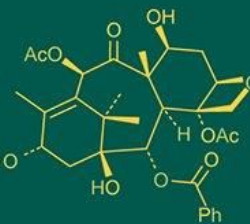
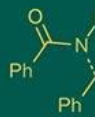
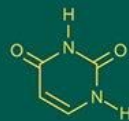
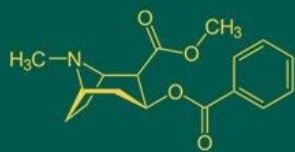


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Study of milling and nutritional characteristics of brown rice obtain from traditional hand pounding

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Abstract

Brown rice is dehulled, rice with pericarp, the seed coat and nucellus, the germ or the embryo, and the endosperm. It is whole grain rice with intact bran layer. Although it has several health claims, it is mostly consumed by a limited number of health conscious and nutritionally aware people. The study aimed to evaluate the nutritional properties of brown (0% polish) and the rice milled by traditional hand pounding. (Shobana *et al.*, 2011).

Milling characteristics of Ratnagiri-7 paddy were evaluated using traditional hand pounding at three moisture content levels: 8%, 12%, and 16%. The results indicated that milling recovery was highest at 8% moisture content (57.07%) and decreased as moisture content increased, reaching the lowest value of 46% at 16% moisture content. Concurrently, broken rice percentage increased with increasing moisture content. The traditional hand pounding method was found to be time-consuming and energy-intensive. Additionally, the nutritional composition of the milled rice was affected by moisture content. As moisture content increased from 8% to 16%, protein, fat, fiber, and ash content decreased, while carbohydrate content increased.

Keywords: Traditional, milling characteristics, pounding, milling recovery, physicochemical, proximate analysis

Introduction

Paddy (*Oryza sativa* L.) is one of the most important staple foods of the world and is the second largest producing crop in India after wheat. Rice, *Oryza sativa* (2n = 24) belonging to the family Gramineae and subfamily Oryzoides is the second most important cereal crop and staple food of more than half of the world's population. Globally, India becomes first in paddy cultivation and second in paddy production, after China. It contributes 21.5% percent of global paddy production. More than 50% of the world's population feed on rice. So as staple food, it plays an important role and used as an important source for number of industrial products like food whole rice, rice starch, rice bran, rice bran oil, flaked rice, puffed rice, paddy as a seed, parched rice, rice straw and rice husk etc.

Konkan region is a major rice producing area of Maharashtra. The Konkan region of Maharashtra is predominant rice growing belt with an average productivity of 33.5 q/ha. The region comprises of five districts viz. Thane, Palghar, Raigad, Ratnagiri and Sindhudurg. The total area under rice cultivation in Kharif 2019 season in the region was 3, 92, 392 ha, out of these, 89% area were sown under rice. Average rice yield was low in the region i.e. 2500-3500 kg/ha in case of high yielding varieties while in case of hybrids 3500-4500 kg/ha. Average seed rate adopted by the farmers was 50-60 kg/ha (Anonymous, 2020) ^[1].

Choudhari *et al.*, (2018) ^[2] they studied Rice nutritional and medicinal properties at Department of Genetics & Plant Breeding, COA, IGKV, Raipur, Chhattisgarh, India. They found that brown rice contains 80% carbohydrates, 7-8% protein, 3% fat, and 3% fibre which was higher than polish rice.

Rohman *et al.*, (2014) ^[3] studied nutritional properties of rice at department of pharmaceutical chemistry, gadjah mada university, yogyakarta, indonesia. Rice bran produced rice bran oil and defatted rice bran. Defatted rice bran component consisted a number of polysaccharide and dietary fiber that support in cancer and cardiovascular diet therapy. It was observed that 100 gm. of white rice contain 10.46 gm of water, 6.81 gm of protein, 0.55 gm lipid, 81.86 gm of carbohydrates. Similarly, 100 gm of brown rice flour contain 11.97 gm. of water, 7.20 gm. of protein, 2.78 gm. of lipids, 76.48 gm. of carbohydrates and 4.6 gm. of fibers.

