RICE MILLING PROCESS

By

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Milling of paddy the major operation in paddy processing. It removes husk and outer layer of bran so as to produce acceptable white rice with minimum breakage and impurities. (The main objective of milling is to obtain maximum head rice Vitb-minimum breakage. Breakage of rice mainly occurs during milling operation, therefore, it is of great importance to the rice industry/Due to bad milling, breakage may be high as half of the total riser It has been reported that if the total efficiency of rice milling operation is increased by 2%, 1.2 million of extra rice can be made available in India.

Output of a milling process comprises one main product i.e., milled rice (or the edible portion) and several by-products., i.e., the husk, the germ, the bran layer and the broken kernels. Among these by-products, the husk can be used as an energy generating material; the germ, the bran layer and the broken kernels can be used to feed animals. Rice milling results in loss the extent of which depends on the milling technique chosen)

**Loss in milling**

Loss in milling is 3n important determinant of the efficiency of a rice mill Loss in milling is quantitative as well as qualitative by nature. Quantitative (or physical) loss is manifested by a low milling recovery rate. Recovery rate, also referred to as conversion rate, is the percentage of the quantity of rice recovered to the quantity of paddy fed into the milling process.

Qualitative loss is manifested by a low rate of head rice, recovery or a high percentage of broken grains in the milled product. In order to reduce loss , in milling, the rice- milling operations, i.e., dehusking and whitening, should be accomplished with care to prevent excessive breakage of the kernal. Loss in milling depends on the milling technique applied, among other factors. Differently, stated, better milling techniques may result in lower loss in milling.
The following terminologies may be known for better understanding of milling.

**Head rice**

It refers to the milled whole rice of 6/8 and more of actual kernel size.

**Broken rice**

Rice kernels, which are lesser than 6/8 of the actual size is called broken rice. It is further divided into three categories,

1. big broken, these include 4/8 to 6/8 of kernel portion,
2. small brokers, these include 1/8 and 4/8 parts of kernel and
3. points-less than 1/8 part of rice grain.

**Rough Rice or Paddy**

Un-hulled rice like it is harvested

**Brown Rice or Cargo Rice**

Husked rice; from which the husks have been removed.

**White Rice or Milled Rice**

Brown rice from which the high-fat, nutritive coat layers have been removed by the whitening process.

**Parboiled Rice**

Rough rice, which has been gelatinized by hydrothermal treatment, improving the cooking qualities and producing a shift of the vitamin’s and nutritive substances towards inside, so that it retains a higher nutritional value when pearled.

**Quick Cooking Rice**
Head rice which has been pre-cooked and re-dried according to different patents, so that it’s cooking time will be reduced to 3-5 minutes.

**Chalky Kernels**

Rice kernels exhibiting a floury surface of over 40% after whitening.

**Red Rice**

Rice grain with red internal coat layer.

**Rice Bran**

The product obtained during the whitening of brown rice, consisting of the inner coat layer, the alurone layer and partially of the germs. It is the raw material for the rice oil extraction silizium. Husk ash can be used as an additive to asphalt.

**Rice Hulls or Rice Husks**

Husks loosely enveloping the brown rice. Often husk are used as fuel in the power station of a rice mill to generate steam and then to drive the entire mill. They contain a high amount of silizium. Husk ash can be used as an additive to asphalt.

**Damaged Kernels**

Whole rice kernels, which have been damaged or discolored by water, pests, heat or other factors.

**Major milling steps**

**Paddy cleaning**

The first step in a rice mill is the cleaning operation. Here we remove fine and coarse impurities as well as stones. Stones are very harmful to our rubber roll husker and a proper destoner will prolong the life-time of our rubber roll by at least 30%.
In case we are producing parboiled rice, then the gravity selector will separate the paddy in a light and a heavy inaction. The light fraction can then be directed to precision graders to remove immature kernels, which would turn dark during the parboiling process.

**Husking and husk separation**

The husking has to be done very carefully, so that we don’t create to much broken, We suggest that the rubber roll husker is adjusted to give about 80 % husked kernels. This makes sure that only a minimal breakage of rice is happening during this process. The un-husked paddy will be separated in the paddy separator and will be returned to the rubber roll husker.

