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Review Article

OXIDATIVE STRESS, CHRONIC DISEASES AND ANTIOXIDANT POTENTIAL OF SOME RELIGIOUS GRASSES OF POACEAE FAMILY: AN OVERVIEW

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ABSTRACT

Increased level of the generation of free radicals or failure of antioxidant system in the cell leads to a condition of oxidative stress. Oxidative stress plays an important role in causing and pathogenesis of many chronic diseases including various kinds of cancers such as ovarian cancer, cervical cancer, oral cancer, breast cancer, lung cancer, leukemia, prostate cancer etc. other than cancers increased oxidative stress is also found in diabetes, schizophrenia, chronic obstructive diseases (COPD), atherosclerosis, alzheimer's diseases, parkinson's disease, rheumatoid arthritis, periodontal disease and sickle cell anemia. Some religious plants of poaceae family such as (i) *Triticum aestivum* (ii) *Oryza sativa* (iii) *Cynodon dactylon* (iv) *Saccharum spontaneum* (v) *Hordeum vulgare* are found to have good antioxidant activity. So they can be use to prepare a antioxidant medicine for the treatment of oxidative stress in cancer and other chronic diseases which further increase the welfare of the patients and create better results.

Keywords: Free radicals, Oxidative stress, Chronic diseases, Poaceae, *Triticum aestivum*, *Oryza sativa*, *Cynodon dactylon*, *Saccharum spontaneum*, *Hordeum vulgare*.

INTRODUCTION

Oxidative Stress and Its Involvement in Various Chronic Diseases

Oxidative stress results if excessive production of free radicals (ROS) completely defeats the antioxidant defense system or if there is a significant decrease or lack of antioxidant defense.¹ Oxidative stress cause oxidative damage to biomolecules resulting in lipid peroxidation, mutagenesis and carcinogenesis. Reactive oxygen species plays an effective role in the pathogenesis of many diseases including cancer.^{2,3} Studies on cancer patients shows the evidence of oxidative stress in many cancers including ovarian cancer.⁴⁻⁶ Cervical cancer.⁷⁻⁹ Oral cancer,¹⁰⁻¹² Breast

cancer,¹³⁻¹⁵ Lung cancer,^{16,17} Leukemia,¹⁸⁻²⁰ Prostate cancer.²¹ Oxidative stress also plays an important role in the pathogenesis of some chronic diseases including, Diabetes,²²⁻²⁷ Schizophrenia,²⁸⁻³⁹ Chronic obstructive pulmonary disease (COPD),⁴⁰⁻⁴² Atherosclerosis,⁴³⁻⁴⁶ Alzheimer's disease,⁴⁷⁻⁵⁰ Parkinson disease,⁵¹⁻⁵³ Rheumatoid arthritis,⁵⁴⁻⁶¹ Periodontal disease,⁶²⁻⁶⁷ Sickle cell anemia.⁶⁸⁻⁷⁰

Plants as a Source of Antioxidants

The use of plant-based antioxidant compounds in foods and preventive medicine are gaining a great deal of interest because of their potential health benefits.^{71,72} It is well acknowledged that plants

are the richest source of antioxidants. Among plants, cereals and legumes are prominent because they contain a wide array of phenolics.⁷³ Phenolic acids occurring in the grain of cereals, primarily, in bound form as conjugates with sugars, fatty acids, or proteins act as effective natural antioxidants.^{73,74} Plant phenolics have multiple biological functions such as antioxidant, anti-inflammatory, anti-cancer and anti-microbial activities.⁷⁵ Natural antioxidants can play a helpful role in human health.

