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RESEARCH ARTICLE

EFFECT OF FLOOD ON THE PHYSICAL QUALITY OF PADDY AND RICE (*ORYZA SATIVA L.)*

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ABSTRACT

Rice is a major component of the agricultural sector in particular and the overall economy in general. Flooded paddy is often sold at low price causing economical loss to the farmers. Therefore, the present study was conducted to study the physical quality properties of flood affected paddy and rice in comparison with normal paddy and rice to find the quality of various physical parameters. Statistically significant difference ($P < 0.05$) in the physical properties such as grain hardness (N: 4.20 Kg and F: 2.91 Kg), bulk density (N: 0.85 g/ml and F: 0.82 g/ml), 1000 kernel weight (N: 15.55 g and F: 14.53 g), kernel length (N: 5.71 mm and F: 5.19 mm), L/B ratio (N: 3.59 mm and F: 3.32 mm)was found between the normal rice and flood affected rice. However, no significant difference was observed in the breadth (N: 1.59 mm and F: 1.56 mm) between the samples. Statistically significant difference was observed in the L* a* b* values in paddy, unpolished rice and polished rice except a* (Hue) value for paddy and b* (brightness) value for unpolished rice, between control and experimental samples. Therefore, further extensive research is needed for the utilization of paddy for the production of more feasible and convenient products in order to minimize the economic losses to the farmers.

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INTRODUCTION

Rice is a major component of agricultural sector in particular and the overall economy in general. Suzanne *et al*. (2013) reported that in 2010, approximately 154 million ha of rice was harvested worldwide, of which 137 million ha (88.0%) of the global rice harvested was in Asia. Paddy loss due to flooding in Bangladesh and India alone amounts to an estimated quantity of 4.0 million tons per year, which is enough to feed 30 million people. Over 20% of rice land in Bangladesh is prone to floods which occur every year (IRRI 2010). Much of this paddy is therefore wasted or it deteriorates due to microbial attack. Several researchers observed physical changes in rice kernels subjected to different soaking times and temperatures (Miah *et al.,* 2002; Kim *et al.,* 2005; Thakur and Gupta 2006). Apparently, higher temperature and longer time for soaking accelerated these changes. Rice is a hygroscopic grain that will readily gain or lose moisture when exposed to varying environments. Moisture changes can induce tensile and compressive stresses within the kernel and often lead to stress crack development. Moisture adsorption is associated with water re-entering the grain.

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This occurs when the vapor pressure at the surface of a grain is lower than the vapor pressure in the surrounding air. The low moisture rice kernels fissure from rapid moisture adsorption was reported more than a half century ago by Kondo and Okamura (1930) and Stahel (1935). Jung and Seung (2009) reported that soaking affected the colour of the brown rice kernels. The rice kernel surface became brighter and less yellowish, increasing the L*value but decreasing the b*value. It was stated that, bran compounds might have diffused into the endosperm and soaking water, while inner compounds might have migrated to the kernel surface. The results indicated that enhanced water diffusion accelerated the migration of the components and thus the colour changed. Such produce is often sold at low price causing economical loss to the farmers, especially small and marginal farmers. Therefore, the present study was carried out to investigate the effect of flood on the physical quality properties of paddy and rice in comparison with normal paddy and rice.

MATERIAL AND METHODS

Paddy was procured from the flood affected areas.Both normal paddy and flood affected paddy samples of same variety were procured from Raavulapaalem in West Godavari district of Andhra Pradesh. The paddy which was flood affected (submerged under water for almost three days at fully matured stage) was collected for the study. The study was carried out at Post Graduate and Research Centre (PGRC),Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad. Grain hardness was assessed by hardness tester.An average of ten readings was taken. Bulk density of the sample was assessed by standard procedures for rice given by Sahay and singh (2005). The bulk density is also represented by hecto-litre weight. The weight of grain per hecto-litre is called hecto-litre weight.

