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"Process of paddy parboiling and their effects on rice" A Review

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Abstract
Parboiling of paddy is also 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 we are use the sun light 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.

Keywords: Paddy, Hot water, Sun light, Hot air, Drier, soaking tank

Introduction
Rice (*Oryza sativa L.*), which is considered as a main staple food and major source of nutrients in many parts of the world, is also an important staple food in India. Despite the fact that the qualities desired in rice vary from one geographical region to another, the demand for parboiled brown rice has been increasing because of its reputation for nutritional excellence and the health claims associated with eating this type of rice.

Parboiling is the hydrothermal treatment of paddy before milling and it includes soaking, steaming and drying. The primary objective of parboiling is to improve the quality of rice and obtain a higher milling yield. The parboiled rice exhibits several advantages over the un-parboiled ones such as improved kernel strengthening, increased milling recovery and prevention of loss of nutrients associated with milling, and improved shelf life. It is suggested that parboiling helps fill the void spaces and cement the cracks inside the endosperm, making the grain harder and minimizing internal fissuring and thereby breakages during milling. From the economic point of view, the quality of milled rice is of paramount importance since grain size and shape, whiteness and cleanliness are strongly correlated with the transaction price of rice, while the presence of broken grains mostly half the market value of head rice. In general, efficient mills produce better quality rice, whereas inefficient mills waste energy, and result in losses. To improve the quality of rice two main factors have to be considered: one, the quality of paddy that goes in for milling; and two, the milling technique; although Bhattacharya has argued that the ultimate cause of breakage in rice milling resides more in the rice kernel than in the milling methods and equipment. Since the percentage of whole grain is the most important parameter in the rice industry, rice processing, therefore, becomes an important factor to be put into consideration in order to improve its quality. To meet this gap in the case of Gibeon rice, which has been less researched in this area, this paper investigates the optimum moisture content and parboiling time for milling Gibeon rice as precursors for improving its quality. This paper argues that the breakage experienced while milling can be attributed to parboiling time and paddy moisture content.

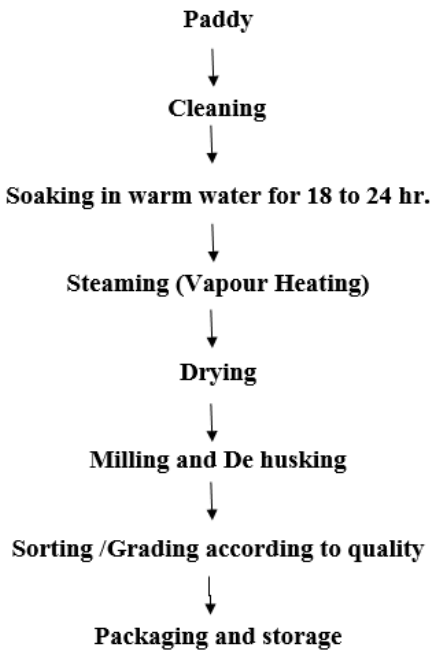
Parboiling is a process developed for improving rice quality. It consists of soaking, steaming and drying of the rough rice. The major reasons for parboiling rice include higher milling yields, higher nutritional value and resistance to spoilage by insects and mold (Elbert *et al*., 2000; Bhattacharya, 1985). The parboiling process is applied to rice with a preliminary objective of hardening the kernel in order to maximize head rice yield in milling. Besides milling yield, it was also the realization of the nutritional and health benefits of parboiled

