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Study of physical and milling characteristics of Himalayan rice

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Abstract
Recently, pigmented rice red rice, black rice and wild rice) varieties have gained attention from consumers for their high bioactive compounds which include phenolic compounds that possess antioxidant, anti-carcinogenic, anti-allergic, anti-inflammatory, anti-atherosclerosis and hypoglycaemic activities. Prescribed methods were used to evaluate the results at YSPUHF, Nauni, Solan, HP. Physical characteristics of rice analyzed of the white paddy varieties was found high value in terms of 1000 kernel weight (g), length (mm) and breath (mm) respectively and low value in L/B ratio and Thickness (mm) in comparison to red rice. In terms of milling red rice took longer time than white rice. And rice recovery (%) was higher of white rice than red rice.

Keywords: Raw rice, flour, parboiled, milling, recovery and kernel weight

Introduction
Rice (*Oryza sativa* L.) is a common cereal crop consumed by over half of the world's population as a staple food. It ranks third in the production next to sugarcane and maize (Monks *et al*., 2013) [14] where 95.0 per cent of the rice is cultivated mainly in Asian countries. The world's rice production is reported to be 755.47 million tonnes from an area of 162.06 Mha (FAO, 2019) [6]. India ranks as the second largest producer of rice in the world next to China followed by Indonesia and Bangladesh. Red rice is especially grown abundantly in the region to endowed traditional red rice cultivars rich in nutritional values, cultural values, fine aroma and medicinal properties.

In rice, protein has gained great attentions due as to its relatively well-balance amino acid profile, which is superior in lysine content as compared to wheat, corn, millet and sorghum (Hegsted, 1969) [8] which has a great potential to improve human nutrition in rural population of Asia. Despite of the amylose content, milled rice prepared by removing around 7-12 per cent of the bran improves its sensory properties and storage stability. As compared to white rice, Vitamin B_1, B_2, C and minerals like N, P, K, S, Mg, Ca, Fe and Zn are 2-3 times higher in red rice (Ramaiah and Rao, 1953; Jing *et al.*, 2000) [16, 9].

Recently, pigmented rice (red rice, black rice and wild rice) varieties have gained attention from consumers for their high bioactive compounds which include phenolic compounds that possess antioxidant, anti-carcinogenic, anti-allergic, anti-inflammatory, anti-atherosclerosis and hypoglycemic activities (Deng *et al*., 2013) [5]. Anthocyanins and proanthocyanidins are found in purple and red bran rice, respectively which results in health-promoting potentials (Abdel-Aal *et al*., 2006) [1]. Pigmented rice is a well-known source of antioxidant compounds including flavonoid, anthocyanin, phytic acid, proanthocyanidin, tocopherols, tocotrienols, γ-oryzanol, and phenolic compounds (Butsat and Siriamornpun, 2010; Goufo and Trindade, 2014) [4, 7]. Apart from cytotoxic effects against hepatocellular cell lines (HEPG2) (Revilla *et al*., 2013) [17]. It is also mentioned in Ayurveda that red rice is best for health, skin, eyesight, diuretic and improves voice and fertility.

Parboiled red rice also releases glucose more slowly than raw red rice, parboiled white rice and raw milled white rice this might be due to the protein-anthocyanin complex migrate into starch gel by unknown mechanism that results in inhibition of enzymatic starch hydrolysis (Parera *et al*., 2000) [15]. Rice bran oil (RBO) is generally considered to be one of the high-quality vegetable oils in terms of its cooking attributes, shelf life, fatty acid composition and stability at higher temperatures as it contains oleic, linoleic and α-linolenic acids as unsaturated fatty acids and palmitic and stearic acids as saturated fatty acids.

It is also rich in various bioactive compounds (phytosterols, sterol esters, triterpene alcohols, γ-Oryzanol, tocopherols, tocotrienols and other phenolic compounds) (Bopitiya and Madhujith, 2014) [3].

