#### CC 8;Unit 1:Technology of Cereal TECHNOLOGY OF RICE (PART 1) By

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#### Introduction

Rice is a manocotylydon cereal and belongs to the family of grass. Botonical name of rice is *Oryza sativa* L. *Oryza glaberrima* is another species grown to a limited extent in Africa. Globally the paddy production is around 720 Million tones and India produces around 150 MT. ( as on 2014)

*Oryza sativa* is classified into 2 sub species namely *indica* and *japonica* and another species is *javonica*. *Indica* rices are grown all over tropics (south and south east Asia). They are photosensitive. *Indica* rices generally yields low, they are long, thin and narrow, they cook to a non-sticky form, which is liked by Indians, Sri Lankans and Pakistanies. *Japonica* types are grown in subtropical and temperate regions (Japan, Korea, Northern China, Egypt, Italy, Spain). The yield is high, they are photoinsensitve and hence are not season bound. *Javonica or bulu* is an intermediate type. These are adopted to the climate near the equator (Indonesia). Following diagram indicates different parts of rice grain.



Fig. 3 Structure of the rice grain. (From Juliano, 1985.)

Rice may be a single name, but all rices do not look, cook or taste similarly.

There are thousands of varieties of rice. Rice has been grown in the world for centuries. It is being grown in all 5 continents, from sea level to 5000 ft above sea level in dry and wet climate, in cold and hot weather. With such diversity in time, space and climate, it is natural

that rice varieties differ greatly in size, shape, colour, smell,milling, cooking, taste nutritive value, and their ability to make different rice products.

Rice is also processed. It is stored, dried, milled, parboiled or treated in other ways. These further changes the properties of rice. These properties of rice, arising from differences in variety or processing are called the quality of rice. The range of qualities of rice and their effects are discussed below:

### Physico-chemical properties of rice involves

1. Milling quality 2. Nutritional quality 3. Size and Shape 4. Physical properties important in handling and processing of rice 5. Cooking quality 6. Eating quality

7. Effect of degress of polishing or milling and 8. Grading for marketing.

1. Milling quality This means how much milled rice is obtained when a given amount of paddy is shelled and milled. Generally it is considered that one part of paddy will yield about two-third parts of milled rice (66.7 kg of rice from 100 kg of paddy). In reality the outturn varies. Better the actual outturn, better will be the milling quality of the sample.

When miller takes a handful of paddy and rubs it hard in his hand, he is trying to judge its milling quality. Now a days laboratory machines are available which can accurately assess the milling quality of paddy (dehuskers, polishers and broken separators).

# Nutrition quality

Majority of people in world depend on cereals for their main food. Among them rice is mostly consumed to a greater extent by one and all. Number of persons cannot afford much of other foods such as fruits and vegetables, milk and animal foods. As a result rice has to supply not only energy they need but also much of their need of proteins, vitamins and other nutrients. Nutritive value of rice is of great importance for the population of South, East and South east Asia. Fortunately the nutritive value of rice is good. Its protein content is rather low (6-8%) among all cereals grains, but quality of its protein is better than any other cereal grain. So, if a persons eats enough rice and a little of other foods, the protein needs are met fairly well. On a thumb rule, rice varieties with bigger and coloured grains tend to have more protein, but not always.

Type of shelling, milling and cooking play an impt role. Juditiously polishing retains lot of nutrients inside the grain. Another way to increase the nutrients is by parboiling the paddy. During this process, lot of nutrients viz. minerals, vitamins get fixed to the inner kernel, which are not lost even when the grain is highly polished.

Cooking is another way of judging the nutrition quality. If rice is cooked in excess water and the gruel is thrown away, the good vitamins also go down the drain. Rice should be best cooked in exact amount of water that it will absorb. In this condition, all the minerals and vitamins will remain in the rice. A pressure cooker, although a little expensive, is very helpful in this respect.