Hectolitre weight=mx0.2 kg

Where, m=weight of product, g

1000 kernel weight of samples were assessed. 1000 sound kernels were selected randomly. The samples were weighed. The procedure was repeated 3 times. An average of 3 readings was taken. Kernel length, breadth and L/B ratio were assessed by standard procedures for rice given by Sahay and singh (2005). Length and width of 10 unbroken grains of each were measured with a grain micrometer. Ten readings were taken and calculated the average length, width and L/B ratio of rice grains. The rice samples were classified using the standard classification as given by IRRI 1996. Colour quality of the samples was estimated by using Hunter lab calorimeter (Colour Quest XE Hunter Lab, USA) Colour lab scale values (CIE LAB scale) were determined by using hunter calorimeter. The paddy and rice of normal and flood affected samples plated in Fig 1 and 2.

Fig. 1. Normal paddy and normal rice

Fig. 2. Flood affected paddy and flood affected rice

RESULTS AND DISCUSSION

The grain hardness was higher for normal rice (4.2 kg) compared to flood affected rice (2.91 kg). Statistically significant difference at P<0.05 in grain hardness was observed in normal rice compared to that of flood affected rice. It may be due to prolonged period of flooding weakens the inside starchy portion of the kernel (Table 1 and Fig 3). The bulk density was higher for normal rice (0.85 g/ml) compared to flood affected rice (0.82 g/ml). Statistically significant difference (at P<0.05) in the bulk density was observed between the samples (Table 1 and Fig 3).

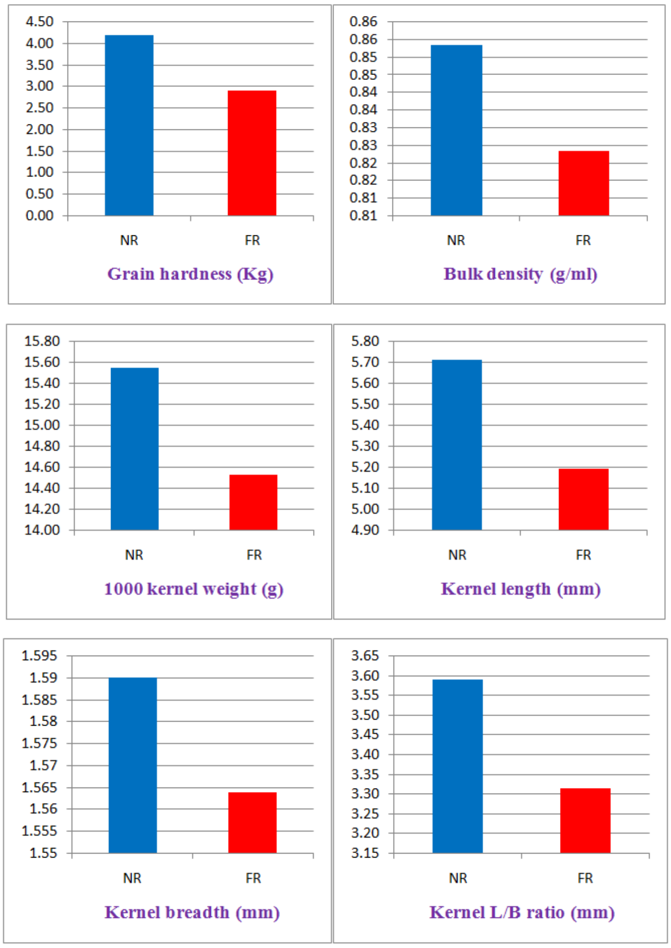

Fig. 3. Physical properties of normal rice in comparison with flood affected rice

Bulk density (BD) is an important physical property of rough and milled rice. The BD of rice depends on grain type (long, medium or short-grain), moisture content, kernel density and additional physical properties such as kernel shape and dimensional characteristics. Wratten *et al.* (1969) studied the physical dimensions and BD of long and medium grain rice varieties conditioned to various MC levels.

