB) for the acceptable level of cookies considering with its nutritional and sensory properties as response variables. Results revealed that Response Surface Methodology (RSM) was applied for optimisation to get optimum levels and it was found that desirable values of 118.90 g, 7.39 g, 53.47 g and 2.70 g for carbohydrate, protein, fat and fibre. The colour, crispiness, and flavour of the cookies score 6 while the taste and overall acceptability score 7. Therefore, it was concluded that RSM was used successfully to optimise the level of RWF and BMB for the development of value-added cookies.

3.3. Impact on Resource Utilisation as a Millet

Murugesan *et. al.* (2015) explored the suitability of three millet flours obtain from India to replace wheat flour in one of them. The results presented in this research are useful for the development of bakery products using millets and to design more efficiently the baking process by optimising the process parameters such as cooking time, temperature, and much more. Producing improved millet-based bakery products would result in increased market demand, thus encouraging farmers to cultivat emillets. This encouragement would lead to greater production of millets globally and will have a significant impact on resource utilisation for agricultural production, as millets are highly drought resistant and require minimal care for production, handling, and storage [10].

Echinochloacolona is an important minor millet cultivated in India which remained as food for the people of the lower economic strata and traditional consumers, because of their coarse texture, characteristic flavour, intensely coloured seed coat and cultural attachments. So, home-based food processing activity was selected for evaluation of nutritional and technological opportunities for better utilisation in the market as compared to the product which already exists in the market. The result of the study shows that millet products (made by *E. colona*) have a potential to be widely acceptable and popularised in the national market. Besides their nutritional contribution, small millets also play a strategic role as an instrument of empowerment of women [15].

A review was conducted on 2005 where transgenesis of minor millets improvement was encouraged and gave handy information on millet tissue culture and genetic transformation. *Echinochloacolona,* barnyard millet was one of the highly promising crops for progress and prospects [12].

3.4. Alternative Grain for Celiac Disease Patient

In 2014, research was undertaken to review recent advances in the nutritional quality and potential health benefits of alternative foods tolerated by patients with gluten related pathologies. They discussed the current status of alternative grains with no or low immunogenic content which may be potential tolerated by patients with Celiac Disease. Minor millets only grown in a few small regions of the world, include teff, millet (pearl, prose, finger, foxtail, and Kodo), fonio (white and black), teosinte, jungle rice and Job'stears. Jungle rice (*Echinochloacolona*) is regarded a noxious gluten-free weed in various crops and particularly in rice fields as it mimics rice in its vegetative growth stage. Jungle rice originates from India, but it is now predominant in the tropics and subtropics. It has relatively low crude protein content (dry matter~5%) and high crude fibre content (~35%) [13].

3.5. Effective Phyto-extractor

Phyto remediation is an emerging, eco-friendly, low-cost alternative technology to remove metals from soil. On 2014, a journal published where grass species of *Echinochloacolona* were used for phyto extraction of lead, cadmium, and chromium contaminated soils. The grass species was grown for 60 days in the experimental pots. For every 20 days, samples were collected from each pot for estimation of total accumulation of heavy metals in the plant. The bio-concentration factor (BCF) was also calculated. The experimental results showed that among the other three grass

species *Echinochloacolona* were good accumulators of cadmium and chromium [14].

In 2015 another study was made to confirm the efficiency of *E. colona* on phyto remediation of lead, cadmium, and chromium. Based on the total accumulations and bio-concentration factor values, the *E. colona* grass species has accumulated metals in the following order chromium > cadmium > lead. The *Echinochloacolona* can be used as an effective phyto extractor of metals [15].

Figure 4. *The grass Echinochloacolona.*

Metals like copper, iron, and zinc are considered as essential plant nutrients; however, these can also be transformed in to toxic elements if their concentration exceeds the required limit. *E. colona* extract removed 3% nickel, 2% copper and 2% Iron respectively [16].

3.6. Ethnomedical Properties

E. colona plants have various ethnomedical uses in different parts of Asia. The entire plant or parts of the plant are used for different disorders including wound healing, antidiabetic, anti-ulcer and antiseptic. The research was done where the wound healing activity of various fractions of *E. colona* was studied. Among the different portions, chloroform fraction (1%) was able to decrease wound area by 14.8 mm^2 on the 10^{th} day. Hydroxy proline content and tensile strength increased 85.87% and 83.37% with chloroform fraction treatment. An indication of angiogenic activity of chloroform fraction of *E. colona* was also proved [7].

3.7. Helps in Phytosociology

Phyto sociological study of plant / weed, which give us knowledge of the dynamics and relative importance of species in particular phyto society or across phytosocieties assume enough relevance in the crop-weed eco-system [17].

E. colona is the most noxious weed in upland rice. It is very competitive weed capable of suppressing growth and development of the crop. It contributes to the yield decline and a reduction in grain quality of 42 to 90% [18].