Antioxidant Activity of Some Religious Plants of Poaceae Family

Triticum aestivum

Wheatgrass (*Triticum aestivum*) belongs to poaceae family. The cereal grasses-wheat grass, barley, and Alfa-Alfa, have been known to enhance health and vitality both in humans and animals. Wheatgrass culms are simple, hollow or pithy, glabrous, and the leaves are approximately 1.2 m tall, flat, narrow, 20-38 cm long and 1.3 cm broad.⁷⁶ Wheatgrass has many chemical constituents such as Vitamin A, B1, 2, 3, 5, 6, 8, and 12, Vitamin C, E and K, Ascorbic acid, Carotene, Sulfur, Sodium, Copper, Calcium, Phosphorus, Iodine, Magnesium, Selenium, Zinc, Boron and Molybdenum, wheatgrass also contains many enzymes including protease, amylase, lipase, superoxide dismutase (SOD) cytochrome oxidase and transhydrogenase, there are also some other particular components present in wheatgrass are amino acids such as aspartic acid, threonine, asparagines, glutamine, proline, glycine, arginine, alanine, valine, methionine, isoleucine, leucine, tyrosine, phenylalanine, lysine, histidine, tryptophan and serine, P4D1 (gluco-protein), muco-polysaccharides, and chlorophyll, bioflavonides like apigenin, quercetin and luteonin, indole compounds, choline and laetrile (amygdalin) which provides an excellent therapeutic potential to it.⁷⁷⁻⁷⁹

Classification of *Triticum aestivum*

Kingdom: Plantae

Division: Magnoliophyta

Class: Liliopsida

Order: Cyperales

Family: poaceae

Genus: *Triticum*

Species: *aestivum*

Synonyms and Religious History

Shoot of *Triticum aestivum* Linn. (Hindi Name-gehun, kanak, Sanskrit name- godhuma) is called as a wheat grass.⁸⁰ Wheat flour is used to prepare chapatis (puri) and also to prepare sweet dish (halwa) for offering to god and worshipping.

Ecology and Cultivation

Triticum is a genus of annual and biennial grasses, yielding different types of wheat, native to south west Asia and the Mediterranean region. *T. aestivum* common or bread wheat is extensively cultivated almost all over the world. Generally, 15-20 species are documented, of which 8 have been reported to occur in India.⁸¹

Antioxidant activity of *Triticum aestivum*

Aqueous and ethanol extracts of wheatgrass inhibit the growth of leukemia cells in a time dependent manner, aqueous extract at 48 hrs has most apoptotic and antiproliferative effect. Also an increase in CAT, SOD, and ADA activities were noticed in the cell lines treated with wheatgrass extracts.⁸² The concentration of vitamin C and E, beta carotene, ferulic acid and vanillic acid present in wheatgrass increases with the germination period of wheatgrass.⁸³ Chlorophyll present in wheatgrass inhibits the metabolic activation of carcinogens,^{84,85} wheatgrass also inhibits the oxidative DNA damage.⁸⁶ Crude ethanolic extract of wheatgrass shows highest free radical scavenging activity and the highest cell killing property on MCF-7 breast cancer cell lines.⁸⁷ The antioxidant activity of Wheatgrass has been measured which are grown under different conditions (1) tap water, (2) tap water with nutrients, (3) soil and tap water, and (4) soil with nutrients, it has been found that the highest FRAP values have been found on day 15 of growth under condition 4 the values were 0.463 and 0.573 mmol of ascorbic acid and trolox equivalents/100g fresh wheatgrass for aqueous and ethanol extracts, respectively and highest ORAC has been found on day 10 with condition 4, the values of aqueous and ethanol extract were

found to be 39.9 and 48.2, respectively.^{88,89} Wheatgrass contains antioxidant enzyme Superoxide dismutase (SOD) which converts dangerous free radical reactive oxygen species (ROS) into less destructive molecule hydrogen peroxides.⁹⁰

Oryza sativa

Oryza sativa, commonly known as Asian rice, is the plant species most commonly referred to in English as rice. *Oryza sativa* is the cereal with the smallest genome, consisting of just 430 Mb across 12 chromosomes. Germinated rice contain numerous nutrients include γ -aminobutyric acid (GABA), dietary fiber, inositols, ferulic acid, phytic acid, tocotrienols, magnesium, potassium, zinc, γ -oryzanol, and prolylendopeptidase inhibitor.⁹¹ Beneficial biological activities of these compounds have been well documented. Regular intake of germinated brown rice has been found good for health such as, it can help to prevent headache, colon cancer, heart disease, and Alzheimer's disease, as well as lower blood pressure and regulate blood sugar level.⁹²

