

## Quality Aspects of Rice (*Oryza sativa* L.) and Rice Products

Vijaya Khader\*

Professor, Former Dean, Acharya N.G. Ranga Agricultural University, Hyderabad, India

\*Corresponding Author: Vijaya Khader, Professor, Former Dean, Acharya N.G. Ranga Agricultural University, Hyderabad, India.

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### Abstract

Rice is a cereal grain, which belongs to the grass species *Oryza sativa* and *Oryza glaberrima*, also known as Asian and Australian rice respectively. The grain comes in more than 40,000 varieties with different shapes, sizes, texture, aroma, and colors. Quality aspects as well as health benefits of various rice products are very important in everyday life and also provide livelihood for rural families by preparing variety of products.

**Keywords:** *Oryza sativa*; Caryopsis; Cereal

### Introduction

The caryopsis (kernel) of rice is harvested with the hull or husk attached. This is called paddy or rough rice. The hull, which constitutes about 20 per cent of the weight of rough rice, is made up of the floral envelopes, the lemma and palea. The hulls are high in cellulose (25%) lignin (30%), pentosans (15%) and ash (21%). The ash is about 95 per cent silica. The high amounts of lignin and silica make the rice hull low value. One of the oldest cereal grains, rice (*Oryza sativa*) is believed to have been grown for at least 5000 years. It is a staple food for more than half of the world's population, particularly those living in southern and eastern Asia. White rice is the most commonly consumed type, but brown (whole grain) rice is becoming increasingly popular in some Western countries due to its health benefits. Various products are made from rice. These include rice flour, rice syrup, rice bran oil, and rice milk. It is usually white in color, but brown rice can come in a variety of shades; brown, reddish, purplish, or black [1,2].

### Quality factors

There are many different types of rice with many different quality i.e. to suit different consumer preferences. Quality factors relate to grain length, stickiness, aroma, texture, and flavor. Nutritional content may also vary between different types of rice. Most countries have set quality standards. Often, these quality standards put more focus on physical characteristics than on the chemical characteristics. Production of good quality milled rice starts at the farm with good quality seeds, and crop care for uniform growth and grain size. The other factors that damage quality such as mixing of varieties, heat discoloration, contamination, insect damage in storage, fissuring during drying, breakage in milling, are controlled in the post-production operations. The same attention, which minimizes physical losses, applies to the production of well milled and

uniformly polished rice. The lack of appropriate technology, technical and management skill causes both poor quality milled rice and economic losses.

### Brown rice

Brown rice (rice after the hull is removed) has the same structure as that of the other cereals. The caryopsis does not have a crease, it varies from 5 to 8 mm in length; and it weighs about 25 mg. Brown rice consists of a pericarp or fruit coat (about 2%), seed coat (testa) and aleurone (about 5%) germ (2-3%) and endosperm (89-94%) As with the other cereals, the aleurone is the outermost layer of the endosperm but is removed with the pericarp and seed coat to make the Bran [3].

In general, the endosperm of rice is both hard and vitreous. However, opaque cultivars are known and some cultivars have opaque areas (called white belly), these are similar to yellow berry in wheat. The opaqueness is caused by air spaces in the endosperm. The thin-walled endosperm cells are tightly packed, with polygonal compound starch granules and protein bodies. The protein bodies are more numerous in the cells just inside the aleurone than in cells near the center of the endosperm. The polygonal starch granules may be formed by compression of the starch granules during grain development. The individual rice starch granules are small, 2 - 4  $\mu\text{m}$  [3]. The vitamin and mineral composition is given in Table 1.

**Milling:** Milling is a series of mechanical operations which remove the hulls, Embryo and outer layers of the kernel. Product fractions from standard milling of rice as follows:

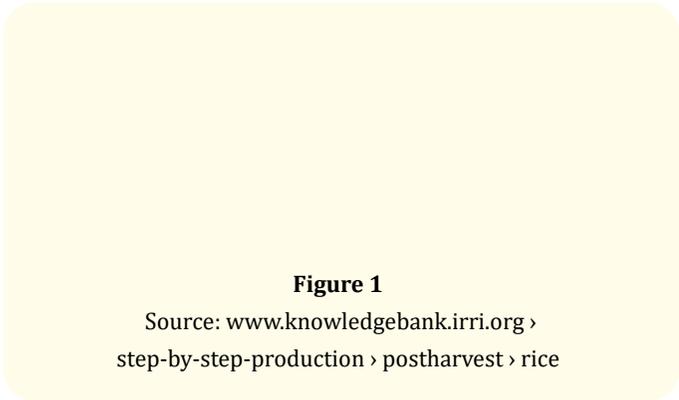
- 100lbs rough rice contains 20lbs hull and 80lbs brown rice.
- 80lbs brown rice contains 70lbs white rice and 10lbs by products.