brown rice (Larsen, 2000) compared to raw brown rice that created the awareness and importance of parboiling among consumers and manufacturers. Several studies have reported on parboiling processes as reviewed by (Luh and Mickus, 1980). Traditionally, parboiling consists of steeping rough rice in water at room temperature followed by steaming or boiling at 100ºC and sun-drying. Recently, more sophisticated procedures such as1 dry-heat parboiling and pressure parboiling have been applied (Bello *et al*., 2004). Parboiling with gelatinizing of rice starch and elimination and filing rice seed chaps, results in improved resistance of seeds against exerted tensions during paddy threshing operations. Also, nick percentage is reduced significantly, operation percentage increases and because of leakage and penetration of bran into the rice seed, bran percentage is reduced significantly and crust percentage is reduced slightly to, which justifies operation percentage improvement (Kshirod *et al*., 1966). This indigenous technique is done to have easy milling as well as reduce breakages during milling. The processes involve soaking the paddy in hot water usually between 10 to 24 hours in order to saturate the paddy with moisture. The soaked paddy is then steam heated till they gelatinized. They are then dried and milled. Paddy rice parboiling process is an old practice done several years ago. More than 1000 years ago parboiling was done in simple clay pots to improve ―shelf life‖ and resistance against insects (Joachim, 2011). The treatment is practiced in many parts of the world such as India, Bangladesh, Pakistan, Myanmar, Malaysia, Sri Lanka, Guinea, South Africa, Italy, Spain, Thailand, Switzerland, USA and France (Pillaiyar, 1981). West Africa and the Caribbean African diasporas are also accustomed to parboiling rice. Parboiled rice has cross culture relevance and is accepted by a number of tribes (Joachim, 2011). In India and Paskistan it's noted for its good storage properties and special taste. The steeped rice at 100°C to gelatinize the starch. The grain expands until the hull's lemma and palea start to separate (Gariboldi, 1984). The parboiled rice is then cooled and sun-dried before storage or milling. The degree of starch gelatinization is responsible for many of the attributes of parboiled rice (Marshall *et al.*, 1993). During the process of gelatinization, alpha-amylose molecules leach out of the micellar network and diffuse into the surrounding aqueous medium outside the granules (Hermansson and Svegmark, 1996). The granules become fully hydrated, producing a maximum in the measured viscosity (Eliasson, 1986; Helbig *et al.*, 2008). The starches in parboiled rice become gelatinized, and then retrograded after cooling. The parboiled rice kernels should be translucent when wholly gelatinized. Retro gradation is where amylose molecules re-associate with each other and form a tightly packed structure.

Methods of parboiling paddy rice

The survey showed that the processes of parboiling have been categorized into three forms. These were the traditional methodology, improved methodology and modern methodology of which the first two are practiced in Ghana. The traditional methodology uses simple tools like earthen or metal cooking pots and a nearby stream or dam serves as source of water. The paddy is not cleaned before soaking and the intensity of heat supply was high Also the volume of water used at soaking and steaming stage is the same. The modern parboiling method employ sophisticated tools like tanks, electric heaters, steam pipes etc and state of the art equipment to do the soaking, steaming and drying processes. The improved methodology is a combination in bits of the traditional and modern methods. In the improved methodology, pre-soaking activities such as washing, de-stoning, separation of immature seed etc. are carried out. Soaking is done in warm water not boiling water. Also, little water is used at the steaming stage as compared to the high volume of water used in traditional methodology that will usually cooked the paddy at the end of process.

Flow chart of paddy parboiled rice



Procedures and processes of parboiling paddy rice

The observed unit operations involved in paddy rice parboiling processes includes.

Sieving: This is done if there are broken grains in the paddy. A wire netting is used to sieve to separate the broken kennels so that they will not get cooked and stick the content together during parboiling. Thick viscous liquid arising from cooked broken-kernels usually stack the paddy together and hampers effective speedy drying. This could lead to fungal growth and spoilage of the rice if care is not taken.

Washing, Floatation and Sedimentation: The paddy is submerged in water and stirred vigorously for the soil and other dirt to dissolve out. The lighter debris float whiles the heavier materials settle at the bottom. The floating debris (dead insect parts, weeds, unfilled seeds etc) are skimmed off while the paddy rice is scooped out leaving heavier materials (sand, stones, pieces of metals etc.) at the bottom and poured away. Washing is done twice or thrice depending on the extent of dirt in rice. Scientifically, the washing removes dirt, debris and fungal toxin found in the rice.

Boiling: The washed paddy is then submerged in water on a pot and partially boiled to a warm temperature of 35 to 40oC. This enhances uptake of water by the paddy, and also deactivates certain enzymes activities. Some microbes and their cellular products could be killed or inactivated at this temperature.

Soaking: The paddy rice is left to stay in the warm water overnight (10-24 hours) for the paddy to imbibed water and become moisture saturated. The scientific principles here are enzymes activation. A conducive environment is created after

content is cooled down for enzymes and pigments transformation. Toxins are diluted and microbial pathogens may be inactivated or removed at such high moisture level. The saturated grains expand and fill the hull's lemma making it lose in the process.

