ISSN: 0976-7126
Kumar *et al.*, 15(3):41-47, 2024

International Journal of Pharmacy & Life Sciences
Open Access to Researcher

A Review on Paddy Parboiling

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Article info

Received: 10/01/2024

Revised: 20/02/2024

Accepted: 21/03/2024

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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 sunlight 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, Hotwater, Sunlight, Hotair, Drier, soaking tank

Introduction

Rice(*OryzasativaL.*), 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 there by 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.

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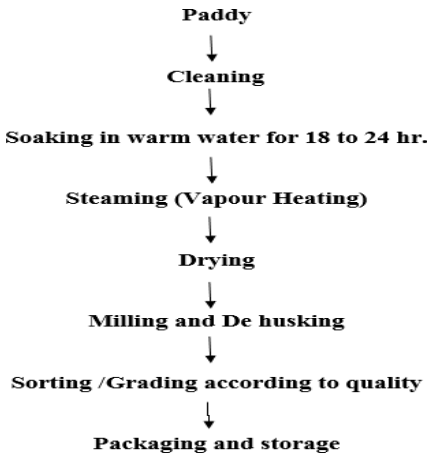
In general, efficient mills produce better quality rice, whereas inefficient mills waste energy, and result in losses. Parboiling is a process developed for improving rice quality. It consists of soaking, steaming and drying of the rough rice. The major reasons for parboiling rice include higher milling 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 at100ºC 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. Parboiled rice has cross culture relevance and is accepted by a number of tribes (Joachim, 2011). 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). 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 40 ^{o}C. 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 allover pot it is an indication that steaming is enough. The heat also evaporates extra moisture in the grain leaving concentrated nutrients in the kernel. 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 into grades (grade1, 2 and 3) as, very few, few and many broken grains respectively).

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 over night, 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). 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.

Methods of parboiling and Effect of parboiling on milling quality;

The method of parboiling may be classified as follows;

- **Traditional method**; by

1. Singleboiling
2. Doubleboiling

- **Modernmethods**

1. CFTRImethod(India)
2. Jadavpuruniversitymethod(India)
3. Avorioprocess(India)
4. Convertedprocess(India)
5. Malekprocess(America)
6. Cristallowprocess(Italian)
7. Fernandesprocess(Surinam)
8. Schuleprocess(German)
9. RicegrowersassociationofCaliforniaprocess(America)

- **Methods under investigation;**

1. Brinesolutionmethod(India)
2. Kisancontinuousmethod(India)
3. Pressureparboilingmethod(India)
4. RPECmethod(India)
5. Sodiumchromatemethod(India)
6. Parboilingwithheatedsandmethod(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 ^{o}C which helps to reduce the soaking time to 24hr. here after soaked paddy is steamed sometimes, the soaking water is heated to about 50 ^{o}C 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 85^{o}C 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 70 ^{o}C. 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 (60-70 ^oC) within1-03 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; Another method developed in the USA**,** which consists of soaking paddy at 100 ^oF for 3 to 6hours, 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 are 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 anti oxidants, 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.

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.

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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Cite this article as:
Kumar V., Ali Mohd. N. and Jakhar A. (2024). A Review on Paddy Parboiling. *Int. J. of Pharm. & Life Sci.*, 15(3): 41-47.

Source of Support: Nil
Conflict of Interest: Not declared
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