PROCESSING TECHNOLOGY OF CEREALS ASFE 2201

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PADDY PARBOILING METHODS

Methods of Parboiling

Traditional methods

1. Single steaming
2. Double steaming

Modern methods being used

1. CFTRI method (Indian)
2. Jadavpur University method
3. (Indian)
4. Converted process (American)
5. Malek process (American)
6. Avorio process (Italian)
7. Cristallo process (Italian)
8. Fernandes process (Surinam)

Modern methods under study

1. Brine solution method (Indian)
2. Kisan continuous method (Indian)
3. Pressure parboiling method (Indian)
4. RPEC method (Indian)
5. Sodium chromate method (Indian)

Single Boiling Method

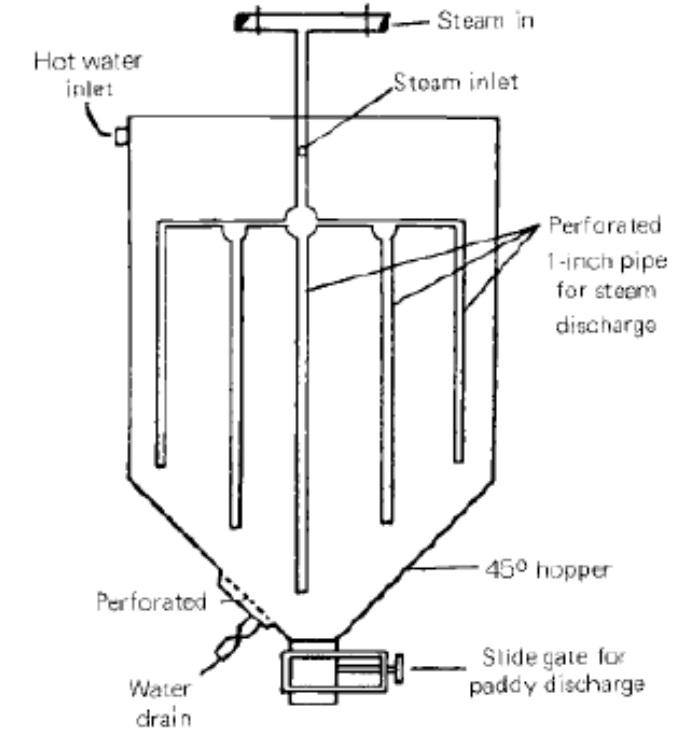
Paddy is soaked in ordinary water for 48-72 h and then transferred to cylindrical iron kettles for steaming in small batches under atmospheric pressure. The parboiled paddy is then dried in the sun before milling.

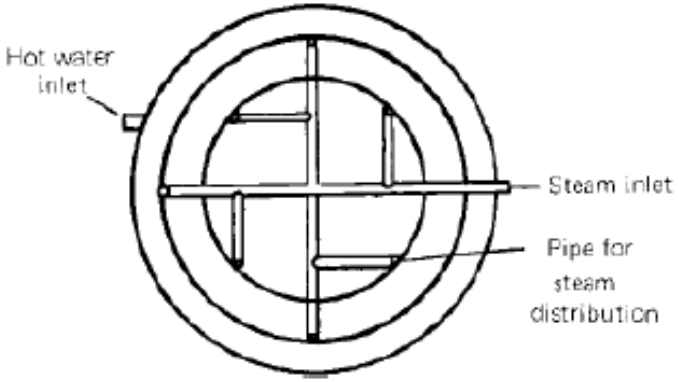
Double Boiling Method

In this method, steam is injected into the raw paddy in the steaming kettle before soaking. This hastens the soaking process. The hot paddy raises the temperature of the soak water to 45-50 °C, which reduces the soaking time to 24 h.
Thereafter, soaked paddy is steamed as in the single boiling method.