Classification of *Oryza sativa*

Kingdom: Plantae

Division: Angiosperms

Class: Monocots

Order: Poales

Family: poaceae

Genus: *Oryza*

Species: *O. sativa*

Synonyms and religious use

Oryza sativa is also known as Sathi or Dhan. Seeds of *O. sativa* is donated to Brahmans. It is believed that all crops are boon of gods. The rice is used in the cooked form (kheer, bare, puri etc.) and is offered to god in the form of oblation.

Ecology and cultivation

Evidence of wet rice cultivation as early as 2200 BC has been discovered at both Ban Chiang and Ban Prasat in Thailand. By the 19th century, encroaching European expansionism in the area increased rice production in much of Southeast Asia, and Thailand, then known as Siam. *Oryza sativa* contains two major subspecies: the sticky, short grained *japonica* or *sinica* variety, and the

nonsticky, long-grained *indica* variety. *Japonica* varieties are usually cultivated in dry fields, in temperate East Asia, upland areas of Southeast Asia and high elevations in South Asia, while *indica* varieties are mainly lowland rices, grown mostly submerged, throughout tropical Asia.

Antioxidant activity of *Oryza sativa*

Among the sources of phenolic compounds, rice (*Oryza sativa*) is one of the most produced and consumed cereals in the world which plays an important role in the diet-health relation containing distinct phenolic compounds, tocopherols, tocotrienols, and γ -oryzanol mainly associated with the pericarp.⁹³ However, grain polishing reduces the concentration of phenolic compounds in the endosperm, which remain in the bran where they can be bounded to carbohydrates, fatty acids or proteins making the hydrolysis process important to obtain maximum yield of the phenolic acids.^{94,95} The most common rice consumed by humans is white rice, followed by brown rice; though rice genotypes with either red, purple or black bran layer have been cultivated for a long time in Asia.⁹⁶ Colored rice contains more anthocyanin and antioxidant activity than non-colored rice. Also, after germination, rough rice retained higher levels of anthocyanin and antioxidant activity than that of rice prepared from dehulled.⁹⁷ Heat shock slightly increased the activity of Catalase, ascorbate Peroxidase, glutathione reductase DPPH (1,1-diphenyl-2-picrylhydrazyl)-radical scavenging activity and suppressed the increase of glutathione reductase and glutathione peroxidase activity during recovery of rice from chilling.⁹⁸ The methanol extract of the rice biomass obtained at 96 hours of fermentation inactivated 50% of free radical in 15 minutes and reduced the peroxide value in the olive oil by 57% after 30 days of storage. The aqueous extract of the rice biomass obtained at 120 hours was found to be the most efficient inhibitor of the darkening reaction catalyzed by Peroxidase.⁹⁹ The crude methanolic extract from Njavara rice bran contains high polyphenolic compounds with superior antioxidant activity. Njavara extracts

also showed highest reducing power activity, anti-proliferative property in C6 glioma cells.¹⁰⁰

Cynodon dactylon

Cynodon dactylon is a rapid growing perennial grass. The leaves are variable in size, from 2.5-20 cm long, 0.5-1 cm broad, flat or sometimes folded or convolute, tapering towards apex. The flowers are green or brinjal in colour and the fruit grains are tiny grayish in colour.¹⁰¹ According to Ayurvedic pharmacopoeia, the plant is pungent and bitter in nature with characteristics fragrance and has cold potency. According to Unani system of medicine, the plant has sharp hot taste with good odour. The *Cynodon dactylon* contains crude carbohydrates, proteins, minerals constituents, oxides of magnesium, phosphorus, calcium, sodium, potassium, alkaloids, β -sitosterol, flavanoids, glycosides and triterpenoids. Other compounds like carotene, vitamin C, fats, palmitic acid etc. are also reported. Green grass contains (on dry matter basis) 10.47% crude protein, 28.17% fiber and 11.75% of total ash.¹⁰²