Steaming: The soaked paddy is then steamed in a pot with little water lining the pot. The high moisture content in the grain is used to gelatinize the starch during the steaming process. The steam is made to reach all sections of the pot by covering with jute sacks and polythene sheets. The covering prevents the steam from escaping easily thereby creating a partial pressure over the content that aid in inward movement of molecules in each gelatinous kernel. When paddy begins to crack open their husks and there is steam vapor arising all over pot it is an indication that steaming is enough. The heat also evaporates extra moisture in the grain leaving concentrated nutrients in the kernel. The high temperature up to 80ºC is able to inactivates or kill some microorganisms and degrade toxins and other poisonous substances present in the rice. Physico-chemical reaction processes e.g. gelatinization, starch retrograding, pigment transformations, enzymes deactivations etc. are all facilitated by the pressurized steaming process. This brings about improved flavor, color-change and cooking characteristics of the rice.

Drying: The steamed paddy is spread out quickly at an airy place to dry. Excessive sunshine is avoided otherwise non-uniform drying of kernel which results in breakage during milling. Other scientific advantages of the drying processes could be the art of drying evaporate the moisture and this concentrates solutes in the kernel drying will also stop microbial pathogens from developing on steamed paddy. It compresses the gelatinous amylase starch together in a compact mass and delocalizes it from the husk making de-husking (milling) easier.

Milling: The dried paddy is milled using a milling machine or, at the local level is pounded using mortar and pestle to separate the kennels from the husk. This process also has the ability to removes pathogens and other dirt's that stick to the hulls.

Winnowing: Winnowing is done either mechanically or manually. Where milling is done manually using mortar and pestle to pound the paddy rice, the rice is winnowed to separate the husks and foreign materials away. Winnowing help to removes dirt, dead insects, and other impurities still present in the rice.

Sorting/Grading: Commercial parboiling groups go further to do handpicking of discolored rice and foreign materials before sorting in to grades (grade 1, 2 and 3) as, very few, few and many broken grains respectively).

Scientific principles (reasons) behind parboiling.

Apart from the above reasons, processors could not give other scientific benefits of parboiling. Even nutritional improvement, a common idea as far as food processing is concern was not mentioned because they cannot get the synergy between parboiling and nutrition l*et al*one movement of water soluble vitamins in rice. This could be traced to the low level of formal education of processors hence their inability to figure out the scientific principles and advantages behind parboiling like inactivation or killing of microbes, and dilution of possible poisons. Since it takes academic knowledge at a certain level to comprehend nutritional characteristics of food, especially vitamins, the low level of formal education among the processors, would surely have an effect on nutritional issues on their product. Though not mentioned, nutritional improvement, especially vitamin B1 (thiamine) enrichment might be one of the important advantages of parboiling process. In 2001, Otegbayo *et al* studied the effect of parboiling on physico-chemical qualities of two local rice varieties in Nigeria. According to Ibukun, (2008) their results indicated that parboiling reduced the breakages, fat, protein and amylose content of the rice while the water uptake and thiamine contents were increased. Also the pre-treatments given to the rice before the parboiling process help remove factors that could antagonized the nutritional qualities of the rice. Firstly, washing paddy rice in water removes dirt, microbes and their toxins in the rice. The long hours of soaking in warm water do not only facilitate water absorption but also further reduces the substances like afflatoxins that are in the rice during storage (old stock). This is because the absorption of water to a saturation point would dilute and reduces the concentration of toxic substances in the rice. The soaking might also cause certain enzymes or pigments transformation and their movement inwards to the endosperm. The steaming to a temperature of 80ºC supplies heat enough to kill pathogens still found in the rice. The activity of pressurized steaming enabled vitamins notably thiamine to move inward onto the endosperm. It further deactivates enzymes and make available substances like vitamins that otherwise could have been inaccessible. The transformation and concentration of enzymes and pigments could be the reason why parboiled products such as millet, groundnuts, rice etc tastes better than non-parboiled ones. In rice parboiling the important nutritional and physiological change is the active movement of soluble molecules. Much of the rice nutrients are concentrated at the embryo (the germ) and during the steaming process, the partial pressure created by covering directs solutes movement inwards onto the endosperm through the aleuronic layer that surrounds the endosperm. Other advantages are easy milling of parboiled paddy rice because the amylase starches retrograde and stack together in a compact manner that pulls away from the husk when dried. This makes the kernel becomes somewhat delocalized and now moves freely inside the husk. This makes it easier for husk to be removed when milled or pounded on mortar and pestle. Since the point of attachment between the husk and the endosperm is also loosened, the husks can easily get removed without breaking off the germ. Non-parboil rice has it husk intimately attached to the embryo where all the nutrients are concentrated. Forceful removals of the husk will usually breaking away the germ with the husk, thereby losing all the vital nutrients, including thiamine. And such rice will certainly not taste the same as rice that retains its germ or embryo after parboiling. Thus the process of parboiling inadvertently cures nutrient deficient-diseases or has the ability to supply certain nutrients that otherwise could have lost to consumers. A number of NGOs and some government agencies have begun training women to improve their parboiling activities. Their efforts all along have been on how to improve head rice yield (HRY) and eliminate stones in the rice in order to get good market but not the nutritional aspect.