CFTRI Method

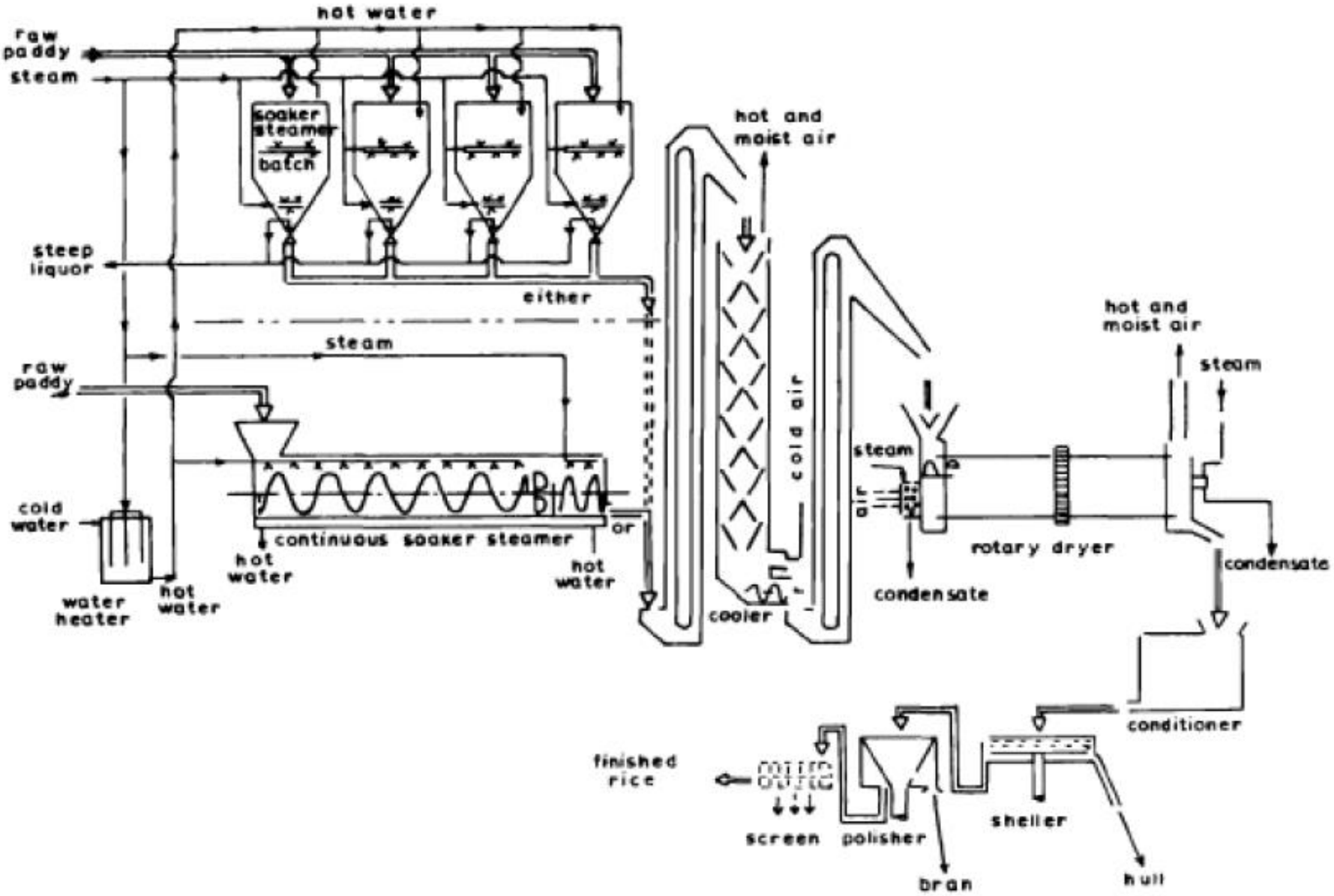
- Parboiling tanks are filled with clean water that is heated to a temperature of about 85 °C by passing steam through the coils inside the tank
- Paddy is dumped into the hot water as quickly as possible The resulting temperature of the paddy-water mixture in the tanks stays at about 70 °C.
- After letting the paddy soak for 3-3.5 h, the soak water is drained and paddy is exposed to steam heat by letting steam at a pressure of about 4 kg/cm2 through the open steam coil.
- Splitting of the husks usually indicates completion of the parboiling process.
- After the steaming is complete, the paddy is removed for drying by opening the bottom door





Jadavpur University Method

- The temperature of soaking varies from 65 to 70°C according to the size of the grain.
- Moreover, the two steps of soaking and steaming are done in the same vessel.
- The steaming time is reduced to 3-5 min.
- The short time of soaking and the elevated temperature eliminate the possibility of fermentation during this operation and, therefore, reduce the chance of development of any off-flavor in the rice produce


hot water
raw paddy
steam
soaker steamer
batch
steep liquor
either
steam
raw paddy
cold water
water heater
hot water
continuous soaker steamer
hot water
hot water
or
hot and moist air
cold air
cooler
steam
air
condensate
rotary dryer
hot and moist air
steam
condensate
conditioner
finished rice
screen
polisher
sheller
bran
hull

Converted Process

- This process, which was initiated in 1941- 1942, was the first American parboiling process.
- Soaking in an autoclave begins with de-aeration of the paddy by vacuum. This facilitates saturation and softening of the grain in water.
- A pressure treatment is applied to the soaking water in the autoclave that in combination with the vacuum reduces the soaking time to less than 3 h.
- After soaking, the paddy is cooked in a rotary steam-jacketed autoclave. Applied vacuum then frees the grain of excessive water and the steam pressure is held at less than 1
- kg/cm2 for about 1 h.
- Final drying is carried out in the same autoclave by applying vacuum and heating with steam.