**Whitening of brown rice**

Depending on the quality of our end product, we recommend to use either 2-or 3 whitening stages and one polishing stage. In case we process standard rice, then 2 whitening passages are acceptable. If we however want to produce high quality export rice, then it would be better to have at least 3 whitening stages, so that our product is treated very carefully and that we don’t get a to high percentage of broken rice,

**Milling equipments**

In some rice growing areas rice milling is accomplished by primitive methods such as pounding the paddy in a wooden mortar and pestle followed by winnowing. It is estimated that in India 1/3 of the total paddy production is processed by hand pounders and foot pounders. Due to impact of the pounder, ride breaks and the post assumed by the grains is non-uniform. Rice and bran get mixed with the husk and a portion of them is lost along with it in the process of separation thereby resulting in low milling yield Labour requirements in above methods are high and the total rice recovery ranges between 60-65% only But the method of milling is simple and no mechanical or electrical power is required, and pounders can be easily fabricated in villages.
The purpose of hulling machine is to remove the husk from the paddy grain with minimum damage to the bran layer without breaking the brown rice.

Due to surface characteristic of paddy it is necessary to apply friction to the grain to remove the husk. Therefore, during hulling, certain percentage of broken can not be avoided. In this respect the construction of machine, its precision adjustment and the operation govern the optimum performance and efficiency of machine and head rice production. The adjustment of hulling machine depends upon the variety and uniformity of grain. Its uniformity is necessary for best performance of equipment.

**Huller**

The most common machine used for paddy hulling in India is (Engleberg huller). The working element of this machine is a ribbed cast iron roller (Fig. 14). The roller rotates on its axis inside a large concentric cylinder. On the inner cast iron roller, spiral ribbed strips are mounted to 1/4 part of length and on remaining 3/4 part 4 to 6 straight ribs are present and bottom half is fabricated by perforated mild steel sheet and can be changed as per requirement. While hulling, the husk and bran are removed through this perforated portion of the frailer. The ribbed roller is rotated at 600 to 900 rpm. Paddy is fed into the hopper and due to rotational direction of the flutes, it is moved around the cylinder and finally towards the outlet. Friction between the grains and the steel parts of the huller causes the husk and bran to be scrapped off. The huller does the job of husking and bran removal simultaneously, thus mixes the bran and broken with husk. It is difficult to separate these ingredients, therefore, the mixture can not be used for oil extraction and is sold as cattle feed. A steel blade is provided which can be moved in or out of the casing. Clearance between the blade and ribbed roller decides frictional forces
generated on the grains. Friction between the grains and the steel parts of the huller causes the husk and bran to be scrapped off. The capacities of huller vary from 250 to 750 kg/hr. The average yields obtainable from huller are about 56% and 62-64% for raw rice and parboiled rice respectively. It generates around 25 to 30% brokens.

**Under-runner disk huller**

The under-runner disk huller consists of two horizontal cast iron disk partly covered with an abrasive layer preferably of emery. The top disk is fixed with the body of the machine, while the bottom disk rotates. The rotating disk is vertically adjustable by which clearance between the two disks is adjusted (Fig. 15). As per the variety and condition of paddy, the clearance is decided. The condition of abrasive coating on the disks also affects the clearance.

Paddy is fed into the equipment from top through a hopper. With an adjustable sleeve uniform flow of paddy is maintained, which also spreads paddy evenly to entire surface of the rotating disk. By centrifugal force the paddy is forced between the disk and dehusking takes place due to friction and pressure. During hulling there is a wearing of abrasive coating and is not uniform over the entire surface of the coating. Hulling is mainly concentrated at the centre, therefore, after sometime a ridge is formed at the outer ring of the coating. The ridge causes excessive pressure on the paddy and grain breaks during hulling. Edible grade oil can be extracted from the bran obtained from disk huller. The machine has longer life and the operating cost is low. Paraboiled paddy can also be processed by this machine. The total and head rice recoveries are lesser than what is obtainable by rubber-roll sheller.