Materials and Methods

1. **Raw material:** Raw material such as red rice and white were procured from KVK Almora, Uttarakhand and then brought to the Department of Food Science and Technology, UHF, Nauni, Solan (HP) for conducting the studies.
2. **Determination of Physical properties of Himalayan rice**:- **Kernel weight (TKW):** A thousand grains were counted manually and were recorded for their corresponding weights by the use of a digital weighing balance with an accuracy of 0.001 g (Ishida Co. Ltd., Japan).
3. **Dimensions (Length breadth and thickness):** Length breadth and thickness of red rice and white rice were recorded with the help of Vernier calliper and expressed in mm. 100 grains were randomly selected and their three principle dimensions (length, width and thickness) Length (L) is defined as the distance from the tip cap to the kernel crown Width (W) is defined as the widest point to point measurement taken parallel to the face of the kernel. Thickness (T) is defined as the distance between the two kernel faces.
4. **Total rice:** Rice yield is the process parameter which shows the quantity of f rice from a paddy sample

$$\text{Total Rice (\%)} = \frac{W2}{W1}\text{X}100$$

Where
W1 = initial weight of sample
W2 = final weight of the sample after sieving

L/B ratio: The L/B ratio is the ratio of length and breadth. L/B ratio of the grain theoretically calculated by using the following equation

$$\frac{L}{B}Ratio = \frac{Length(mm)}{Breadth(mm)}$$

5. **Milling percentage:** Weight of polished rice includes head and broken also. The Milling
   Recovery (MR) is calculated by the following formula suggested by (Mahadevamma, S. and Tharanathan, R. N. 2007.)
6. **Broken percentage:** The broken percentage of rice is shown in form of percentage. It is determined by using following equations.

$$Broken\ percentage\ (\%)\frac{W1 - W2}{W}X100$$

Where
W = initial weight of sample (kg);
W1 = Weight of sample after milling
W2 = final weight of the sample after sieving (kg).

7. **Rice Recovery:** After the milling process, the rice was thoroughly cleaned for husk and bran. The cleaned rice was separated into whole and broken.
8. **Parboiling methods:** Procedure used for the preparation of parboiled rice. **(**Manful, J. T.2007).

Results and Discussions

1. **Physical characteristics of paddy and rice: Thousand kernel weight:** The thousand kernel weight of paddy varieties namely white, raw milled and parboiled, was found to be 25.00±1.00 gm, 19.93±0.21 gm and 20.40±0.68 gm and red varieties, raw milled and parboiled 23.90±0.5gm, 20.60±0.17 gm, 22.10±0.79 respectively (Table 1a&b).
2. **Dimensions of paddy and rice:** The length of the paddy ranged from 8.93±0.16 to 5.91 mm with a mean value of 7.30±0.34 mm for the variety white, for the variety red it ranged from m8.26±0.02 to 7.03±0.01 mm with a mean value of 7.37 mm variety was found more as compared other two varieties (Table 1). The width of paddy, milled and parboiled ranged from 2.53±0.01 to 2.25±0.02mm with a mean value of 2.23mm for the variety white varieties, for the variety red it ranged from 2.23±0.01 to 2.47±0.02with mean value of 2.35 mm was found more as compared to the other two varieties (Table 1). The thickness of paddy ranged from 1.91±0.01to 1.63±0.02 mm with a mean value of 1.73 mm with a mean value of white verities and for red varieties ranged from 1.97±0.01 to 2.01±0.06 respectively. Among all varieties, the thickness of red was found more and the thickness of the white rice paddy variety was found to be less compared to other (1).
3. **Length/breadth ratio:** The length/breadth (L/B ratio) of the paddy ranged from 3.59±0.02 to 2.62±0.01 mm with mean value as 3.31forwhite varieties, the L/B ratio ranged from 3.68±0.01 to 2.83±0.01with a mean value of 3.14 for red respectively. Among all varieties, the L/B ratio of red varsities was found more and the L/B ratio of the white paddy variety was found to be less as compared to others (Table 1a&b).