Steps in the rice parboiling process using the improved equipment Principles of paddy parboiling:

Step-1: Washing

Paddy is washed clean in a basin containing a large quantity of water (about 3 liters of water for 1 kg of paddy rice). This washing makes it possible to remove all types of dirt or residues from the paddy (sand particles, grass, etc.) as well as unripe grains. These unripe grains, which float at the surface during washing, are collected using a small basket or a sieve. Sand found at the bottom of the basin is discarded after carefully retrieving the clean paddy. Depending on the amount of dirt it contains, paddy can be washed 2 to 4 times.

Step-2: Soaking in hot water;

After draining, the paddy is poured in a cast aluminums pot containing clean water. This water should be floating above the product. The solution is then put on a fire and left until temperature reaches approximately 60°c. At this temperature, the women processor can hardly dip her fingers in the water as it is very hot. This marks the end of the heating process. This single operation, during which the paddy is occasionally stirred, will generally last 20 to 40 minutes for a quantity of about 25 kg of paddy. After heating, the paddy is removed from the fire, then left to cool down overnight, i.e. roughly for 12 hours.

Step-3: Pre-cooking the paddy with steam

The drip-dry paddy is poured in the steaming pan which has been inserted into a pot containing clean water (about 10 liters). Indeed, water contained in the pot should not touch the bottom of the pan so that the product will not be wet. The water is heated to its boiling point and the vapour generated passes through the holes in the pan to pre-cook the paddy rice. This process will end when it is observed that the husks of some paddy grains have burst or a heavy sound is heard when tapping the grains using the palm of one's hand. Duration of this process is about 13 minutes for 24 kg of paddy.

Step-4: Drying the Paddy

Steamed paddy is first dried in the sun for about 1 hour 30 minutes, then collected and dried in the shade for the remaining period, which can last for about 16 hours before hulling takes place. For both purposes, paddy should be properly spread on tarpaulin, canvass or drying areas. Drying the paddy in the sun then in the shade will reduce water content of the paddy to about 21% and 10% respectively. According to the women involved in this process, the end of the period of drying in the shade can be determined when the husk can be easily removed by rubbing the paddy between the palms of both hands; this signals the end of the entire paddy rice parboiling process and hulling of the paddy can then start or paddy can be stored.

Principles of paddy parboiling

Soaking: The paddy rice is left to stay in the warm water overnight (10-24 hours) for the paddy to imbibed water and become moisture saturated. The scientific principles here are enzymes activation. A conducive environment is created after content is cooled down for enzymes and pigments transformation. Toxins are diluted and microbial pathogens may be inactivated or removed at such high moisture level. The saturated grains expand and fill the hull's lemma making it lose in the process.