**Centrifugal dehusker**

Centrifugal dehusker shells paddy due to impact. The paddy grains are subjected to a centrifugal force by means of rotating impeller with a rotational speed ranging between 2500-
3000 rpm. It creates an impact force sufficient to shell paddy grains. Casing of the dehusker is lined with a rubber sheet (Fig.16). The paddy is fed to the centre of the rotor from which it is thrown towards the casing with great force and is shelled upon hitting. The salient features of the centrifugal dehusker are, its high capacity and simple construction, because there is only one moving part i.e. impeller. Heating of grain does not takes place, as there is no grinding friction action. The initial cost of the machine and the operational cost is low. It requires less power, 1 hp/500 kg paddy dehusking per hour. The total and head rice yield is more than the huliers. The machine needs adjustment according to paddy variety.

**Rubber roll sheller**

Rubber-roll sheller consists of two rubber rolls rotating in opposite direction at different speeds. A feeder feeds paddy unto the machine (Fig. 17). Paddy is fed in thin layer between the rotating roll by the feeder. One of the roll is fixed while the other is adjustable to obtain desired clearance between them. The rolls are driven mechanically and the adjustable roll normally runs about 25% slower than the fixed one. Difference in surface speeds of the rolls develops a shearing force on the grain surface, resulting in the opening and breaking of paddy. The clearance between the roll is kept smaller than the thickness of paddy and may be adjusted subsequently by judging the shelling efficiency. In the gap paddy is fed to it. At decreased gap excess pressure results which cause more breakage of grain and can also cause colouring of shelled rice. In the modern machines, the gap between the rolls is adjustable by suction method, therefore, as per need this gap is automatically maintained.

**Constraints of rubber roll sheller**

To obtain optimum hulling efficiency or performance, the grain should be evenly distributed over the full width of the rolls. In case of non-uniform distribution roll surface wears
out unevenly. This adversely affects the efficiency and capacity of the machines. Long paddy varieties have been reported to put pressure on rubber-rolls on increased area resulting in increased wear of roll surface.

**Husk separator**

It is simple machine having a fan and an arrangement to distribute the product of sheller uniformly on an oscillating sieve with fine perforations. This is done to ensure that air flows across uniformly and blow away the husk. The broken, germs and bran are separated through perforations while the immature grains are also blown away by fan.

**Paddy separator**

All the paddy dehusker, disk huller, centrifugal dehusker or rubber roll sheller are not able to remove 100% husk from paddy. About 80 to 95% husking can be achieved through the machines depending on their efficiency. In addition to the quantity of unshelled paddy with brown rice depends on the following factors:

- Uniformity of paddy
- Variety of paddy
- Condition of paddy
- Husking machine
- Condition of husking machine
- Operator’s skill

The product obtained after husking is mixture of shelled rice, unshelled paddy, husk, broken, bran and dust. With plansifter and husk aspirator dust, husk, broken germs and bran can be removed. For separation of brown rice and paddy, separators are used. The following difference in characteristics of paddy and brown rice are used in paddy separators.
a. The average of weight of paddy is lighter than brown rice.
b. The paddy grain is more buoyant than brown rice.
c. The paddy grains are longer, wider and thicker than the brown rice.

d. Unshelled paddy is separated from the brown rice kernel with the following equipment.

**Compartment type paddy separators**

The equipment has a number compartments arranged in a single or multiple deck (Fig. 18) which varies according to capacity of the machine. This assembly is normally made of wood, however, machines fabricated out of steel are also available. The number of decks varies from 1 to 4 as per need of rice mill. The capacity of a compartment is about 40 kg of brown rice (long grain) and 60 kg (short grain) per hour. This quantity is normally used to determine the number of compartments required for a rice mill. For separation of paddy and brown rice the machine is kept slightly inclined. The inclination depends on the percentage of paddy in the mixture.

Each compartment of the machine has a particular zigzag shape. The sides and ‘z’ shaped steel flanks have an impact angle of about 30°. Paddy and rice mixture when fed to the machine, strike repeatedly the opposite walls of the compartment due to oscillating motion of the table and paddy being lighter than rice, does not flow down. The angular flanks force paddy grains to move upward while the brown rice moves downward along the slope of the table.

