

Application of different kinds of Rice Products w. r. t. their characteristics, efficacy and effectiveness toward health: a systematic review.

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ABSTRACT

Rice (*Oryza sativa*) is one of the oldest cereal grains in the world. It contains carbohydrates, which provide energy to the body. Fermented beverages from cereals especially rice are very popular across the Asian countries namely India, China, Japan, Korea, Philippines and Vietnam. Raw rice and parboiled rice are mostly used for the preparation of several processed rice products. Different types of rice varieties such as white rice, black rice, brown rice, basmati rice, jasmine rice, wild rice and golden rice and their differences on the basis of their nutritional content, cholesterol level, fats, vitamins and minerals content etc. Every rice variety have its own benefits of consumption and many nutritional properties such as white rice is rich in carbohydrates, brown rice is high on fibre and low in calories, black rice is rich in anthocyanin, basmati rice is rich in aroma content, jasmine rice is rich in quality and aroma, wild rice is high in antioxidant properties and golden rice is rich in vitamin A. Cereal grains are considered to be one of the most important sources of dietary proteins, carbohydrates, vitamins, minerals and fibre for people all over the world. However the nutritional quality of cereals and the sensorial properties of their products are sometimes inferior or poor in comparison with milk and milk products. The fermented rice water which contains many antioxidants when compared to the plain rice water. Inositol is the major constituent which helps in decreasing hair fall. Washed rice water (WRW) is the leftover water after washing rice grains and is usually discarded. The WRW contains leached nutrients (from washing the rice prior to cooking). The paper reviewed the current understanding of the potential use of different kinds of rice products i.e. before cook and after cook as a nutrient source. This paper aims to describe the preparation of raw materials, traditional processing, composition, and

ethno-medicinal importance of each food to encourage entrepreneurs to develop large-scale production to meet the growing market demand of functional foods.

Keywords: *Oryza sativa*, Washed rice water, fermentation, fibre, nutritional properties

I. INTRODUCTION

Rice (*Oryza sativa*) is a fundamental food for almost half of the world's population, supplying nearly all the daily calories especially in Asia. Rice covers about 69% of the cultivated area and is the major crop, covering about 63% of the total area under food grains. It is the staple food of almost the entire population of Odisha; therefore, the state economy is directly linked with improvements in production and productivity of rice in the state. In the 1950s Odisha was a leading rice-producing state in the country and it used to supply a sizable amount of rice grain to the central pool of food stocks. Popular High yielding varieties i.e. Pooja, Mahalaxmi, Khandagiri, MTU-1001, Swarna, Lalat, Naveen.^[1]

In India, due to growing urbanization of our society the demand for fast and convenience foods has increased. Rice is processed and reprocessed into numerous kinds of such foods. Process of rice depends on grain type and textural qualities for use in various kinds of prepared and convenient type rice products such as breakfast rice cereals" quick cooking rice, baby foods etc. Rice-based products that have been popular in India for a long time include rice flakes (poha avalakki, popped, puffed or expanded rice, which are processed from rice or paddy; dosa, papads, vermicelli, crispies, muruku, etc.^[2]

About 85 percent of the rough rice produced in the country is converted into rice. A fraction of rough rice (10%) is used for making rice

products (puffed rice and flaked rice) and about 5 percent of production is used as seed for the next crop.^[3]

Fermented rice water has been treasured as a traditional remedy for promoting beauty and enhancing health. With a history dating back centuries, this natural elixir is particularly popular in East Asian countries. Although scientific research on its specific benefits is limited, fermented rice water is believed to possess several advantages due to its nutrient content and the fermentation process it undergoes. Fermented rice water, a simple yet potent elixir, has become a staple in natural beauty routines, revolutionizing the way to approach hair and skincare.^[4]

Washed rice water (WRW) refers to the water used in washing rice before the rice is cooked. Milled rice is washed prior to cooking to remove the bran, dust, and dirt from the rice. Rice washing can remove a significant amount of water-soluble nutrients from the rice. Several studies shown that rice washing can lose up to 7% protein, 65% crude fat, 30% crude fiber, 59% thiamine, 26% riboflavin, 60% niacin, 26% Ca, 47% P, 47% Fe, 11% Zn, 70% Mg, and 41% K via leaching from the rice.^[5]

Rice water retained after soaking or boiling rice is commonly consumed but, in general, rice water is discarded in many food preparation procedures worldwide.^[6]

Rice water has been continuously produced as a waste product in cooking rice. Before the rice is served on the table, it undergoes several rinsing processes to remove dirt and debris. Most importantly, remove the surface starch that causes the rice to clump together or get gummy as it cooks. After cleansing the rice, the starchy water is rice water. Rice water is rich in amino acids, vitamins (A, B, C, & E), anti-oxidants, flavonoids, and phenolic compounds. It is also commonly used in skincare and hair products because it contains ferulic acid, an antioxidant, and allantoin, with anti-inflammatory properties. Moreover, rice water is used as a fertilizer and for pests and insect control like fruit flies, plant lice, flea beetles, and other pests that can be reduced.^[7]