Steaming: The soaked paddy is then steamed in a pot with little water lining the pot. The high moisture content in the grain is used to gelatinize the starch during the steaming process. The steam is made to reach all sections of the pot by covering with jute sacks and polythene sheets. The covering prevents the steam from escaping easily thereby creating a partial pressure over the content that aid in inward movement of molecules in each gelatinous kernel. When paddy begins to crack open their husks and there is steam vapor arising all over pot it is an indication that steaming is enough. The heat also evaporates extra moisture in the grain leaving concentrated nutrients in the kernel. The high temperature up to 80oC is able to inactivates or kill some microorganisms and degrade toxins and other poisonous substances present in the rice. Physico-chemical reaction processes e.g. gelatinization, starch retrograding, pigment transformations, enzymes deactivations etc. are all facilitated by the pressurized steaming process. This brings about improved flavor, color change and cooking characteristics of the rice.

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Methods of parboiling and Effect of parboiling on milling quality;

The method of parboiling may be classified as follows;

- **Traditional method**;by

1. Single boiling
2. Double boiling

- **Modern methods**

1. CFTRI method (India)
2. Jadavpur university method (India)
3. Avorio process (India)
4. Converted process (India)
5. Malek process (America)
6. Cristallow process (Italian)
7. Fernandes process (Surinam)
8. Schule process (German)
9. Rice growers association of California process (America)

- **Methods under investigation;**

1. Brine solution method (India)
2. Kisan continuous method (India)
3. Pressure parboiling method (India)
4. RPEC method (India)
5. Sodium chromate method (India)
6. Parboiling with heated sand method (philipines)

Traditional method

The traditional process consists of soaking paddy in water at room temperature for 24-48 hr. or more steaming in kettles under atmospheric pressure and drying under sun light.

In a single boiling method paddy is soaked in ordinary water for 24-72hr. and then steamed. In double boiling method steam is first injected in to row paddy in the steaming kettle before soaking. Hot paddy raises the temperature of soaking water to 45-50 ºC which helps to reduce the soaking time to

24hr. there after soaked paddy is steamed sometimes, the soaking water is heated to about 50ºC than the row paddy is put in to it and in this case first steaming is not required.

Modern method

1. **CFTRI method;** In this process, parboiling tanks are filled with clean water and heated to a temperature of about 85ºC by passing steam through the coils placed inside the tank. Sometimes hot water is pumped from other sources into parboiling tanks. The resultant temperature of paddy water mixture in tank stays around 70ºC. After soaking paddy for 3 to 3.5 hrs, water is drained out. The water discharge value is kept open in order to remove condensed water during steaming. Soaked paddy is exposed to steam at a pressure of about kg/cm^2 through the open steam coils. Soaking and steaming of paddy are done in same. The parboiled paddy is taken out by opening the bottom door and dried either under sun or by mechanical drier.

2. **Jadaopur University method;** All the operations of this method is fully automatic and average processing time is five to six hours. Soaking of paddy is completed in high temperature water (60-70ºC) within 1-03 hours, while the steaming time is limited to 3.5 minutes. After steaming and before drying, the paddy is rapidly cooled. Drying taken place in a rotary steam jacketed high temperature Air dryer. In this process two different may be applied with the first, the soaking and steaming take place in the same tank, where as in the second, these two operations are performed separately in a horizontal apparatus. In both the cases saturated steam is used. The steamed paddy is rapidly cooled in a drought of cold air.

3. **Pressure parboiling method;** This method of parboiling was developed at Tiruvarur in Tamil Nadu. The parboiling is achieved by penetration of moisture into the paddy in the form of water vapour under pressure. This results in gelatinization of starch of the kernel. The paddy is soaked for 40 minutes at 85-90 ºC. There after it is steamed under pressure for 18 minute. The water vapor which penetrates the kernel drives out entrapped air. It is reported that the whole process is completed in 1 to 1.5 hrs. the rice obtained by this method has a slightly yellowish uniform color. Reduced soaking period of paddy is the main advantage of this method. It was also observed that such parboiled paddy has better shelling, has more fat in bran and increased storage life of rice grain.

4. **Avorio process;** Developed in Italy in the Avorio process, paddy is kept in a perforated basket and moved into a hot water tank for soaking, later steamed under pressure in a rotating cylinder and dried in hot air driers.

5. **Corversion process;** the process was developed in the USA. In this paddy is soaked in cold water, air in the soaked paddy is removed in vacuum, then steamed under pressure and dried in vacuum drier.