Table 1. Physical properties of normal rice and flood affected rice

Sample	Grain hardness (Kg)	Bulk density (g/ml)	1000 kernel weight (g)	Kernel length (mm)	Kernel breadth (mm)	L/B ratio (mm)
Normal rice	4.20±0.93	0.85±0.01	15.55±0.34	5.71±0.26	1.59±0.08	3.59±0.17
Flood affected rice	2.91±0.18	0.82±0.01	14.53±0.03	5.19±0.29	1.56±0.05	3.32±0.16
CD	0.632	0.013	0.555	0.260	N.S.	0.161
SE (d)	0.298	0.005	0.195	0.123	0.030	0.076
SE (m)	0.211	0.003	0.138	0.087	0.021	0.054
CV	18.763	0.689	1.585	5.033	4.197	4.917

Table 2. Colour scores of paddy, unpolished rice and polished rice

Details	L*a*b* Values					
	Paddy		Unpolished rice		Polished rice	
	NP*	FP*	UNR**	UFR**	PNR***	PFR***
Light (L*)	51.16±0.24	47.08±0.05	55.35±0.14	59.58±0.06	69.75±0.11	65.27±0.10
CD	0.406		0.259		0.243	
SE (d)	0.142		0.091		0.085	
SE (m)	0.101		0.064		0.06	
CV	0.355		0.194		0.154	
Hue (a*)	6.64±0.30	6.23±0.05	5.07±0.17	2.65±0.07	-1.45±0.09	1.60±0.10
CD	N.S.		0.306		0.226	
SE (d)	0.177		0.107		0.079	
SE (m)	0.125		0.076		0.056	
CV	3.371		3.404		135.524	
Brightness (b*)	24.67±0.44	20.55±0.06	20.78±0.32	20.37±0.11	14.19±0.15	15.50±0.19
CD	0.728		N.S.		0.398	
SE (d)	0.255		0.196		0.14	
SE (m)	0.181		0.139		0.099	
CV	1.383		1.166		1.152	

*NP- Normal paddy and *FP- Flood affected paddy
**UNR- Unpolished normal rice and **UFR- Unpolished flood affected rice
***PNR- Polishednormal rice and ***PFR- Polished flood affected rice

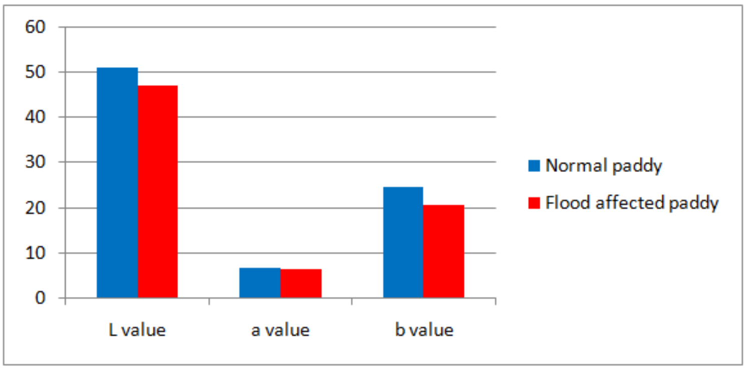

Fig. 4. Graphical representation of color scores of normal paddy and flood affected paddy

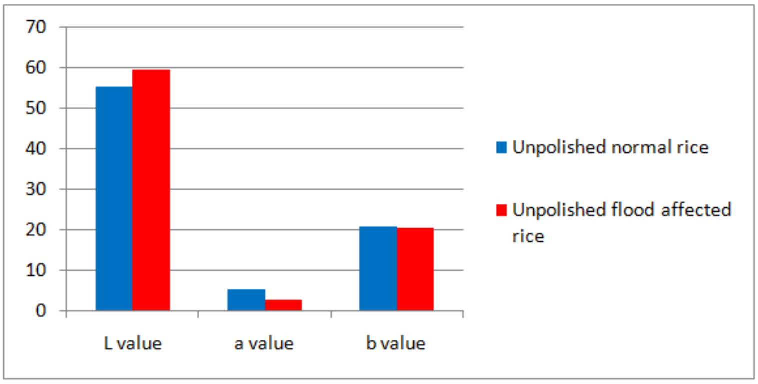

Fig. 5. Graphical representation of color scores of unpolished normal rice and unpolished flood affected rice