#### Size and Shape

Rice grains comes in various size and shapes. There are varieties as low as 7mg weight of each grain and a maximum of 30 - 35 mg per grain. The grain length and breadth or width greatly differ from variety to variety. The ratio of length to breadth, which gives an idea of roundness or slenderness of the variety, varies from 1.6 (almost round) to 3.8 (very narrow and slender). Following table gives the clarity.

Property	Paddy	Milled Rice
Length (mm)	6.1 – 10.8	4.0 - 7.7
Breadth (mm)	2.3 - 3.6	1.7 – 2.9
L/B ratio	2.0 - 4.1	1.6 – 3.8
Grain weight (mg)	10 - 38	7 – 28
Density (mg/ml)	1.17 – 1.24	1.44- 1.46
Bulk density (gm/litre)	550-650	770- 850
Bulk volume (litre/kg)	1.54- 1.82	1.18 – 1.30
Angle of repose $(^0)$	34 - 38	37-38
Porosity (empty space in grain mass, %)	45 - 55	41 - 47

Range of some physical properties of paddy and milled rice

Different people like different type of size and shape rice. Some like very long and slender rice like Basmati, while some like very small and round grains, for example ponny or Samba rice of Tamilnadu and Sri Lanka. Sona mahsuri from Karnataka. Japanese like round grains. Most rice varieties in India are rather long (> 6 mm) and rather slender (l/b ratio of 2.4 to 3).

Rice is being classified as coarse, medium and fine on the basis of its l/b ratio alone. When the ratio is <2, the rice are named coarse, if it is >3, the rice is fine and those between 2 and 3, they are named as medium. But this classification has some limits, as it considers only shape but not the size, that is the grain weight.

# **Cooking quality**

Rice is mostly cooked in water. The time required to cook it fully, appearance of the grain after cooking and the quantity of solid substances that goes out into the gruel make up its cooking quality.

The time required to cook the rice is generally 15 to 30 min. This time is generally determined by the size and shape of the variety. The smaller the variety and more the slender the variety the quicker does the variety get cooked. On the other hand, the bigger the variety and the rounder the variety, the more time it needs to be cooked. Cooking is more difficult in hill stations and mountainous regions, because water boils at a lower temperature there. For such places small and slender rice varieties are more suitable.

# **Eating quality**

The main properties that determine the eating quality of a sample of cooked rice are its stickiness and softness (or hardness). – Hardness and stickiness of the cooked rice differs from variety to variety. These properties depend on the properties of starch present in the rice. In milled rice, about 90% is starch. - Amylose in rice starch varies from 0 to 35%, higher amylose makes the grain to cook hard, and separate grains or fluffy. Vice versa is the case with low amylose rice varieties, where the grains are soft and sticky.

Rices of India and of other South Asian countries (Bangladesh, Sri Lanka, Pakistan and Nepal), Malaysia and Thailand prefer to have high amylose rice. Rice of Japan, Korea, China (East Asian countries) prefer to have low amylose rice (15 to 25%) and these rice cook soft and sticky. Rice of Philippines and Indonesia of South-Asia are

intermediate in nature. Another type of rice which is of low amylose or high amylopectin are also named as Waxy rice, which cooks pasty and appears like waxy are named as Waxy rice.

### **Effect of Degree of Milling or Polishing**

- The amount of bran removed from 100g of brown rice, is termed as degree of milling. This terminology varies from place to place. In India, it is 3-8%; where as in America it the DOP goes up to 10-12%. This DOM is also an important criteria for the quality of rice. Protein, Vitamins, minerals, fibre, sugars are located on the layers of grain. Starch is less in outer layers, but increases to the centre.

With progressive milling, the nutrients decreases . With 2-4% DOM, the grains could not be stored . For storage, the DOP of rice plays a role. With milling, the whiteness increases.

# Grading for the marketing

Market quality is expressed in terms of rice grades. Strict grading is practiced in developed countries like USA, Europe and rice exporting countries like Thailand. The important factors in rice grading are moisture content, % of broken grains, red grains, chalky grains, impurities, other seeds etc. Limits of these factors are laid down for specific grades of rice.