**Removal of bran**

In this process, the silver skin and the bran layers of the brown rice are removed. It is also termed as “whitening”. The two processes used to remove the bran layer from the brown rice are abrasion and friction. Abrasion process uses a rough surface, which may be an abrasive stone to break and peel the bran off the grain. The friction process uses the friction between the grains
themselves to break and peel off the bran. Three kinds of whitening machines were widely used in the rice processing industries, (1) the vertical abrasive whitening cone, (2) the horizontal abrasive whitening machine and (3) the horizontal jet pearler.

**Vertical whitening cone**

This machine basically consists of a cone shaped cast iron cylinder with an abrasive coating. The cone is fixed on vertical shafts that rotate either clockwise or counter clockwise. A wire screen having mesh size as per the variety of paddy to be polished is fixed around the cone. The average distance between the cone coating and the screen is about 10 mm. Adjustable rubber brake divide the wire screen at regular intervals. The brakes are 30 to 50 mm wide depending on the size of the machines. (Fig. 19).

Brown rice is fed into the centre of the machine through a hopper. Feeding of brown rice is adjusted by a sleeve, which also uniformly distributes the brown rice to the entire surface of cone. The centrifugal force generated by rotation of cone feed the brown rice between the cone and wire mesh. Rubber brakes restrict the movement of rice, thus, applies pressure. As a result of pressure brown rice is pressed against the abrasive coating of the cone. This friction removes bran layer partly or fully whitened rice leaves the cone through a self-unloading discharge spout.

**Horizontal abrasive whitener**

The machine consists of an abrasive roll operating in a cylindrical metal perforated screen which is horizontally mounted. The screen cylinder covers the emery roll leaving an uniform gap where brown rice is fed through a small screw conveyor. The emery roll rotates while the screen cylinder remains stationary. Polishing is obtained due to rubbing of grains with emery roll, screen and rice grain. Bran removed from rice escapes through holes and is aspirated
out by a blower. The blower, which collects, and carries the bran also provides cooling the rice grains, emery roll and screen.

**Jet pearler**

The jet pearler is used to remove the final part of the bran layer and simultaneously cool the grain through an air stream of ambient temperature.

In consists mainly of a horizontal partly hollow perforated shaft on which a cast steel cylinder with friction ridges is clamped. Just behind the two ridges the cylinder has a long opening which allows passage for air. This cylinder runs inside a hexagonal chamber consisting of two' halves hexagonal screens with slotted perforation. A feeding screw with horizontal shaft feeds the rice into the press chamber of the machine. The clearance between the hexagonal screen and the cast steel cylinder is adjustable by a screw controlling the distance between the two halves of the screen. The rice produced by this machine is free of bran and cool. However, for medium and long grain varieties its performance is not as good as for short grain varieties and there is considerable increase in brokens.

**Rice polishers**

In some markets there is demand for a glossy and highly polished rice. For this, polishers are used after the whiteners. Two types of polishing machines are in use as under.

**Vertical polishing cone**

It is a similar machine as the vertical whitening cone. The basic differences between the two are that in polishing (1) the cone is made of steel and is covered with wood on which leather strips have been nailed (2) no rubber brakes are used and (3) the speed of rotation of the cone is about 25% lower than the whitening cone. The operation of this machine is similar to vertical whitening cone.
Horizontal polisher

It consists of steel cylinder on which a large number of leather strips are screwed. The cylinder is mounted on a horizontal shaft that rotates inside a cylindrical chamber covered with slotted perforated screen. The leather strips roll the whitened rice over and over against the screen. Under slight pressure, the remaining bran is removed and the rice becomes shiny and glossier. This machine produces few brokens. Its power requirement is 30 to 40% less than of whiteners.

Glazing

Some people/countries demand glazed rice. Such rice appears very shiny and more transparent because the surface is coated with a thin layer of talc and glucose. Normally head rice is glazed.

