

A Staple Food-Chemistry and Nutrition

Dr. Rajeev Ramachandra Kolgi^{1*}

Department of Chemistry and Biochemistry, Government Science College Bengaluru-01, Karnataka, India
Corresponding author Email id: [rajeevkolgi\[at\]gmail.com](mailto:rajeevkolgi[at]gmail.com)

Abstract: *The human diet is comprised of diverse components which include both nutrients, supplying the raw materials that drive multiple metabolic processes in every cell of the body, and non-nutrients. The present discussion outlines the chemistry and nutritional quality of foods like rice, other cereals, coarse grains and role of diet in controlling disorders.*

Keywords: nutrients, rice, coarse grains

1. Introduction

Over the last several decades, many jurisdictions around the world have witnessed the increasing prevalence of acquired metabolic syndromes, in particular obesity, diabetes, fatty liver disease and cardiovascular diseases [1-4]. In recent years, the upward trend is especially striking in developing countries where changes in diets and lifestyle accompany modernization [1, 5]. To counter the increasing public health complications caused by changing nutrition practices, health organizations have provided dietary recommendations [6]. Whereas past interventions designed to address cases of single nutrient deficiencies have achieved clear indicators of success [7].

Cereals

Rice

Rice is the seed of the grass species *Oryza sativa*. There are strong regional preferences for size, shape, flavour and cooking texture.

Milling and polishing

Paddy has coarse outer brown husk which makes up about a quarter of its weight below this is rice bran which is light brown layer.

Paddy milling is designed to remove the husk and the bran layers, and produce an edible, white rice kernel that is sufficiently milled and in so doing some or all the bran and also the germ comes off. Such extensive polishing gives white rice which is in consumer demand. However many nutrients like vitamins and proteins are present in the bran and germ will be lost.

Parboiling of paddy a technique for getting rice from paddy is done in three steps, Soaking, Steaming and Drying. Soaking means paddy is penetrates in to water. In heating the energy weakens the granules structure and more surfaces become available for water absorption. Parboiled paddy may be dried by traditional and modern methods. In to the traditional method sun light is used with hot air. This is the longer dried method but gives very good milling qualities. While the modern dried methods to take the minimum time for drying. Parboiling is a well-developed pre-milling treatment to achieve the maximum recovery of total head rice in rice milling and to minimize the breakage. Parboiling treatment was first developed in some Asian countries for

the purpose of reduce the milling losses. The main objective the parboiling to increase the total and head rice yield of paddy, to prevents the loss of nutrients during milling. Parboiling of paddy is effected the nutritional quality of rice and cooking qualities of rice. Parboiled rice takes longer cooking time for required softness. Parboiled rice needs the double time than row rice to attain same level of softness in cooking. The parboiled rice contains less starch and more oil than row rice bran [9, 10]. About half of the rice grown in India is parboiled and today parboiling has been both commercialized and improved. Slow operated method which takes several days to get parboiled rice may acquire a bad smell as a result of fermentation by microorganisms and poisonous mycotoxins may be elaborated. New commercial parboiling techniques shorten the process to one of soaking for a few hours in hot water followed by drying when both the development of smell and toxins is obviated, while the desired gelatinization does take place.

Puffed rice and beaten rice

Both paddy and rice are puffed. The product from paddy is called kheel and ground product sattu. A puffing process involves the release or expansion of a gas within a product either to create an internal structure or to expand or rupture an existing structure. Puffing has been used since ancient times to alter the structural characteristics of foods. Puffed or expanded rice has been a popular snack in India for centuries (Murugesan & Bhattacharya, 1986), where moistened grains are puffed by a high-temperature, short-time heat treatment (usually produced using sand heated to about 200°C). White, glistening, plump grains are what the user expects of puffed rice [11, 12].

Beaten rice expected to be thin, papery, friable and as broad in shape and as white in colour as possible. Paddy is soaked in water for 2 or 3 days till soft and the same water is brought to boil for few minutes and cooled. The swollen grains are next placed in a concave iron or earthenware pan over a strong fire till the grains burst, after which they are pounded with a pestle to flatten the grain and remove the husk, which is thereafter winnowed away.

Nutrients in rice and its products

Rice is generally considered a high glycemic index (GI) food, however this depends on varietal, compositional, processing and accompaniment factors. Being a major contributor to the glycemic load in rice eating populations, there is increasing concern that the rising prevalence of

insulin resistance is as a result of the consumption of large amounts of rice.