Malek Process

- This method was perfected a little later than the converted process. The amber coloured parboiled paddy is prepared by successive unit operations that leave the grain remarkably hard.
- The paddy is steeped in tanks filled with hot water for 3-6 h. It is then cooked by the injection of steam into a vertical cylindrical autoclave that has a truncated cone bottom and is provided with charging and discharging ports or valves at the inlet and outlet, respectively.
- The paddy is moved in and out of the autoclave by gravity.
- Drying is performed in two stages:

(1)in a steam-heated rotary cylindrical drier

(2)In a forced hot air columnar drier at low temperatures.

Effect of Parboiling on the Nutritional Value of Rice

An average chemical composition of rice is shown in the table

	Water (%)	Protein (%)	Fat (%)	Ash (%)	Carbohydrate Total (%)	Carbohydrate Fibre (%)	Minerals and vitamins (mg/100 g) Cal-cium	Phos-phorus	Iron	Sodium	Potas-sium	Thia-mine	Ribo-flavin	Niacin
Brown	12.0	7.5	1.9	1.2	77.4	0.9	32	111	1.6	9	214	0.34	0.05	4.7
White fully milled (common)	12.0	6.7	0.4	0.5	80.4	0.3	24	94	0.8	5	92	0.07	0.03	1.6
White fully milled (waxy)	13.2	5.6	0.9	0.5	79.8	0.3	36	100	2.0	10	130	0.07	0.04	2.0
Enriched, all types	12.0	6.7	0.4	0.5	80.4	0.3	24	94	(2.9)	5	92	(0.44)	(—)	(3.5)
Long grain, parboiled	10.3	7.4	0.3	0.7	81.3	0.2	60	200	(2.9)	9	150	(0.44)	(—)	(3.5)
Long grain, precooked	9.6	7.5	0.2	0.2	82.5	0.4	5	65	(2.9)	1	—	(0.44)	(—)	(3.5)
Rice bran	9.7	13.3	15.8	10.4	50.8	11.5	76	1386	19.4	trace	1495	2.26	0.25	29.8
Rice polish	9.8	12.1	12.8	7.6	57.7	2.4	69	1106	16.1	trace	714	1.84	0.18	28.2

- Concentration of nutrients in the bran is higher than in either raw or parboiled rice. ***(Because bran is an admixture of the outer layers of the rice kernel, it appears that most of the nutrients are present in the outer layers of the shelled rice)***
- The loss of nutrients during milling is reduced to a certain extent by parboiling.

. It has been claimed that parboiled rice contains more vitamins, proteins, and minerals and loses fewer nutrients during cooking than raw rice.

The high nutritive value of parboiled rice may be due to

(1) The diffusion and heat sealing of vitamins and other nutrients into the endosperm
(2) The low degree of polish required for consumer acceptability, which means that less bran and nutrients are removed.

Parboiled rice contains less oil or fat compared to raw rice

(soaking operation brings about certain enzymatic changes that release oil from the combined state in which it is present in the rice kernel; subsequent steaming causes the oil to move towards the periphery of the kernel, which is removed with the bran during milling)

Approximate percentage losses of important nutrients during milling

	Losses during milling (% of total)
Protein	15.0
Fat	85.0
Calcium	90.0
Thiamine	80.0
Riboflavin	70.0
Niacin	68.0
Pantothenic acid	62.0
Pyridoxine	56.0

Effect of Parboiling on Cooking Quality of Rice

The cooking quality of rice may be expressed with respect to:

1. Time of cooking
2. Swelling capacity
3. Expansion ratio
4. Colour
5. Solids in gruel
6. Pastiness.

Time of Cooking

Raw rice cooked in boiling water needs about 15-20 mm to become fully cooked, whereas, parboiled rice requires 30-40 mm to be cooked to a comparable degree of softness.

Swelling Capacity

- This is the ratio of the final to the initial volume or weight of the rice.
- The water absorption capacity, as reflected by the swelling ratio, is significantly lower for parboiled rice than for raw rice cooked for the same period.
- Raw rice cooked for 15 or 20 mm has a lower swelling ratio than parboiled rice cooked for 30 or 40 mm, respectively.
- Semi-parboiled rice has a swelling capacity between that of raw and parboiled rice.

Expansion Ratio

- This is the ratio of the dimensions of the cooked and uncooked rice.
- The expansion ratios both along the length and breadth of parboiled rice are lower than the ratios for raw rice cooked for the same period.
- At an equivalent stage of softness, the parboiled grain has expanded more along the breadth than raw rice.

Colour

Parboiling changes the characteristics and appearance of the milled rice, but when cooked by boiling, the kernels are almost as white as raw rice.

Solids in Gruel

- The loss of solids into the gruel is greater in raw rice than in parboiled rice because the starch is gelatinized in parboiled rice.
- Semi-parboiled rice has an intermediate amount of loss.

Pastiness

- Parboiled rice cooks more flaky than raw rice because of gelatinization.
- Parboiled rice grains, after cooking, appear larger than cooked raw rice grains of the same variety and give the impression that they are coarse, bold-grained strains.
- Because parboiling and the subsequent gelatinization harden the grain, it needs a longer time to cook to a soft consistency and swells more during this period without disintegration.