Aside from these vitamins and minerals, rice water contains starch, giving its opaque, white color. These starches are beneficial to plants as they encourage healthy bacteria and fungi such as mycorrhizae to grow in the roots. The vitamins and minerals from the rice add small amounts of NPK (nitrogen, potassium, and phosphorus) into the soil, which are also quite beneficial to plants (Dr. Kris, 2019). It also possesses Antioxidant, anti-colitis,

anticancer, antitumor, anti-mutagenic, antidiabetic, ocular impairment, anti-aging, and anti-inflammatory. Rice water also has vitamin B, C, E and minerals which promotes skin cell growth & stimulates blood flow.^[8]

Rice water that has been fermenting for 4 days, it is likely that it will have a strong smell and be slightly sour. This is because the fermentation process will have produced lactic acid, which is a natural preservative. However, the rice water may also be cloudy and have a slightly slimy texture. Rice beer is believed to be Mother Nature's elixir because it is enriched with probiotics. It is a rich source of nutrients which makes it a natural antioxidant. Rice beer is known for its wide array of medicinal properties as well as health benefits. It is the perfect antidote to boost strength, remove fatigue, relieve pain, prevent gastronomical disorders, treat infections and more. In tribal communities, babies are fed a few drops of the traditionally brewed rice beer post-birth.

The main aim of this study was thus to develop a semi-solid dosage form incorporating rice water and to test such formulation on human skin to evaluate its biological and sensory effects. To carry out this proposal, rice water was prepared, physico-chemically characterized and tested in vitro for antioxidant activity and anti-aging effects. In this study paddy rice, with peel, was used to produce the rice water, in order to maintain all the rice components. The rice water presenting the best antioxidant activity was incorporated in a hydrogel formulation with very few ingredients in order to incorporate almost 96% of the rice water in the composition. After the characterization of the hydrogel, biological and sensory effects and the safety of the formulation were evaluated in vivo, in human volunteers.

II. DESCRIPTION

Rice is life for millions of people in the globe. It is deeply embedded in the cultural heritage of the society. In many developing countries rice cultivation is a primary source of livelihood. In countries like Asia and Africa hundred millions of families are reliant on rice cultivation only. Rice (*Oryza L.*) contains many sources of nutrients and essential components of functional foods, such as fiber, starch, minerals, and antioxidants. Rice is rich in carbohydrate, has a moderate amount of protein and fat, and is high in vitamin B complex vitamins like thiamin, riboflavin, and niacin.^[9] Dietary fibers, such as polysaccharides, oligosaccharides, pectin

substances, starch, gums, lignin, and many other related substances, have many health benefits for the body.^[10] Starch, made up of amylose and amylopectin, is the major carbohydrate in rice. The rice grain is made up of 12 % water, 75–80 % carbohydrate, and just 7% protein containing all of the essential amino acids. It has high biological value (74%) and protein efficiency ratio (2.02–2.04%) due to the presence of a greater lysine concentration (about 4%). Calcium, magnesium, and phosphorus, as well as traces of iron, copper, zinc, and manganese, are present. Rice is considered as the queen of cereals due to its nutritious value and ease of digestion. Starch, glucose, sucrose, and dextrin make up around 80% of the carbohydrate in freshly harvested rice grains.

Rice By-Products

Different kinds of rice by products those are prepared and available in the market the items. Rice used in Beverage Making, Rice Paper, Rice Glue, Rice Cakes (mochi) etc.

Pharmacological studies

Antioxidant potential

Rice is the world's leading cereal crop and is consumed by more than half of the world's population. The bran layer that covers the rice grains is packed with nutrients and phytochemicals, including tocopherols, tocotrienols, γ -oryzanol, B vitamins, and phenolic compounds. These substances are believed to play an important role in protecting against various degenerative diseases (Pramai and Jiamyangyuen, 2016). It has been commonly reported that anthocyanins play an essential function in reducing the risk of oxidative damage and are potential drug candidates for treating cancer and cardiovascular diseases. The study found that cyanidin-3-O-glucoside (Cy-3-G) has a strong antioxidant activity and can reduce the levels of free radicals, which is beneficial for the health of the cells.^[11]

Neuroprotective potential

The researchers observed The riceberry is given once a day, with doses including 180, 360, and 720 mg/kg body weight (BW) for 2 weeks showed that rice berries could significantly prevent memory impairment and hippocampal neurodegeneration in the hippocampus. In addition, riceberry could also reduce hippocampal acetylcholinesterase activity and the formation of lipid peroxidation products.^[12]