# Milling of Rice

The step where the husk removal from the paddy is named as dehusking. The step where the removal of different layers of pericarp, testa, aleurone and part of germ to get edible white rice or milled or polished rice is named as polishing or whiteness.

Initially hand pounding was practiced, in some of the villages this is practiced even today. Generally head rice yield will be less in hand pounding.

**Engelbeerg hullers** : In this mechanized unit, it is designed to remove the husk and bran layers of rice in a single operation. In this bran, pulverized husk, milled rice are combindly obtained along with high breakage. The capacity varies from 100 to 500 to 1000 kg per hour. The average milled rice is 50 to 60 % of the weight of the paddy input.

Scheme of milling. Machinery for milling were of basically 2 types: Schule type and Satake type. Of late Buhler (Swiss) and China type have also appeared in our country. Generally, in our country, we find the capacity of the rice mill will vary from 4 to 6 tonnes per hour or even 120 tonnes per hour which is situated in Punjab. The block diagram for rice milling is



**Different sized brokens:** small brokens, large broken rice , small broken rice

# **Parboiling of rice**

Parboiling of rice is an ancient traditional process of India. Nearly 60% of paddy produced is parboiled in India. i.e about 70 Million tones of paddy. Hence parboiling is a vast and important industry in India. Quality of rice produced in India differs depending on the method of production. Central Food Technological Research Institute, Mysore has improved the process of making parboiled rice in the Country.

Parboiling is nothing but partial boiling. The paddy is soaked, water drained, and the soaked paddy is cooked by steam or by hot air or by hot sand and then dried and milled. There are several methods of parboiling.

**Single boiling process**: Here the paddy is soaked in cold water for about 3 days. Afterwards the paddy is removed from water and steamed for 3 to 8 min. It is then dried and milled.

The quality of the rice w.r.t colour and appearance are quite good. But the rice bears a bad smell, owing to long duration of soaking and bactaria acting on the material.

**Double boiling process**: Here paddy in dry condition is heated by steam in hundies. The hot paddy is then put into a tank containing cold water and soaked for about 36 h. The soaked paddy is again taken out , steamed and dried . The process is similar to single boiling method and the product is almost similar to former method. The main difference is initially the paddy is steamed in dry condition, this hot paddy is dumped into cold water and further the process is similar.

**CFTRI Hot-Soaking Process:** This process was developed in order to avoid the bad smell which was existing in the process. In the present process paddy is soaked in hot water  $(65 - 75^{\circ} \text{ C})$ , microorganism action does not occur in hot water. Therefore smell is completely avoided. Because of soaking the paddy at high temp. the soaking time is reduced to 3 - 4 h (compared to the 72h in the previous method). Afterwards, the water is removed and the soaked paddy is steamed and then dried and milled as before. This is practically followed in number of industries.

**Colour of Parboiled rice:** Milled parboiled rice generally brownish colour. This colour depends on time, temp. of soaking, duration steaming etc. Longer these, darker is the colour and vice-versa. If less colour is required, after steaming, tempering should be avoided. Even pressure of the steam plays a role in development of the colour of the rice. If paddy is not soaked properly, white belly occurs in the final rice. Hence sufficient soaking is to be carried out.

### Properties and advantages of parboiling

Parboiling changes various properties and also quality of rice. These change in properties are i) reduces the breakage ii) it increases the vitamins and minerals in the rice iii) it increases the oil content in the bran iv) It affects the flow and packaging properties of the grain v) It changes the cooking and eating quality of the rice.

#### Ageing of rice

Peculiar property of rice is that its cooking and eating quality depends on its age after harvest. Rice is grown once or twice in a year. But it is consumed through out the year. Hence it is to be stored and it is observed that its age strongly affects its quality. New rice swells poorly during cooking and gives out a thick and sticky gruel. The cooked rice is very sticky and lumpy. These properties change slowly while storage. After few months of storage the opposite properties occur and rice cooks fluffy, grains elongate well non-sticky and the gruel will be thin and non-sticky. This phenomenon of change in cooking and eating properties of rice during its storage is called ageing of rice. It has been noticed that ageing becomes quicker when the storage temperature is high and slower when the temperature is low. This is the reason rice becomes old faster in summer and remains fresh and new for long time in winter. Why these changes occur is not clear to anyone.