Vitamins	
Thiamine	0.33
Riboflavin	0.09
Niacin	4.9
Pantothenic Acid	1.2
Pyridoxine	0.79
Minerals	
Phosphorus	2.85
Potassium	340
Calcium	68
Magnesium	90
Iron	-
Copper	0.3
Manganese	6

**Table 1:** Vitamin and mineral composition (mg/100g).

- 70lbs white rice contain 48lbs head rice and 22lbs broken rice
- 22lbs broken rice contains 8lbs second head (large pieces up to ¾ of a kernel), 10lbs Screenings (Medium sized pieces less than 1/3 Kernel) and 4lbs brewers (Smallest kernel fragment screened and is used as fermentation food stock)
- 10lbs by product contains 3lbs polish and 7lbs bran.

(Polished rice may be surface coated with glucose by tumbling to improve its gloss, sheen and uniformity).



**Figure 1**

Source: [www.knowledgebank.irri.org/step-by-step-production/postharvest/rice](http://www.knowledgebank.irri.org/step-by-step-production/postharvest/rice)

**Summary of rice process techniques is given bellow:**

- Harvest dry/store; dehull (brown rice takes 45 min to cook); Mill (white rice takes 15min to cook). Dry cooked rice Minute rice (5 min).
- Harvest dry/store Parboil, dehull (Parboiled brown rice takes 50 min to cook); Parboiled rice mill (Parboiled rice takes 25 min to cook); Partial cooking of parboiled rice and dry to get classic rice product (Takes 10 min to cook); Complete cook parboiled rice and dry takes 5 – 10 min. stand.

**What are the chemical characteristics of grain?**

- Whole and broken grains
- Shape and size of the grain
- Color of grain
- Chalkiness
- Weight
- Damaged and discolored kernels
- Foreign material like dirt, stones,
- moisture content of the grain

**What are the physical characteristics of grain? (Before cooking)**

The chemical characteristics are about how the grain looks after cooking and how it feels when it is eaten

- Gelatinization temperature
- Amylase content
- Gel consistency
- Texture (how it feels when eaten)
- Aroma (how it smells)

**Effect of milling on the nutritive value**

Effect of milling on composition of rice is given in Table 2. Vitamin B1 content in the various fractions on rice is given in Table 3.

	Carbo-hydrate %	Protein %	Fat %	Mineral content %	Fibre %	Vit.:B1 mg/100 g
Brown rice	86	8.7-9.9	2.2-2.4	1.2-2.1	0.6-1.1	0.40
Milled rice	90	6.7-8.7	0.3-0.4	0.4-0.9	0.2-0.4	0.07

**Table 2:** Composition of rice before and after milling.

Note: Rice milled after parboiling has a vitamin B<sub>1</sub> content of 0.15-0.20 -mg/100g.

	Proportion of the grain %	Vitamin B1 content mg/100g
Milled Rice		
Inner endosperm	73	0.03
Outer endosperm	19	0.13
Rice Bran		
Pericarp Aleurone	6.0	0.31
Epi blast	0.3	0.78
Embryo		
Plumule	0.3	0.46
Radicle	0.2	0.64
Scutellum	1.2	1.89

**Table 3:** Vitamin B<sub>1</sub> content of the fractions of the rice grain.

The loss of vitamin B1 in milling can be readily understood from the above table which shows the distribution of the vitamin in the different parts of the rice grain.

### Parboiled or converted rice

Soaking and cooking has been practiced in many places. During parboiling the soluble vitamins diffuse into the endosperm and greatly enhance the nutritive value of the milled rice. Process of parboiling and its effects are given in Table 4.

### Product effects

- Head yields approach total yield (65-70%)
- Increased resistance to cooking/disintegration
- Increase in digestible protein
- Flavor/colour characteristics different from milled rice.

The 'converted' rice produced in the United states is produced from cleaned paddy. Paddy is placed in large chambers and subjected to high vacuum to evacuate air from the kernel tissue. Hot water is directly percolated into the evacuated tank and external pressure is applied to infuse the soluble nutrients of the hull and bran into the endosperm. Following sufficient hot water treatment, the steep water is drained and the rice is subjected to live steam.

### Rice products

Whole rice grain may be pretreated under controlled cooking; cooling, and dry conditions to produce a quick-cooling instant product and requires less than five minutes preparation time.

- **Rice cereals:** Ready-to-eat breakfast cereals are prepared from milled rice as flakes or puffs. Rice is frequently pre cooked under steam pressure, conditioned to uniform kernel moisture and passed through high pressure, smooth flaking rolls, and toasted. Vacuum puffing of grains or flaked rice is common.
- **Rice flakes:** Flaked rice is one of the popular form of processed rice. The process involves soaking paddy, sand roasting and flattening by pressure so as to form flakes. If the pressure after gelatinization of rice is sufficiently intense, very thin flakes could be obtained. It possess nutritional and textural properties of parboiled rice. If further improvements are made by addition of suitable flavours, spices or sweetening agents, rice flakes are bound to become very popular and can compete with corn flakes as a breakfast cereal.
- **Puffed rice:** The grain is put into a strong vessel usually constructed out of steel or bronze to avoid corrosion. This vessel, called a "puffing gun" is heated and may be revolved in order to increase the pressure i-ne-J? eased until the required temperature is reached. This may be as high as 572°F (300°C). At this point the gun is discharged by the operator suddenly releasing the pressure. This causes the steam inside the structure of the grain to expand and blow up the volume of the grain to about ten times its original size. The nutritional quality of processed products prepared from paddy such as flaked rice, puffed rice is almost similar to that of rice [4].