Hepatoprotective potential

The liver is an important part of the body's detoxification process, as it helps to eliminate a wide range of drugs and substances that can cause damage. Exposure to harmful chemicals and toxins can cause the liver to function less effectively. Anthocyanins with antioxidant activity are believed to be beneficial to liver health, and several studies have reported hepatoprotective effects of anthocyanin extracts from foods and plants.^[13]

Antiultraviolet potential

The black sticky rice extract (*Oryza sativa* var. *glutinosa*) showed that increasing the extract's concentration will increase the sun protection factor (SPF) value. Black glutinous rice contains anthocyanins. Anthocyanins are derivatives of flavonoids through the phenylpropanoid pathway, which are derived from malonyl-CoA and p-coumaroyl-CoA precursors. Flavonoids have a protective effect from ultraviolet radiation due to their ability to transfer electrons to free radicals, activate antioxidant enzymes, and inhibit oxidation.^[14]

Antiproliferative potential

This revealed that the levels of flavonoid and phenolic compounds were significantly higher than those of ferulic acid and coumaric acid. The highest antioxidant activity was observed in black rice bran, brown rice bran extract, and brown rice. Black rice bran extract showed antiproliferative activity.^[15]

Gastroprotective potential

The effectiveness of 800 mg/kg black rice bran was almost comparable to that of omeprazole at 10 mg/kg, with rates of 78.9% and 85.2% for ulcer inhibition. Black rice bran cannot normalize the quantity of stomach mucus walls, downgrade gastric volume and total acidity, or increase gastric pH. However, it can enhance the nitric oxide levels in gastric tissue, with tissue MDA levels being normalized with DPPH radical scavenging activity. These results confirm the gastroprotective activity of black rice bran, with a potential mechanism of action through antioxidant activity.^[16]

Antiobesity potential

Rice bran has antioxidant and cardio protective properties, which may help to improve things like blood pressure, hepatic steatosis, and inflammation. It is also possible that rice bran extract can help to organize adipose tissue growth and obesity. In addition to body weight, adipose

tissue mass, and vessel density, realtime polymerase chain reaction was used to observe the mRNA expression of angiogenic variables such as matrix metalloproteinases.^[17]

Antimicrobial potential

The antimicrobial effect of rice bran has only been studied in a medical setting. According to the most recent estimates, at least 15 bioactive compounds in rice bran may contribute to its antimicrobial ability, which has been tested on a variety of bacteria. For example, rice bran extract inhibited *Salmonella typhimurium* entry and replication in mouse small intestinal epithelial cells in vitro. Furthermore, rice bran and its extracts inhibited *Clostridium* spp., *Salmonella enterica*, *Vibrio cholerae*, *Shigella* spp., and *Escherichia coli* replication and/or colonization. The results of this study revealed that the antimicrobial activity in these two extracts did not differ between gram-negative and gram-positive microorganisms (*E.coli* and *L.innocua* respectively), with a remarkable activity in the extract with a high γ -oryzanol concentration.^[18]

Antidiabetic potential

According to in vivo studies in mice, the antioxidant properties of γ -oryzanol are also mediated by the activation of antioxidant enzymes such as superoxide dismutase, catalase, and glutathione peroxidase. Rice components, particularly macronutrients (starch, proteins) and bran compounds (γ -oryzanol, phytic acid, ferulic acid, γ -aminobutyric acid, tocopherols, and tocotrienols), have been identified as being potentially beneficial for diabetes prevention and control. The protective effects of rice bran constituents are mostly related to the reduction of the food glycemic index, which is partly due to the inhibition of α -amylase and α -glucosidase (vitamin E is an exception), with implications for blood glucose reduction. Ferulic acid has bioactive effects on several pathological processes of diabetes, including the potential inhibition of protein aggregation and amyloidogenesis.^[19]

Rice water is also commonly used in skincare and hair products because it contains

ferulic acid, an antioxidant, and allantoin which contains anti-inflammatory properties. A study conducted by Binic, et. al (2013) showed that rice wine, a fermented rice water, helps improve skin damage from the sun. It increases the collagen in the skin, which keeps your skin supple and helps prevent it from wrinkling. Their study concluded that rice water contains natural sunscreen properties which protects the skin from the harmful ultraviolet light emitted by the sun.^[20]

A study was conducted by Marto, et. al. in 2018, as per the study it has been observed that rice water contains anti-aging properties which can be incorporated into cosmetic formulations. The gel formulation with rice water as its major component was found to be compatible with human skin and showed suitable cosmetic properties. Thus, it was concluded that rice water should be considered as an anti-aging ingredient that can be used as a raw material for products. A research study conducted by De Paepe, et al. (2002) showed that the rice starch present in rice and rice water helps dermatitis patients heal their damaged skins by using the rice starch as a bathing additive. The application of the rice-starch containing bath solution on patients with atopic dermatitis resulted in positive improvements on the patient's skin. Their study had concluded that the usage of rice starch formulated in a bath product, produces a potential skin repairing bath additive for barrier damaged skin. Further in different studies it was found that the rice water is used in plant growth because of the nutrient contents. Specifically it is used in tomato plants (plant height, fruit weight, and the number of fruits beared)