It was concluded that brown rice contain high amount of protein, lipids and fibers. while low amount of carbohydrates. Brown rice varieties which are cultivated in Konkan have many health benefits. The average yield of rice is about 4.5 to 5.0 t/ha. It consists of 28.50% (17.35 ppm) and 32.7% (7.9 ppm) high iron content in brown and polished rice, respectively. It also consists of 42.82% (28.35 ppm) and 43.0% (24.25 ppm) high zinc content in brown and polished rice, respectively. It also has low glycemic index (53). Brown rice varieties having high milling (64.17%) and head rice recovery percentage (60.65%) with good cooking quality. Also, these varieties are having low amylose, high zinc, iron, riboflavin and antioxidant, nutritional and physico-chemical properties. Now a days due to its nutritional, medicinal, health benefits people are getting aware about brown rice. (Waghmode *et al.*, 2018) ^[4].

In ancient time hand pounding method most predominantly used in rural areas of Konkan region of Maharashtra for paddy milling, millet milling. Study of the milling characteristics and nutritional properties of rice obtained from traditional hand pounding method was necessary, this gives wide scope to study, milling of rice obtained from traditional hand pounding.

Materials and Methodology

Study of the laboratory and field experiments of traditional hand pounding method have been conducted at College of Agricultural Engineering and Technology, Dapoli.

Material and equipment's

The paddy was procured from Department of Agronomy, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. Ratnagiri-7 variety of paddy is used for study of traditional hand pounding. Equipment's used during sample preparation of paddy for milling, proximate analysis of sample obtains by using mortar, pestle, sieve, weighing balance, muffle furnace, Soxhlet apparatus, oven, distilled water, chemicals such as NaOH, CuSO₄, Sulphuric acid, catalyst K₂SO₄, petroleum ether, beaker etc.

Milling of paddy by traditional hand pounding method

The effect of operational parameters on the performance of traditional hand pounding method was studied. The sample of paddy of Ratnagiri-7 variety of 1000 gm was measured by removing and adding of water i.e., to decrease moisture level from 12% m. c. to levels 8 m. c. and to increase from 12% m. c. to 16% m. c. respectively. Sample of paddy having moisture 8% (M₁), 12% (M₂), 16% (M₃) respectively allows to pound into mortar by hand pounder i.e., pestle. It was allowed to pound through three replications of each pass (P₁) by taking constant time period of 15 to 20 min, for pounding of 1000 g. As the paddy sample required time was 15 minutes by hand pounding. It was considered to be 15 minutes for all replications of hand pounding.

Milling characteristics of the rice obtained from traditional hand pounding

Performance evaluation of the traditional hand pounding method was done by considering following parameters. Described by Das *et al.*, (2016) ^[5].

Milling recovery

Take 1000 g sample of rough paddy having moisture content level of 8%, 12% and 16%. Allow milling of paddy by hand

pounding method and also in developed pounding machine for 10 min time span. After 10 minutes stop pounding, remove husk by manually winnowing or aspirator. Weight milled rice and find out milling recovery by following formula.

$$\text{Milling Recovery (\%)} = \frac{\text{Weight of milled rice}}{\text{Weight of rough rice}} \times 100$$

Percentage head rice

Take 1000 g sample of rough paddy having moisture content level 8%, 12% and 16%. Allow milling of paddy by hand pounding method and also in developed pounding machine for 10 min time span. Remove husk by manually winnowing or aspirator. Milled rice allows to pass through grader which separate broken and whole head rice. Weight head rice and milled rice and find out percentage of head rice by using following formula.

$$\text{Percentage of Head Rice (\%)} = \frac{\text{Weight of Head rice}}{\text{Weight of Milled rice}} \times 100$$

Percentage broken rice

Take 1000 g sample of rough paddy having moisture content level of 8%, 12% and 16%. Allow milling of paddy by hand pounding method and also in developed pounding machine for 10 min time span. After 10 minutes stop pounding, remove husk by manually winnowing or aspirator. Milled rice allows to pass through grader which separate broken and head rice. Weight broken rice and milled rice and find out percentage of broken rice by using following formula.

$$\text{Percentage of Broken Rice (\%)} = \frac{\text{Weight of Broken rice}}{\text{Weight of Milled rice}} \times 100$$

Percentage of husk

Take 1000 g sample of paddy having moisture content level of 8%, 12% and 16%. Allow milling of paddy by hand pounding method and also in developed pounding machine for 10 minutes time span. After 10 minutes stop pounding, remove husk by manually winnowing or aspirator. Take weight of husk removed from milled rice and weight of milled rice and find out percentage of husk by using following formula.