- **Instant hot baby cereals:** Produced by drum drying a slurry of rice flour. Thin sheets of cooked dehydrated cereal are removed by surface scraping rotating steam heated drum. The sheets are ground to yield thin flakes which readily hydrate and form a characteristic, soft, pasty porridge.
- **Quick cooking rice:** One of the reasons why rice has not been particularly popular in Western countries is that it takes from 20 to 30 min to cook. Suitable treatment by the food technologist provided quick cooking rice which can be prepared for the table from 1 to 5 minutes. One successful commercial process involves heating the dry rice for 15 minutes at 93°C (200°F). This causes cracks or fissures in the grain. It is then soaked, cooked in hot water or steam: Washed to stop the cooking process and dried in hot air to a moisture content of 8-14 per cent. It is the initial fissuring that allows the final product to be so quickly cooked.
- **Rice flour fryums:** Rice flour fryums are prepared generally by housewives in many families. Generally they are prepared once in a year in summer and stored for the rest of the period. They are prepared in many shapes and sizes to add variety to food. They are served as snacks or along with meal after frying in oil. They are crisp and crunchy and liked by children [5]. Preparation of rice flour fryums is given below. Five kg of rice flour, Boil 10 kg of water with salt, Add ground chili if desired, Add rice flour and cook till the starch is gelatinized and mouldable dough is formed, Make into different shapes using moulds on to a plastic sheet or cloths, Dry them in sun till completely dry/Remove from the sheet, dry again and pack and Fry in oil before serving
- **Popped rice:** This product is obtained by direct puffing of paddy. Recent studies in this institute have shown that pre-drying paddy to 9 per cent moisture followed by raising the moisture to 14 per cent, resting and puffing gave a much better volume expansion (further by 20%) than when the moisture is directly adjusted to 14% and puffed.
- **Waxy and non waxy rice:** Non waxy rice (containing amylose in addition to amylopectin) has a translucent endosperm, whereas waxy (0 to 2% amylose) rice has an opaque endosperm because of the presence of pores between and with in the starch granules. The waxy rice flour has superior quality for use as a thickening agent for white sauces, gravi-9, puddings and oriental snack foods.

### By products

#### Rice bran

Rice bran on an average contains 15 per cent oil and is a very valuable source of oil to the country. Because of its high fat and protein content rice bran is fed as a concentrate to poultry, cattle and pigs. Rice bran has better nutritional values for sheep and swine than for cattle and chicken. Rice bran is also used as a culture medium for production of mushrooms. About per cent of rice bran is also used as fertilizer in Japan [6].

One hundred kilogram (100 kg) of paddy rice will generate approximately 5–10 kg of bran. Rice bran is a mixture of substances, including protein, fat, ash, and crude fiber. In many cases, bran contains tiny fractions of rice hull, which increases the ash content of bran. Bran composition is largely dependent on the milling process. In modern rice mills, several different kinds of bran are produced: coarse bran (from the first whitening step), fine bran (from second whitening step) and polish (from the polishing step). Polish consists of part of the endosperm and is often referred to as meal.

#### Rice bran oil

The use of rice bran oil is similar to that of other oils. The steps involved in preparation of the oil are given below [7].

- Dewaxing: To remove wax
- Degumming: To remove Phospholipids
- Neutralization or Deacidification: To remove the fatty acids
- Bleaching: To remove colour
- Deodorization: To remove smell
- Winterization: To remove Saturated glycerides.

Rice bran oil is rich in unsaturated fatty acids particularly oleic acid and linoleic acid.

#### Rice polishing

Rice polishing is used in breakfast cereals as a source of dietary fibre, protein and minerals.

#### Rice flour

Rice flour has steady demand for breakfast foods like idly, dosa, baby foods, meat products, dusting powder, bread mixes and for formulations of pancakes and waffles.

Other products can be prepared using rice flour are Idiapam, Akkiroti, Palatalikal, Pootarekulu, Chegodilu, Arisalu, Jentikal, Pappuchekkalu, Undrallu, Vennundalu and Appadalu.

#### Conclusion

Rice is most popular staple consumed throughout the world, thanks to its affordability and ease of access. There are many different types of rice which are produced via different stages of processing or with the addition of extra additives. The health benefits are many include supply of energy, fighting inflammation, supporting nervous system health and a natural diuretic.

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