Rice (*Oryza sativa* L.) is a major dietary component of people in most of the countries. It is highly consumed in Asia and Africa and less in the European Union (Vlachos and Arvanitoyannis, 2008). This staple food provides 700 calories/day-person for about 3 000 million people of the world's population (Vlachos and Arvanitoyannis, 2008). Rice is a rich source of carbohydrate, and it contains a moderate amount of protein and fat, and also a source of vitamin-B complex such as thiamin, riboflavin and niacin (Fresco, 2005). Rice main carbohydrate is starch, which is composed of amylose and amylopectin. The rice grain constitutes 12% water, 75%–80% starch and only 7% protein with a full complement of amino acids. Its protein is highly digestible (93%) with excellent biological value (74%) and protein efficiency ratio (2.02%–2.04%) owing to the presence of higher concentration (about 4%) of lysine (Eggum, 1969, 1973, 1977; Bressani et al, 1971; Juliano, 1993). Minerals like calcium (Ca), magnesium (Mg) and phosphorus (P) are present along with some traces of iron (Fe), copper (Cu), zinc (Zn) and manganese (Mn) (Oko et al, 2012). Rice protein is superior in lysine content to wheat, corn, and sorghum. Milled rice has lower crude fiber content than any other cereal, therefore; it makes rice powder suitable for infant food. For growing children, rice needs to be supplemented by other protein sources (Hegsted, 1969; Juliano, 1985).

Polished rice has lost its bran and also its tiny germ, and since they are rich in protein, fat, ash and fibre naturally these constituents are all lowered. Hand pounded rice which retains a good part of the bran is close in composition to brown rice. Since starch, protein, and water in much the same relative proportions make up 95 to 99 percent of all these forms of rice, their calorific value is almost identical. The difference lies in the vitamins and minerals, since these are largely present in bran and germ which get removed on milling [13].

Both puffed and beaten have undergone fairly drastic treatments so it is not surprising that their level of nutrients especially vitamins and minerals suffer in consequence. About half of the thiamine disappears from both products and riboflavin is all but destroyed, especially in the puffed product. Niacin is fairly well retained as is calcium.

The practice of using excess water for boiling and discarding extra water after cooking leaches away valuable nutrients. This can be easily avoided by using just as much water as the rice will absorb.

Other cereals

Coarse grains refer to cereal grains other than wheat and rice or those used primarily for animal feed or brewing. These grains are warm-season cereals valued for their food, feed and fodder uses in various parts of the world. These are largely grown in the semi-arid tropical regions of Asia and Africa (Rai et al.2008).

Rice and wheat are classified as fine minerals but there are number of coarse cereals or millets that can be raised on poor soils. These have tough, fibrous outer layers and yield rather coarse flours, if suitably processed using new methodologies, the textural properties of these millets can be turned to advantage in food formulations.

Coarse cereals include maize (*Zea mays*), sorghum (Jowar; *Sorghum vulgare*), oats (Jai; *Avena sativa*), barley (Jow; *Hordeum vulgare*), pearl millet (Bajra; *Pennisetum glaucum*) and other minor millets such as Finger millet (Ragi; *Eleusine coracana*), Kodo millet (Arikalu; *Paspalum setaceum*). They are rich in dietary energy, vitamins, several minerals (especially micronutrients such as iron and zinc), insoluble dietary and phytochemicals with antioxidant properties (Bouis 2000). Finger millet is the richest source of calcium (300 to 350 mg/100 g grain). Small millets are a good source of phosphorus and iron. In view of these nutritional properties these coarse cereals have of late been also designated as nutriceals. They are rich in compounds that help against several chronic diseases like ischemic strokes, cardiovascular diseases, cancers, obesity and type II diabetes (Jones et al.2000; Jones 2006). They are nutritionally comparable or even superior to major cereals such as wheat and rice, owing to their higher levels of protein with more balanced amino acid profile (good source of methionine, cystine and lysine).