# By-products of rice milling and their utilization

During milling of paddy we get i) husk ii) bran iii) germ and iv) broken rice as the main by-products.

If 100 kg brown rice is taken and 5% polish is given, we say that 5 kg of bran is obtained and 95 kg of milled rice obtained. This milled rice contains head rice as well as broken rice. The broken rice will vary from 20 to 25% under ordinary conditions. There are cases where 50 to 60% broken rice will be available, for which reasons are many.

Bran from raw rice will contain 13 to 15% oil and that from parboiled rice will contain 15 to 20% oil. The problem of rice bran oil from raw rice, is, it is unstable, due to the presence of lipaze enzyme which hydrolyze the fat and liberates Free Fatty Acids. In the case of parboiled rice bran, there is no FFA, as the enzymes are stabilized while parboiling.

#### Nutritional significance of rice bran

Rice bran is rich source of fibre, minerals, vitamin B and E, oryzanol etc. These are known to minimize several diseases like heart attack, blood pressure, diabetics, colon cancer, obe**sity etc.** Brans of rice, oat, barley, wheat ,etc are good sources of dietary fiber. In western countries, these brans are processed and incorporated in baked products. Efforts are to be made in our country to utilize rice bran for this purpose.

Husk utilization : Husk content varies from variety to variety of paddy. On an average ~ 20% husk can be considered. Around 22 - 25 million tones of husk is available in our country annually. Its fuel value is about half of coal and about one third of mineral oil. Husk is largely used as a fuel.

Furfural, chloroform, silica, sodium silicate, silica gel, insulatd bricks are other derivatives from husk. Furfural is used in the manufacture of resins corrosion resistant pipes and for refining of lubricating oil.

### Brokens

Large and medium brokens go with bulk of the milled rice. Only fine brokens are collected separately in big mills, and more often along with stones. Such brokens can not be easily purified; however if paddy is thoroughly cleaned and milled, pure fine broken can be obtained and can be used in preparing certain products like semolina, idli, dosa, deep fried products, flaked rice and in brewery.

# **Rice Germ**

Very little portion of germ is present in rice. It is about 2% of the grain. In some of the places it is used along with rice bran. But the germ separation is a laborious technique to be followed. Chemical composition of rice germ is : Fat 25-32% ; Protein : 26 % (Lysine rich); *in-vitro* digestibility: 84%; starch : 5% ; Crude fibre : 3%; sugars : 12% ; dietary fiber : ~ 18 % ; Vitamins, minerals etc.

Germ can be incorporated into bread, cakes etc at 10% level with favourable consumers acceptance. Rice germ products, particularly rice germ oil are available and highly regarded in Japan. Rice germ can provide a rich source of nutrients.

# Conclusion

Rice is the principal staple cereal grain in the world. In rice there are different types which depends on their physico-chemical properties like amylose content, gelatinization temperature, equilibrium moisture content on soaking at room temperature, cooking quality by viscography, hardness and softness of rice grain after cooking etc properties. In rice we have raw, cured and as well as parboiled. Parboiling induces several changes in the properties of rice, specially oil content in bran increases, breakage decreases and hence head rice increases. Parboiled milled rice contains high amount of thiamine. There are different byproducts of rice before and after par boiling. In raw the by products are husk, bran, broken, germ and same in parboiled one, but with different properties. Mainly husk is used as a fuel, it is also a source of silica content. Bran is mainly used for extraction of oil, the content is high in parboiled one. Broken are used for making rice flour, and it also used in the preparation of various products like idli, dosa, upmav, pan cakes etc. Germ is a rich source of protein, vitamins and oil content. After brief processing, it can be used in the preparation of bakery products with judicious care.