Classification of *Cynodon dactylon*

Kingdom: Plantae

Unranked: Angiosperms

Unranked: Commelinids

Order: Poales

Family: poaceae

Genus: *Cynodon*

Species: *C. dactylon*

Synonyms and religious use

Cynodon dactylon belongs to the family Poaceae. It is also known as Durva grass, Bermuda grass, Dog's Tooth grass, Indian Doab, Scutch grass, Bahama grass, Devil's grass, Couch grass, Dhub, Doob and Durba in different parts of the world.¹⁰⁵

Durva is a Sanskrit word that means, which is cut or eaten by the animals. It is the most sacred plant of India next to tulsi. Hindus worship the God Ganesha with the leaves durva religiously.

Ecology and cultivation

Cynodon dactylon is found abundant as weed along the roadsides, in lawns and can readily take possession of any uncultivated area. In winter, the grass becomes dormant and turns brown in

colour. Growth is promoted by full sun and retarded by full shade. It can spread very quickly from the rooted runners, which grow more than 7.5 cm day. Planting is best done in wet weather to ensure quick sprouting. It gives a complete ground cover in 4-8 weeks when sprigged 30-45 cm apart.¹⁰⁴

Antioxidant activity of *Cynodon dactylon*

The enzymatic and non enzymatic antioxidant effects of the protein fraction of *Cynodon dactylon* were determined in Ehrlich's Lymphoma Ascite (ELA) transplanted swiss albino mice, shows an increased level of enzymatic and non enzymatic antioxidants level, confirm the protective action of the plant against the free radical damage caused by ELA tumor cells.¹⁰⁵

The activity of enzymatic antioxidants (U/ mg of protein) such as Catalase (CAT), Superoxide dismutase (SOD) and Glutathione peroxidase (GPX) were found to be significantly high in mice treated with ethyl acetate fraction of *C.dactylon* when compared to the control mice.¹⁰⁶

Auddy et al., found that the ethanolic extracts of the *S. cordifolia*, *E. alsinoides*, *C. dactylon* plants showed antioxidant activity in *S. cordifolia* > *E. alsinoides* > *C. dactylon* order. Water extracts of these three plants shows the antioxidant activity order as *E. alsinoides* > *C. dactylon* > *S. cordifolia*, indicating the differential solubility of active principles.¹⁰⁹

Saccharum spontaneum

Saccharum spontaneum belongs Poaceae family locally known as Kasa is a tall erect reed-like perennial grass. It is distribute throughout India¹⁰⁸ and tropical Asia.¹⁰⁹ Leaves and stalks contain lignin, carbohydrates, proteins and amino acids.¹¹⁰ Roots and root-stocks contain starch and polyphenolic compounds. Aerial parts possess laxative and aphrodisiac properties, and are useful in burning sensations, strangury, phthisis, vesical calculi, blood diseases, biliousness and haemorrhagic diathesis.¹¹¹ The stems are useful in vitiated conditions of pitta and vata burning sensation strongly and dyspepsia, haemorrhoids, menorrhagia dysentery, agalactia phthisis and general debility.¹¹²

Classification of *Saccharum spontaneum*

Kingdom: Plantae
Unranked: Angiosperms
Unranked: Monocots
Unranked: Commelinids
Order: Poales
Family: Poaceae
Genus: *Saccharum*
Species: *S. spontaneum*

Synonyms and religious use

Saccharum spontaneum is also known as Kush, Kans grass. Kush is considered synonymous to a Brahmin and it is used only during Jneu and Shradha ceremony.¹¹³ Image of Lord Brahma is made from leaves of Kush.¹¹⁴ Kush is worshipped from the time of Lav & Kush, the children of Lord Ramchandra and Goddess Sita.