However, a study conducted to assess the phytosociological studies of weed species in a paddy field at Baikunthpur, Koriya district, Chattisgarh, India where results obtained that *E. colona* were the most common weed in 2007, 2008 and 2009. The Importance Value Index (IVI) showed that the most plants within the community were Poaceae and Cyperaceae. Though they are the significant barriers to rice production because of their ability to compete for CO_2, space, moisture, sunlight and nutrients, it has been observed that grain yield in paddy is drastically reduced if it is not removed at an early stage of growth. This observation will help farmers and agriculturists of the study area to identify the weeds and so, assist in planning a suitable strategy for their control as these weeds compete with paddy crop as resources and hence reduce its yield [17].

3.8. Helps in Nanoparticle Research

Nanoparticle research is currently an area of potential application in biomedical, optical and electronic fields. Silver (Ag) was known only as a metal till the recent past, and it is when nano era came in to existence that people started to believe that silver could even be produced at the nano scale range. Silver nano particle (AgNP) reported as various applications as sensors, DNA detection, Catalyst. From a therapeutic point of view bio synthesized AgNPs use as an antifungal agent, photo voltaic, batteries to increase energy.

E. colona helps to synthesised silver nanoparticles by eco-friendly reduction method. The aqueous extract of *E. colona* plant aerial parts was used as reducing and stabilising agent, and the characteristic brown colour indicates the formation of AgNPs in the reaction mixture. Use of *E. colona* extract offers an affordable, environmentally friendly technique for the synthesis of large-scale AgNPs [19].

4. Saves Poor from Starvation

Eight minor millets crops are grown in different regions of Africa, Asia and Eurasia, *Echinochloacolona* is one of them. *E. colona* are invariably increased in the semi-arid and mountainous regions of tropics and subtropics, where monsoon failure and drought are frequent, and soil fertility is poor, and the land terrain is steep. These areas are also hot spots of poverty and frequent starvations in populous countries [20]. Traditional agriculture in these regions has found more dependability on minor millets like *E. colona* because of their extreme hardiness. They survive with rainfall 3 cm or even lower. They offer a more probable harvest from shallow and less fertile soils and insteep slopes of hillocks and mountainous terrains.

Besides that, the nutritional significance of minor millet *E. colona* lies in their richness in micro nutrients like calcium, iron, phosphorous, vitamins, and sulphur containing amino acids. While their starch is comparable to major millets in gelatinization temperature, their carbohydrate has an individual uniqueness, which makes it a health food. It has a

relatively higher proportion of non-starchy polysaccharides and dietary fibre and low glycemic index. It releases sugars very slowly, and its fibre content is reported to exclude the incidence of duodenal ulcer in regular consumers. The soluble fibre content of minor millets varies from around 3.4% to 6.5% in barnyard millet (*Echinochloacolona*). For this excellent property of minor millet, they have been recently designated as 'nutritious millet' by Prof. M. S. Swaminathan. These unique properties of minor millets are shifting the nutritious millets from poorman's grain to the health food of the affluent.

5. Prospects

Various research and reviews of *Echinochloacolona* plant derivatives are at the introductory level which requires further studies to help determine the mechanism of action. Maximum research is done where *E. colona* is shown as problematic weeds in a rice field, but the ethnomedical properties, antimicrobial and antioxidant properties of *E. colona* and the significant impact as a functional food and as gluten-free diet should need further and more research.

6. Conclusion

This review provides an overview of various aspects of *Echinochloacolona* that need to be carried out in developing the suitable clinical therapeutic field. The overviews are as follows:

- Jungle Rice might be potentially useful as a bio herbicide for weed control in agriculture because of its phyto-toxic effects, and it should be investigated further in the field for their practical application.
- The extracts of Jungle rice or *Echinochloacolona* plant is active against Gram-positive bacteria, *i.e*. *Streptococcus pneumoniae* and *Staphylococcus aureus* and Gram-negative bacteria*, i.e*. *Escherichia coli* and *Pseudomonas aeruginosa* as well as the fungal strains *Aspergillus oryzae* and *Aspergillus niger*.
- The extracts of *E. colona* plants possessed significant antioxidant activity. *E. colona* has total phenolic and flavonoid contents, *i.e.* 734.25 and 7774.54 mg/ml.
- Jungle rice or *E. colona* might play a significant role as a functional food. It can reduce GI and GL level of refined foods which will be very helpful for the people suffering from degenerative diseases.
- *E. colona* is an important minor millet which has a significant impact on resource utilisation for agricultural production, as millets are highly drought resistant and require minimal care for production, handling and storage.
- The nutritional and technological opportunities for better usage of jungle rice are widely acceptable and play a strategic role as an empowerment of women.
- Jungle rice considered as a gluten free weed which plays an important role for the patients who are suffering from Celiac Disease as an alternative grain.
- *Echinochloa colona* were used for phyto extraction of lead, cadmium and chromium contaminated soils.
- The wound healing activities and angiogenic activity of *E. colona* can also be a great significant to us.
- *E. colona* also plays a major role in phyto sociology and nano-particle research.

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