Fermented rice water is a rice water that is left to ferment and has gone slightly sour. It is rich in antioxidants, minerals, B vitamin, E vitamin, and traces of Pitera, a chemical produced by *Saccharomyces fibuligera* yeast during the fermentation process. It contains phenolic and flavonoids which can help to reduce free radical damage caused by environment.

Minerals and vitamins content in different Rice Products:-

Raw Milled Rice (Values per 100 gm's)

Food Value	Minerals and Vitamins
Moisture - 13.7%	Calcium - 10 mg
Protein – 6.8%	Phosphorus - 160 mg
Fat – 0.5%	Iron - 3.1mg
Fibre - 0.2%	Small amount of Vitamin E
Minerals - 0.6%	Small amount of Vitamin B Complex
Carbohydrates - 78.2%	Calorific Value - 345

Raw Hand pounded Rice (Values per 100 gm's)

Food Value	Minerals and Vitamins
Moisture - 13.3%	Calcium - 10 mg
Protein - 7.5%	Phosphorus - 190 mg
Fat - 1.0%	Iron - 3.2 mg
Fibre - 0.6%	Small amount of Vitamin E
Minerals - 0.9%	Small amount of Vitamin B Complex
Carbohydrates - 76.7%	Calorific Value - 346

Fermented rice water (Values per 100 gm's)

Food Value	Minerals and Vitamins
Protein – 0.374%	Calcium – 9.23 mg
Amino Acid – 0.423%	Sodium – 17.18 mg
Carbohydrates – 0.461%	Selenium – 0.3 mg
Mineral content of fermented rice water	
Iron-3.53	Iron-3.57
Phosphorus-1.41	Phosphorus-4.9
Niacin-	Niacin-
Folic Acid-	Folic Acid-

III. DISCUSSION

This review uses a comparative method, collecting various sources from research journals. This journal review was carried out using the PubMed, Scopus, and Science Direct databases. Exclusion criteria were: journals outside the last 10 years, journals that were not original research, and review or open review journals. Articles were retrieved using the search terms “Oryza L” OR “Rice” AND “pharmacological activities. The main components of rice are polyphenolic compounds, flavonoids, and anthocyanins^[21] which have poor physicochemical stability in the digestive tract.^[22] Flavonoids are included in the category of active compounds that have low solubility and bioavailability properties and low intestinal permeability; most flavonoids are included in the Biopharmaceutics Classification System (BCS) IV category. The gastrointestinal tract degrade phenolics, and flavonoids are unstable in intestinal pH, which adversely affects their solubility,

absorption, dissolution, bioavailability, and efficacy.^[22]

WRW reuse should be encouraged, as it is linked to better governance of water [6], especially when freshwater demand is projected to increase by 55% by 2050 [7] owing to population growth and climate change [8,9]. However, most research on WRW reuse has focused on its potential applications in human or animal health and cosmetics, such as skin and hair care, and very little on agricultural use.^[23]

The fermented rice also possesses “probiotics” activity. The lactic acid bacteria present in fermented rice breakdown the anti-nutritional factors in the rice resulting in an improved bioavailability of micro-nutrients and minerals such as iron, potassium and calcium. These activities are enhanced by the phenolic compounds which are p-hydroxybenzoic acid derivative and syringic acids and

hydroxycinnamates derivatives present in fermented rice. [24]

IV. CONCLUSION

Health benefits of rice include providing fast and instant energy, good bowel movement, stabilizing blood sugar levels and providing essential source of vitamin B1 to human body. Other benefits include skin care, resistance to high blood pressure, dysentery and heart diseases. The global rice consumption by 2022 is 510 million tons. Assuming 1 kg of rice is washed with 1 L of water, approximately 510 billion L of WRW would be generated and which would typically be discarded into the environment. Reusing this nutrient-enhanced WRW to improve soil fertility and plant growth would thus be beneficial. WRW reuse should be encouraged, as it is linked to better governance of water, especially when freshwater demand is projected to increase by 55% by 2050. Global interest in cereal-based fermented products is increasing due to low fat cholesterol high minerals dietary fibers and phytochemicals content. Beyond the basic nutrients, cereal based fermented food confers several health promoting attributes as it contains edible beneficial microbes, also called probiotics; fermentable sugars (of microbial and food origin, i.e. prebiotics), and digestive aids such as a group of microbe-derived hydrolytic enzymes, etc.

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