$$\text{Percentage of Husk (\%)} = \frac{\text{Weight of Husk}}{\text{Weight of Rough rice}} \times 100$$

Percentage of milling loss

Take 1000 g sample of rough paddy having moisture content level of 8%, 12% and 16%. Allow milling of paddy by hand pounding method and also in developed pounding machine for 10 minutes time span. After 10 minutes stop pounding, remove husk by manually winnowing or aspirator. Take weight of straw, stones, dust from milled rice and weight of rough rice and find out percentage of milling loss by using following formula.

$$\text{Milling Losses (\%)} = \frac{\text{Weight of unhusk rough rice + stone + dust}}{\text{Weight of Rough rice}} \times 100$$

Proximate analysis of brown rice

Proximate composition of brown rice was calculated by using standard method of analysis (AOAC, 2000) ^[6] for different milling methods such as protein content, fat content, fiber

content, moisture content, carbohydrate content and ash content evaluated using standard methods.

Results

Milling characteristics of rice obtained from Ratnagiri -7 paddy variety was explained in below figures 1,2,3,4 and 5. The result obtained from traditional hand pounding methods was given in table 1 and it was observed that, in treatment P₁M₁ (i.e., 8% m. c.) the milling recovery was highest i.e., 57.07% with low head rice recovery 1.96% and high broken

percentage i.e., 54.13%. At P₁M₂ (i.e., 12% m. c.) the milling recovery decreased up to 51.84% with high head rice recovery increased up to 2.60% and broken percentage reduced up to 49.40%. From the table 1, it can be concluded that as moisture content increased from 8% to 12% the broken percentage decreased with increased in head rice recovery. At P₁M₃ i.e., 16% moisture content milling recovery, head rice recovery, broken percentage was decreased up to 49.23%, 2.433% and 46% respectively. as moisture level increases from 8% to 16%.