6. **Malek process; A**nother method developed in the USA**,** which consists of soaking paddy at 100ºF for 3 to 6 hours, steaming for 15 minutes and drying in hot air drier at low temperature.

7. **Fernandez process;** The process used extensively in Latin America is similar to hot soaking methods.

Advantages, disadvantages, changes of parboiling and some definitions;

- The milling yield increase and the quality is increased as there are fever broken grains.
- The grain structure becomes compact and vitreous, even if some kernels were entirely or partially chalky.
- The milled rice becomes translucent and shining.
- The shelf life of parboiled paddy and milled parboiled rice is longer than in the row state, as germination is no longer possible and the kernel become hard enough to resist the attack by insects and to adsorption of atmospheric moisture.
- The grain remains firmer during cooking and less likely to become sticky.
- It reduces the breakage rate during the hulling process.
- It makes for improved yield.
- It helps to reduce losses of nutritive elements during the process of hulling and cooking the rice.
- Through the parboiling process, the rice undergoes chemical, physical and sensory changes as follows:
- A greater amount of water is absorbed during cooking causing the rice to swell.
- After cooking the rice absorbs less fat from added condiments, the rice keeps longer and does not become rancid easily.
- Parboiled rice retains more proteins, vitamins and minerals.
- Shelling of parboiled paddy is easier.
- Parboiled rice is more digestible and less solids are left behind in the cooking water.
- Bran of parboiled rice has more oil.

Disadvantages of parboiling;

- The heat treatment during parboiling destroys some natural antioxidants, hence rancidity developed in parboiled rice during storage is more than that in row rice.
- Parboiled rice takes more time to cook than row rice and may have characteristics off flavor which may not be liked by row rice eaters.
- Parboiling process needs extra capital investment.
- Parboiling add to the cost of drying.
- As paddy is soaked for a longer time during parboiling, it may be attacked by spores which may cause health hazard.
- More power is required for polishing of parboiled rice, the process become difficult and lower the capacity of polisher.

In spite of the above disadvantages 1 to 2% extra rice is obtainable than row rice milling. In India if 50% of the paddy production is converted into parboiled rice, it is possible to sore about more than 1000millions by virtue of extra rice and it's by product value.

Effect of parboiling

- **Chemical changes**
- The water-soluble substances (vitamins and minerals) are dissolved and allowed to permeate the grains.
- The lipoid materials in the endosperm are dissolved.
- The gelatinized starch appears like a compact and

homogeneous mass.
- Lipoid matter is separated and goes deeper into the compact mass of gelatinized starch.
- Fat-soluble substances in the germ and the outer part of the endosperm are dissolved and disseminated in the grain.

Physical changes
- The milling yield is better and quality is improved as there are less broken grains;
- Parboiled rice, even without milling, can be better stored and for a longer period as germination cannot take place and the compact texture of the endosperm allows it to better resist insect attacks and not to absorb moisture from the surrounding environment.
- Parboiled rice can be conserved longer and is less subject to rancidity.
- The process of drying makes it possible to reduce the water content of the grain to an optimal level for milling.

Grain dimensions
- For each rice variety and processing method, 10 whole grains were randomly selected from the milled rice, and the length, width and thickness determined using a micrometer screw gauge. This measurement and all others relating to physical quality were carried out in triplicate.
- All latent or active biological processes (germination, proliferation of fungal spores, and development of insects at varying phases) are terminated.

Level of impurities
- A 20 g sample of milled rice was weighed. The head rice and broken grains were removed. Foreign matter such as dead insects, pieces of wood, dust, stones and unshelled paddy were then weighed.% Impurities = weight of impurities x 100/20 g.

Sensory changes
- The most significant ones are as follows:
- Cooked parboiled rice has better digestibility ratio by reason of its texture and firm consistency.
- After cooking, the grains are firmer and tend to be less sticky.