Rice is normally glazed in batches. The glazing drum is partly loaded with rice and is slowly rotated. White shiny talc powder and glucose solution is then added to the rice. Dry talc powder about 10-12% by weight is required. Glucose is added to the rice as 1:1 solution with water. About 1.0 kg glucose solution is required for 1000 kg of rice. Finally water is evaporated and the talc and glucose remain attached to rice. After glazing operation there is an increase in weight i.e., 1000 kg rice becomes 1060 kg after glazing.

Grading

Grading in rice milling usually refers to the separation of brokens from the head rice and the further classification of brokens. Three machines are used for grading of milled rice (1) adjustable reel graders, (2) indented cylinder graders and (3) oscillating sieves.
By knowing the following parameters, the efficiency of rice milling and quality can be calculated. Expressions usually used to estimate the milling efficiency of the rice mill and equipment are:

1. Foreign matter $\% = \frac{\text{Weight of foreign matter}}{\text{Total weight of paddy}} \times 100$

2. Grass and weed seed $\% = \frac{\text{Weight of grasses and weed seeds}}{\text{Total weight of paddy}} \times 100$

3. Dead and immature grain $\% = \frac{\text{Weight of grasses and immature grains}}{\text{Total weight of paddy}} \times 100$

4. Broken grain $\% = \frac{\text{Weight of brokens}}{\text{Weight of paddy}} \times 100$

5. Husked rice $\% = \frac{\text{Husked grains}}{\text{Total weight of paddy}} \times 100$

6. Milling recovery $\% = \frac{\text{Weight of total rice}}{\text{Total weight of paddy}} \times 100$

7. Head rice $\% = \frac{\text{Weight of head rice}}{\text{Weight of milled rice}} \times 100$

8. Broken rice $\% = \frac{\text{Weight of broken rice}}{\text{Weight of milled rice}} \times 100$
Milling efficiency gives the performance of any huller or shelter machine. To determine the milling efficiency knowledge of coefficient of hulling and coefficient of wholeness of grain is required. The product of the two coefficients is the overall milling efficiency of the machine.

Milling efficiency % = Coefficient of hulling x coefficient of wholeness of kernel x 100

Coefficient of hulling = \( \frac{\text{Weight of brown rice}}{\text{weight of paddy fed to machine}} \) x 100

Coefficient of wholeness = \( \frac{\text{Weight of brown head rice}}{\text{Weight of total brown rice}} \) x 100

RICE BYPRODUCTS UTILIZATION

Rice brokens, rice husk, rice bran and rice germ are the four major byproducts of rice milling industry. By effective utilization of the byproducts, one can increase the revenue in rice milling industry.

(a) Rice brokens and its utilization:

In India, rice brokens are used in the preparation of breakfast dishes. Traditionally in some other countries broken rice is used in starch manufacture and brewing. An alcoholic beverage is produced in certain parts of Andhra Pradesh and also in Nepal. Brokens are processed for food uses into flour _ semolina and noodles, raw or pre-gelatinized. Extrusion cooked products for infant foods and snacks have been developed.

Although 5 - 50% of the rice grains may break during milling, the medium and large broken are mixed with heard rice in trade practice. Therefore, it is only the very small brokens that are separated during grading of milled rice.
(b) Rice husk and its utilization:

Rice husk constitute 20% of the total weight of paddy. Rice hull has the lowest content of protein and available carbohydrates and the highest content of crude fibre, crude ash Silica. The use of disposal of husk has frequently proved difficult because of the tough, woody, abrasive nature of the husks with low nutritive properties and resistance to weathering. The lightness of husk imposes problems in volume handling. The equilibrium moisture content of husk is less (10.8% at 70% RH).

Rice husk commercial uses:

(i) Husk as fuel: Rice husk is mainly used as fuel because of its high calorific value that has ranged from 2937.29 K.Cal per kg to 3461.31 K.Cal per kg

(ii) Husk in cattle feed preparations: Though poor in nutritive value, whole or ground husk is incorporated in cattle and /poultry feeds (40 - 50%). The other agricultural uses of husk are bedding and litter, compost, mulch, seedling aid, sewage and sludge modifier.