Milling characteristics of paddy

1. **Milling time:** Milling time for raw white rice was recorded as 2.50 min/kg and for parboiled white rice as 2.00 min/kg while in the case of raw red rice milling time was recorded as 3.30 min/kg and 3.00 min/kg for parboiled red rice. It was found that the milling time after parboiling decreased as compared to raw rice. Similar findings have been reported by Bagheril *et al.* (2013) [2] and Modgil and Rani (2016) [13].
2. **Total rice (%):** The paddy variety for making rice (Raw milled and parboiled) namely white shows value of total rice is 69.00±1.0% and 77.75±2.08%, and red varieties 64.50±1.00 and 73.00±1.15 respectively.
3. **Broken (%):** The broken per cent of raw white rice was found to be 6.00 per cent while the minimum broken per cent of 4.00 per cent was recorded after parboiling. Similarly, in the case of red rice 8.00 per cent of the broken per cent was found in raw red rice with a minimum broken per cent (6.00%) found after parboiling. Similar results have been reported by Kumar *et al.* (2018)).
4. **Husk (%):** Husk per cent in raw white and red rice was found to be 22.88 per cent and 24.80 per cent whereas 17.75 per cent and 20.08 per cent were recorded after parboiling respectively. Similar findings have been reported by Modgil and Rani (2016) [13]. (Table 2a&b).

Table 1a: Physical characteristic of paddy

Parameter	White Paddy	Red Paddy	t-value	Sign. (Two tailed)
1000 kernel weight (g)	25±1.00	23.9±0.50	1.29	0.324
Length (mm)	9.12±0.16	8.27±0.02	0.0645	0.954
Breadth (mm)	2.54±0.01	2.24±0.01	0.159	0.888
L/B ratio	3.59±0.02	3.69±0.01	0.067	0.952
Thickness (mm)	1.91±0.01	1.97±0.02	0.088	0.937

Table 1b: Physical characteristics of rice

Parameter	White Rice	Red Rice	t-value	Sign. (Two tailed)
1000 kernel weight (g)	19.9±0.21	21.6±0.02	0.285	0.802
Length (mm)	7.09±0.01	6.83±0.01	0.096	0.932
Breadth (mm)	1.91±0.15	2.34±0.01	0.000	1.000
L/B ratio	3.71±0.02	2.91±0.15	0.007	0.994
Thickness (mm)	1.66±0.01	1.93±0.01	0.021	0.985

Table 1c: Physical characteristics of rice

Parameter	White Parboiled rice	Red Parboiled rice	t-value	Sign. (Two tailed)
1000 kernel weight (g)	20.4±0.36	22.1±0.79	0.3167	0.7815
Length (mm)	5.92±0.07	7.02±0.01	0.0520	0.9633
Breadth (mm)	2.26±0.01	2.47±0.01	0.0844	0.9404
L/B ratio	2.61±0.15	2.84±0.01	0.0577	0.0577
Thickness (mm)	1.64±0.10	2.01±0.15	0.0000	1.0000

Table 2a: Milling characteristic of paddy

Parameter	White Paddy	Red Paddy	t-value	Sign. (Two tailed)
Milling time	2.5.00±0.15	3.30±0.10	0.985	0.397
Rice recovery (%)	69.00±1.00	65.00±1.00	0.994	0.393
Broken (%)	6.00±1.02	8.00±1.05	0.642	0.566
Husk (%)	23.00±1.20	25.00±1.00	0.890	0.438
Bran (%)	2.00±1.20	2.00±1.03	0.970	0.437

Table 2b: Milling characteristics of parboiled paddy

Parameter	White Parboiled Paddy	Red Parboiled Paddy	t-value	Sign. (Two tailed)
Milling time	2±0.07	3.00±0.07	0.973	0.402
Rice recovery (%)	77±2.08	73.00±1.15	0.92	0.423
Broken (%)	4±1.00	6.00±1.00	0.3974	0.717
Husk (%)	18±1.02	20.00±1.00	1.1190	0.344
Bran (%)	1.00±0.06	1.00±0.07	0.862	0.301

Conclusion

The findings of the present study confirmed the varietal influence upon dimensional and physical attributes of rice. The perusal of results showed that the dimensional and physical properties of rice vary from short to long grain varieties. It was concluded that the Himalayan red rice is found low recovery percent and high in broken and husk % and can be taken for further to evaluated in different parameters and value added products to explore the milling characteristics and cooking quality.

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