Effect of parboiling on milling quality;

In row rice milling several factors are responsible for breakage of kernel cracking of kernel is one of the main factors for breakage. Cracks developed because of delayed harvesting, threshing or rapid drying. In mature and chalky machinery influence milling out turn and quality. Rice breakage is related to milling conditions, particularly by the relative humidity, temperature and extent of milling. During shelling or husking operation, breakage occurs. Parboiling of paddy results in reduction of breakage imported to kernel because of gelatinization of starch the cracks incomplete grains filling and chalkiness are completely healed. The most advantages aspect of parboiling is the increase in the head yield of rice during polishing, the polish percentage and breakage with time but parboiled rice takes longer times than row rice to attain same degree of polishing. Parboiled rice requires three to four times as much abrasive load as row rice for same level of polishing. As per liking for color of rice need of polishing for parboiled rice less as compared to row rice for example if consumer needs 80% bran removal to achieve this parboiled rice needs polishing of 3% where as row rice has to be polished to 4% for same quantity of bran removal.

Some definitions about paddy

Rough rice or paddy: Defined as rice in the husk after threshing.

Stalk paddy: Defined as un threshed in the husk, harvested with part of the stalk.

Husked rice/brown rice: Rice from which the husk only has been removed retaining still the bran layers and most of the germs. Such rice is sometimes reflected to as bran rice even though there are variations having red or white bran coats.

Milled rice: Rice from which husk, germs, bran layers have been substantially removed by lower machinery, also known as polished rice and if milled to high degree it is called as white rice.

Under milled rice: Rice from which the husk germs and bran layers have been partially removed by power machinery and is also known as unpolished rice.

Hand produced rice: Rice from which the husk, germ and bran layers have been partially removed, without the use of power machinery, also known as "home produced" or "hand milled rice".

Parboiled rice: Rice, which has been specially processed by steaming or soaking in water, heating usually by steam and drying. Parboiled paddy can be milled to various degrees or home produced in the same way as ordinary paddy. It is called as parboiled milled or parboiled hand pounded.

Raw milled: The paddy, which is milled not after giving heat treatment, such as parboiling.

Coated rice: Defined as rice milled to a high degree and then coated with glucose on "Talcum".

Whole grain: Refers to husked, milled or hand produced rice which does not contain any broken grains smaller than 3/4 of the size of the whole kernel.

Broken rice: Husked, milled or hand produced rice consisting of broken grains of less than $3/4^{th}$ size of the whole grain but not less than 1/4th.

Fragmented rice: Small broken up to 1/4th size of the whole grain.

Husk: The by-product from the milling of rice consisting of the outermost covering of the rice kernels.

Bran: A by-product from the milling of rice consisting of the outer layer of the kernels with part of germ.

Rice polishing: Now defined as the by-product from milling rice, consisting of the inner bran layer of the kernel with part of the germ and a small percentage of the stone interior also known as rice meal or rice flour elsewhere.

Glutinous rice: A type of rice, which after cooking has a peculiar sticky regardless of how it is cooked.

Scented rice: A type of rice, which contains aroma and gives scented smell on cooking.

Rice flour: Ground polished rice which is mainly starch with very little gluten. Used in the same way as corn flour and for noodles, sweets and short pastry.

Quick cooking rice: Rice that had been completely cooked then dehydrated.

Head rice yield: Head rice yield is the weight percentage of rough rice that remains as whole rice (three-fourths kernel or greater) after complete milling.

Milling yield/Total yield: Milling yield is the weight percentage of rough rice that remains as milled rice; i.e., the sum of head rice and "broken."

Rice bran oil: It is the oil extracted from the germ and bran of rice.

Puffed rice: It is a type of puffed grain made from rice; usually made by heating rice kernels under high pressure in the presence of steam, though the method of manufacture varies widely.

Popped rice: Raw rice is traditionally popped by heating rough rice at higher temperatures about 240°C for up to 45 seconds. The hull contributes to pressure retention before popping. A good popping varieties have a tight hull and a significant clearance between hull and brown rice and when freshly harvested are free of grain fissures.

Rice flakes: The production of rice flakes begins with parboiling of rice which helps to soften the grain and prepare it for processing. Once the rice is tender, the cooked grains are rolled and flattened. After the mixture is the desired thickness, the flattened rice is allowed to dry completely. The dried flakes are run through another rolling process to create simple flakes.

Conclusion

- Soaking temperature is one of the most important processes of rice parboiling.
- They are unaware of the important health benefits that their practices bring to the public.
- In this term minimizing the cost as well as improving the quality.

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