(iii) Gaseous fuel from husk: Conversion of paddy husk to fuel oil by reaction with CO and water gas in the presence of catalyst and water was carried out. Under optimum conditions, more than 99 per cent of organic matter in the husk was converted into liquid and gaseous products. Out of this 40-50 per-cent is benzene soluble liquid product and the rest are gaseous (Regional Research Laboratory, Dhanbad, India).

(iv) husk briquetting: compression or extrusion of husk has been advanced as a solution to the problems of density and transportation cost. The briquettes can be used as industrial and domestic fuel.

(v) Husk boards: All types of panel boards used for exterior or /interior purposes in the form of wall boards, floor or ceiling can be made from husk using resin to bind the materials together.
The alternative would be chemically transform some of the cellulose on the exterior of the husks to be a plastic which would bind the husk together.

By mixing rice husk with 8% by weight of synthetic resin and pressing in a preheated hot press using definite pressure at 154 - 21 CPC composite boards could be prepared. The husk has to be ground to a particle size of 40 to 60 mesh (BS) to make board without any binder. The powdered husk was mixed thoroughly with 2% sulfuric acid at 5 - 8% of husk weight and dried. The dried mixture was pressed slowly by a hot hydraulic press at 60 - 70 kg/cm² pressure and at 165°C for 20 - 25 min, the board of 1.1 to 1.3g/c.c density was obtained. In another process, the ground husk of 10 - 20 mesh was mixed with phenol formaldehyde resin at 7 - 8% of husk weight. The resin coated husk was dried in the sun and hot pressed slowly using the resin as binder boards of densities ranging from 0.6 to 1.06g / c.c were made by applying pressures of 20 kg / cm² and 140g/cm² respectively.

(vi) Furfural from husk: Treatment of husk with sulphuric acid and steam distillation produces furfural. Rice husk yields 12 - 13% furfural. Furfural is used in the plastic, synthetic rubber and oil refining industries.

(vii) Sodium silicate from husk ash: It is used in the manufacture of soap, detergents, silica gel, as adhesives, bleaching and sizing of textiles and paper pulp, glass foam, pigments, water proofing mortars and cements. Sodium silicate from grey ash was extracted by cold or hot process by using 10% sodium hydroxide solution. To reduce the cost of the product, sodium carbonate and sodium hydroxide in the ratio of 10:1 may also be used. Activated carbon was used in bleaching the sodium silicate. The extracted solution was concentrated to 55° C

(viii) Silicon tetra chloride from rice husk. Laboratory process for the manufacture of silicon tetra chloride from rice husk has been developed. The process is a combination of chlorination
and pyrolysis of rice husk leading to a mixture of silica and carbon formed by the carbonization of the cellulosic matter in the husk. Pyrolyzed husk can be chlorinated at 1000°C to give a nearly quantitative yield of silicon tetra chloride.

(ix) Molecular sieves from husk. Molecular sieves are porous crystalline alumino silicates of the zeolite mineral group. They emerge as a new class of adsorbents and catalysts. Molecular sieves find application in chemical, petrochemical and gas industries as absorbent, for desiccation, drying, bulk separation and recovery of gases and liquids. Regional Research Laboratory, Jorhat, India has developed a process for the synthesis of type’ A’ and type’ X’ molecular sieves using paddy husk. The process involves the extraction of silica from paddy husk, mixing the extract with definite proportion of sodium aluminate under suitable conditions to prepare alumino-silicate gel and crystallizing the gel under normal pressure and suitable temperature to produce desired molecular sieve powder.

(x) Husk ash in rubber compounding; Superior mechanical properties were claimed of natural rubber compounds loaded with rice husk char. Rubber compounds containing 50-100 parts of ash by weight of .100 parts of rubber show mechanical properties that are superior to those given by commercially available ground silica or clay fillers.

(xi) Activated carbon from husk ash: Black ash is treated with 7.5% NaoH solution and autoclaved at 1.4 kg/cm² for 15 min. The material is washed to remove sodium silicate. The carbon was then stirred with 2% solution of zinc chloride, filtered, autoclaved at 2.1 kg/cm² for 30 min dried and ground to pass 100 mesh screen. Activated carbon is used in sugar industry for bleaching.