Ecology and Cultivation

Kans grass (*Saccharum spontaneum*) is a grass native to South Asia. In the Terai-Duar savanna and grasslands, a lowland ecoregion at the base of the Himalaya range in Nepal, India, Bangladesh and Bhutan, kans grass quickly colonises exposed silt plains created each year by the retreating monsoon floods, forming almost pure stands on the lowest portions of the floodplain. Kans grasslands are an important habitat for the Indian rhinoceros (*Rhinoceros unicornis*).

Antioxidant activity of *Saccharum spontaneum*

S.spontaneum root extract was found to have effective free radical scavenging and antioxidant activity might be due to the presence of various phytoconstituents such as alkaloids, flavonoids, tannins, steroids, terpenoids, glycosides and phenolic constituents and it can be a potential source of natural antioxidant that could have great importance as therapeutic agents in disease prevention.^{115,116}

Hordeum vulgare

Hordeum vulgare (Barley) a member of the grass family Poaceae is one of the main cereal crops grown around the world.¹¹⁷ Barley grains have been used for several food purposes as whole grains or in the form of value-added products. Barley grains are commonly made into malt in a traditional and ancient method of preparation. In a

2007 ranking of cereal crops in the world, barley was fourth both in terms of quantity produced (136 million tons) and in area of cultivation (566,000 km²).

Classification of *Hordeum vulgare*

Kingdom: Plantae
Unranked: Angiosperms
Unranked: Monocots
Unranked: Commelinids
Order: Poales
Family: Poaceae
Subfamily: Pooideae
Tribe: Triticeae
Genus: *Hordeum*
Species: *H. vulgare*

Synonyms and religious use

Hordeum vulgare is also known as Jaw or Jav. Jaw assumed always pure. In modern time people generally do not use it for eating but save it for Havan, worship and other social customs. Kumar et al. (2007) mentioned barley emerging aroma is believed to be appreciated by the gods.¹¹³

Ecology and cultivation

Barley is a widely adaptable crop. It is currently popular in temperate areas where it is grown as a summer crop and tropical areas where it is sown as a winter crop. Its germination time is one to three days. Barley is more tolerant of soil salinity than wheat, which might explain the increase of barley cultivation in Mesopotamia from the second millennium BC onwards. Barley is not as cold tolerant as the winter wheat. Barley has a short growing season and is also relatively drought tolerant.

Antioxidant activity of *Hordeum vulgare*

Hordeum vulgare contain a wide range of phytochemicals, primarily phenolic compounds including flavonols, phenolic acids, and procyanidins. Some studies have been reported which shows the antioxidant activity and phenolic contents of barley.¹¹⁸⁻¹²⁰ Madhujith et al. (2004) reported ferulic, caffeic and vanillic- acids as the major phenolic components in barley seeds.¹²² A study on antioxidant activity of *Hordeum vulgare* found that the 80% methanol extract of barely seeds demonstrated better antioxidant

action than the 100% methanol extract. The antioxidant activity of barley seed extract was also found to be considerably varied among the varieties tested, the antioxidant extracts from barely seeds might be used to protect vegetable oils from oxidation.¹²² The increased deposition of stone forming constituents in the kidneys of calculogenic rats were significantly lowered by curative and preventive treatment with ethanolic extract of *Hordeum vulgare* seeds (EHV), also the treatment with EHV produced significant decrease in lipid peroxidation, and increased levels of superoxide dismutase and Catalase activity which suggest that ethanolic extract of *Hordeum vulgare* seeds has an antiurolithiatic and antioxidant agent.¹²³

SUMMARY

The imbalance between the production of free radicals and antioxidant defense system of the cell leads to oxidative stress. Oxidative stress is found to be involved in many chronic diseases including cancer. Some religious grasses of poaceae family such *Triticum aestivum*, *Oryza sativa*, *Cynodon dactylon*, *Saccharum spontaneum*, *Hordeum vulgare* as were found to have good antioxidant property, so they can be used to prepare herbal drugs to treat the condition of oxidative stress in many chronic disease.

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