Coarse cereals also contain condensed tannins, whose primary function is to protect grains from molds and protect them from deterioration (Waniska 2000), though they are also responsible for the astringency of the grain. Besides barley and sorghum, ragi is the only millet which contains tannins (Siwela et al.2007). Tannins decrease digestibility of proteins. Avenanthramides are amides of cinnamoylanthranilic acids and are found exclusively in oats. They have anti-inflammatory, anti-atherogenic and antioxidant properties (Emmons et al.1999; Chen et al.2004). Alkyl resorcinol produced by various plants, bacteria and fungi are bioactive compounds possessing beneficial activities for human health such as anticarcinogenic activity (Kozubek and Tyman 1999; Ross et al.2004).

Coarse cereals constitute important sources of nutrients for the gut microbiota and contribute to a healthy gut microbiome. Furthermore, the gut microbiota converts coarse cereals into functional substances and mediates the interaction between the host and these components play important role in preventing chronic diseases.

For instance, a previous study reported that coarse-cereal fiber had a positive effect on cardiometabolic and obesity-related diseases [14]. Idehen et al. found that barley phytochemicals (phytosterols, flavonoids, phenolic acids, etc.) can exert antioxidant, cholesterol-lowering, and anti-cancer functions to prevent cardiovascular diseases [15]. It has been reported that phytosterols play a crucial role in inhibiting the progression of cancers [16].

Colorectal Cancer

Epidemiological studies have suggested that IBD patients exhibit a higher risk of CRC and that the incidence of cancer is positively correlated with the duration of IBD [17]. A

recent study suggested that coarse cereal diets are beneficial for relieving CRC. Zhang et al. reported that intake of foxtail millet ameliorated AOM/DSS-induced colitis-associated CRC in mice via the activation of AHR and GPCRs and the inhibition of STAT3 phosphorylation by the microbial metabolites of the foxtail millet. In line with a previous study, the abundances of *Bifidobacterium* and *Bacteroidales_S24-7* were increased after millet consumption, compared to the control group [18]. Similarly, Yang et al. studied the effect of sorghum in an HFD-induced CRC mice model. The results showed that sorghum exhibited tremendous anti-CRC effects by suppressing the growth and metastasis of cancerous colon epithelial cells, as well as protecting against gut microbiota alterations linked to colitis [19].

Metabolic Syndrome

Metabolic syndrome is a complex disease with a rapid increase in incidence in recent years, and dietary intervention is an effective approach to ameliorate the metabolic status of patients [20]. Dietary composition can actively change the composition and function of intestinal microflora, so as to improve individual conditions related to metabolic disorders [21]. Barley β -glucans have been demonstrated to exert a hypoglycemic effect and a cholesterol-lowering effect. In an experiment by Velikonja et al., the impact of a dietary supplement of barley β -glucans on metabolic syndrome patients was investigated. After treatment, TC in plasma was decreased compared to the control group. Moreover, the fecal SCFAs were markedly changed, with increased propionic acid, while the acetic acid was decreased in the control group. Furthermore, 16s sequencing results showed that the populations of health-associated *Bifidobacterium spp.* and *Akkermansia muciphila* were increased after barley β -glucans consumption [22].

Neurodegenerative Disorders

Neurodegenerative disorders such as Alzheimer's disease (AD) and dementias are major causes of incidence rates, reduced quality of life and medical costs in elderly people [23]. There is evidence that microbial changes are related to neuroinflammation and cognitive impairment, which are two critical features of AD pathogenesis and progression [24]. Although neurodegenerative diseases are currently incurable, one third of dementia cases can be prevented by addressing lifestyle factors, including diet [23]. As an example, β -glucan prevents cognitive impairment caused by a high-fat and fiber-deficient diet (HFFD), as shown by behavioral appraisal through object positioning, new object recognition and nesting tests. The results showed that β -glucan reversed the cognitive function loss through more optimized synaptic and signaling transduction pathways in crucial brain areas, while intake of β -glucan also improved gut barrier dysfunction and reduced bacterial endotoxin translocation. Moreover, β -glucan alleviated gut microbiota dysbiosis caused by HFFD, especially Bacteroidetes at phylum level and its lower taxa [24]

2. Conclusion

Nutrition science, an ever expanding subject with multi-disciplinary roots is important for the mental, physical and

social well being of all people. Our changing life styles and promotion of variety of ready to eat and fast foods which are commonly available in the market call for an adequate knowledge of the nutritive value of foods and appropriate choices to be made to maintain health. In short, nutrition science is the area of knowledge regarding the role of food in maintenance of health.

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