(xii) Cement from husk ash; In the preparation of cement from paddy husk, the silica in the paddy husk ash should be made available in a non-crystalline form. Burning of husk below
400°C makes silica remains in a non-crystalline form. The ashes prepared by burning husk below 400°C were mixed with 25 - 40% lime and were thoroughly ground in a vibratory grinding mill. After 3 days of curing the compressive strength was 55 - 105 kg/cm² compared with 115 kg/cm² in the portland cement. After 7 days of curing, the compressive strength was 80 - 130 kg/cm² compared with 175 kg/cm² for standard portland cement.

(c) **Rice bran and its utilization:**

Rice bran in commerce consist of seed coat, aleurone and sub-aleurone layers of the kernel with part of the germ and a small portion of the starchy endosperm. Considering the richness in oil, protein, minerals and vitamins in rice bran, the much needed nutrients can be made available for the society by suitable processing or blending and converting it into suitable forms.

The nature and composition of the bran obtained from rice depends on the system of milling and on any pre-treatment given to the paddy. When paddy is milled by single hullers, a mixture of powdered husk and true bran is obtained. Hence this bran contains very low amounts of oil and protein and high amounts of fibre and ash. It has very little industrial use.

When paddy is milled in sheller mills, it is first dehusked and then polished in a polisher. The main rice bran of industrial importance is the true-bran, that is, the outer layer of brown rice separated during its polishing. Bran composition is affected by the degree of milling. As the degree of milling increases beyond 5%, the amounts of oil, fibre and ash in it decrease and that of starch increases gradually.

Rice bran is the most valuable byproduct of rice milling industry. It contains 12 - 15% protein, 14 - 20% oil if the paddy is raw and 18 - 25% parboiled and is rich source of vitamins.

(i) **Rice bran as a source of oil:**
The brown rice grain contains only about 2.5 - 3% fat. Bulk of the grain oil is situated in a thin layer within the outer parts of brown rice. Pure rice bran contains not less than 15% and even up to 25% oil. The bulk of the oil of rice grains (50 - 80% of total oil) comes into the bran during its polishing. There was a wide gap between the availability and demand for edible oil in India. As a matter of fact, there has been severe shortage of edible oil in the country. By effective utilisation of rice bran as a source of oil, the import of edible oil can be reduced considerably.

Rice oil is extracted from bran by using the solvent hexane in solvent extraction plants. Low FFA oil is used for edible purpose after suitable refining. High FFA oil is used for soap manufacture. The deoiled rice bran is a good source of protein and used as an ingredient in feed manufacture.

(d) Rice germ and its utilization:

Rice germ is characteristically richer in protein and fat, but lower in fibre than the bran. It is extremely small and is located on the ventral side of the caryopsis. It has 2 - 3% weight of brown rice. About one third of brown rice lipid is in the germ. Non-protein nitrogen in rice germ is about 13% of total nitrogen. Germ is also rich in vitamins.

High quality protein, edible oil and vitamins are the most valuable components of rice germ, but it contains impurities, natural toxicants and allergens besides heavy load of microorganisms exceeding several million per gram.

Any attempt in utilizing germ for food preparation should involve steps in quick separation, moist heat stabilization, defatting and hygienic handling. Purified germ can be used for the preparation of milk, snacks and sweet.
ABOUT AUTHOR

Dr. S. Krishnaprabhu, is graduated in B.Sc., (Agriculture) from Agricultural college and Research Institute, Madurai, Tamil Nadu, where he did his M.Sc. (Ag.) in 2002. He has been working in Annamalai University from 2002, where he obtained his Ph.D in Agronomy also with specialization in Nutrient Management and presently he is Assistant professor in Agronomy., his specialization in Nutrient management and crop improvement and he has been teaching courses on principles of Agronomy, Irrigation and dry farming management, Agronomy of field crops and crop production to under graduate students for ten years. He is supervising has to his credit of more than ten numbers of research papers published various international journals. Also, a widely accepted two text books entitled, 'Scientific Production of Field Crops' and 'Rice Crops Production' aid value to his name.

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