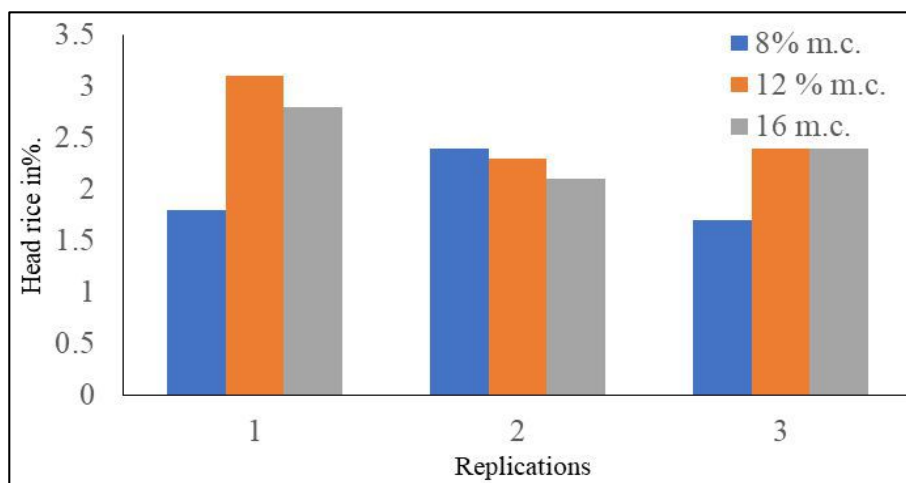


Fig 1: Head rice recovery from hand pounding method

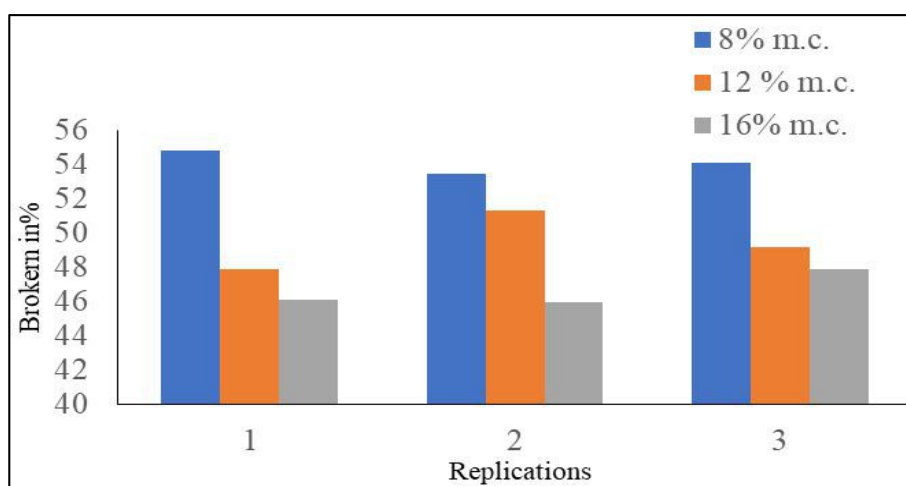


Fig 2: Broken rice recovery from hand pounding method

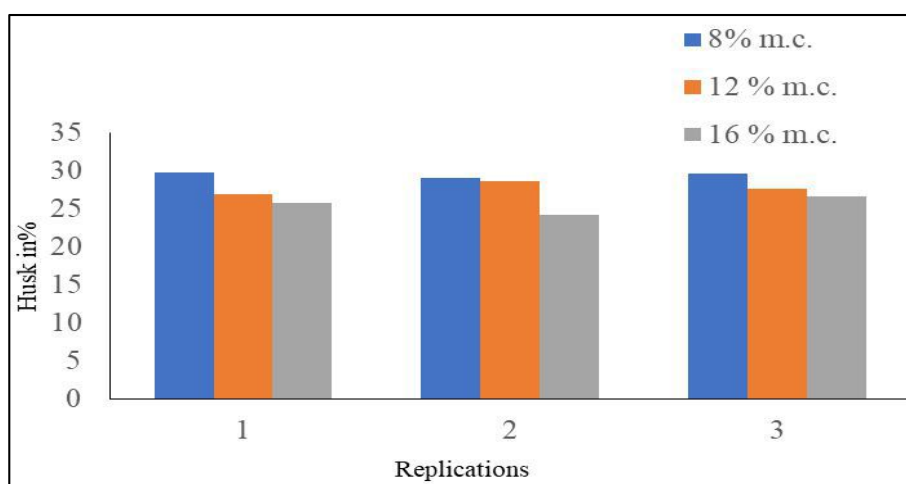


Fig 3: Husk recovery from hand pounding method

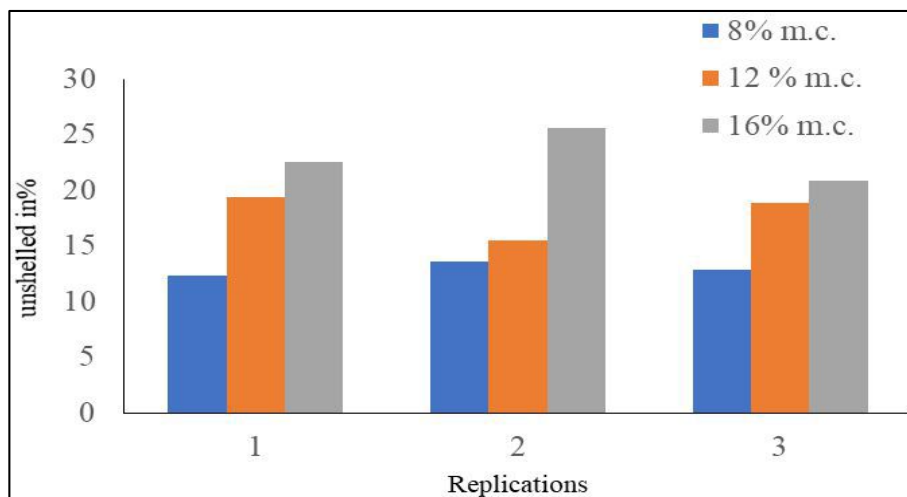


Fig 4: Unshelled paddy recovery from hand pounding method

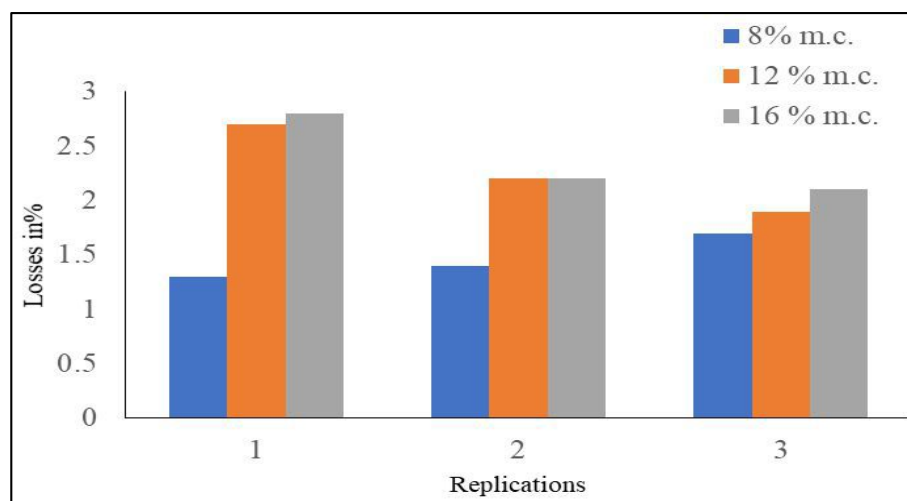


Fig 5: Losses obtain in hand pounding

Table 1: Milling characteristics of sample obtained from traditional hand pounding method.

Sr. No.	Treatment details	Milling Recovery (%)	Head Rice (%)	Broken Rice (%)	Husk Percentage (%)	Percent Milling Losses (%)
1	P ₁ M ₁	57.07	1.96	54.13	29.5	1.46
2	P ₁ M ₂	51.84	2.60	49.40	27.70	2.26
3	P ₁ M ₃	49.23	2.43	46	25.56	2.36

Statistical analysis for milling characteristics of traditional pounding method for paddy was given as below. For whole rice, broken rice, Husk, unshelled and losses at three levels of moisture i.e., 8%, 12% and 16%. With three replications. From the statistical analysis, it was observed that head rice recovery varies non significantly with m.c. and rpm. While broken rice, husk, unshelled, losses vary significantly with

m.c. and non-significantly vary with rpm. As moisture content increases paddy get break instead of shelling, and shelling was less, so above milling properties get varies inversely with m.c. Nutritional characteristics of Ratnagiri-7 rice obtained by hand pounding method were measured are presented protein content, moisture content, fat content, ash content, fiber content and carbohydrate content in Table 2.

Table 2: Nutritional composition of Ratnagiri-7 rice obtained by hand pounding method

Sr. No	Milling Method	Moisture content (%)	Protein content (%)	Fat content (%)	Fibre content (%)	Ash content (%)	Carbohydrate content (%)
1	Hand pounding	8	8.98	2.53	3.25	2.27	74.97
2	Hand pounding	12	7.13	2.11	2.17	1.44	75.15
3	Hand pounding	16	5.44	0.98	1.36	0.86	75.36

From Table no 2, it was observed that protein was found to be 8.98%, 7.13%, 5.44% at 8%,12% and 16% moisture content, respectively, which was lowest in rice obtain from power operated pounding machine. Fat content retained was found to be 2.53%, 2.11% and 0.98% at 8%,12% and 16%

moisture content respectively in rice obtain from traditional hand pounding which was less in rice obtained from power operated pounding machine. Fiber content was also reduced from 3.25% to 1.36% as moisture content increases from 8% to 12%. Similarly, result was found in case of percentage of

carbohydrates was increased from 74.97%, 75.15% and 75.36% as moisture was increased from 8%, 12% and 16%. From above table 2, it was observed that protein, fat, fiber, and ash inversely proportional to moisture content. While carbohydrates are directly proportional with moisture content.

Conclusion

In case of traditional hand pounding method of milling, time required for milling of 1 kg paddy was 15 minutes. In hand pounding method, high milling recovery was obtained from milling of paddy sample having 8% moisture content and it was decreased as moisture content increased from 8% to 16%. Head rice recovery was increased as moisture content increased from 8% to 12% and again get decreased as moisture level increased from 12% to 16%. Nutrient such as protein, fat, fiber recovery was highest in sample of a rice obtained from traditional hand pounding method. As moisture content increased protein, fat, fibre, ash content get decreased while percentage of carbohydrate was increased.

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