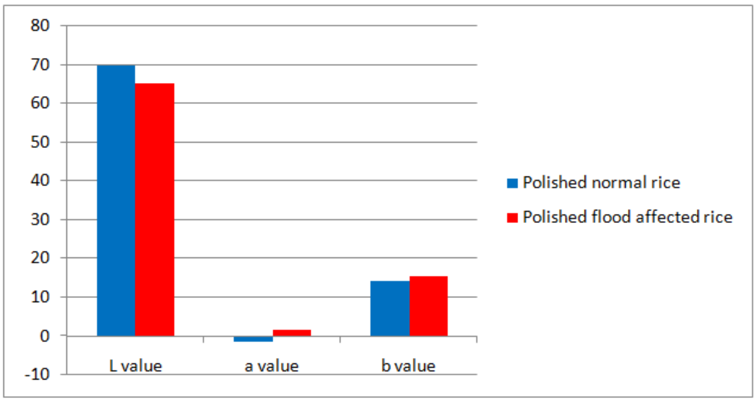

Fig. 6. Graphical representation of colour scores of polished normal rice and polished flood affected rice

It was found that the rough rice length, width, thickness, and BD were linear and direct functions of MC. This trend was also observed by Morita and Singh (1979), who studied the BD of short-grain rough rice. In a related investigation of physical properties of rough and milled rice, Bhattacharya *et al*. (1972) reported that as MC increased, kernel density and BD of rough rice increased. The 1000 kernel weight was higher for normal rice (15.55 g) compared to flood affected rice (14.53 g). Statistically significant difference (P<0.05) in 1000 kernel weight was observed between the two samples (Table 1 and Fig 3). Kernel length, breadth and L/B ratio between both the samples was higher for normal rice (5.71 mm, 1.59 mm, 3.59 mm respectively) and lower for flood affected rice (5.19 mm, 1.56 mm, 3.32 mm respectively).

Statistically significant difference at P<0.05 in kernel length and L/B ratio was observed between the two samples. According to the IRRI 1996 classification the studied variety MTU 7029 falls under Medium slender rice but the flood affected rice looks like short slender. This may be due to loss of starchy portion of the grains during milling and polishing. However, statistically significant difference was not observed in kernel breadth of the samples. This may be because the breadth wise breakage was lower compared to length during milling and polishing (Table 1 and Fig 3). The colour values were mainly determined in the form of light (L*), hue (a*) and brightness (b*). The colour scores of paddy, unpolished rice and polished rice are presented in Table 2 and Fig 4 to 6. The L*a*b* values for normal paddy were 51.16, 6.64 and 24.67 respectively and for flood affected paddy they were 47.08, 6.23 and 20.55 respectively. The L* and b* values for normal paddy samples were significantly higher. Statistically significant difference at P<0.05 in L* and b* values was observed between the two samples. There was no significant difference in a* values between the two samples. The lightness (L*) value for both the samples showed opposite results i.e., normal paddy slightly towards whiteness (100) and flood affected paddy slightly towards blackness (0). Whereas in case of a* value, for normal paddy it was more towards redness (+a* value) compared to flood affected paddy. Similar results were obtained for b* value, in that it was towards more yellowness (+b* value) for normal paddy compared to flood affected paddy. The L*a*b* values for unpolished normal rice were 55.35, 5.07 and 20.78 respectively. The Lab values for unpolished flood affected rice were 59.58, 2.65 and 20.37 respectively. Statistically significant difference at P<0.05 in L* and a* values was observed between the two samples. Statistically significant difference in b* values was not observed between the two samples.

The lightness (L*) value for both unpolished normal rice and unpolished flood affected rice resulted towards whiteness (100). The L* value for unpolished flood affected rice was more compared to unpolished normal rice. In case of a* value unpolished normal rice resulted more towards redness (+a*) value compared to unpolished flood affected rice. For b* value unpolished normal rice showed more yellowness (+b*) compared to unpolished flood affected rice. The L*a*b* values for polished normal rice were 69.75, -1.45 and 14.19 respectively. The L*a*b* values for polished flood affected rice were 65.27, 1.60 and 15.50 respectively. Statistically significant difference at P<0.05 in L*a*b* values was observed between the two samples. The lightness (L*) value for both polished normal rice and polished flood affected rice was towards whiteness (100). The L* value for polished normal rice was more compared to polished flood affected rice. In case of a* value polished normal rice showed towards greenness (-a* value) but polished flood affected rice showed a* value towards redness (+a* value). For b* value polished flood affected rice showed more yellowness (+b* value) compared to polished normal rice. During soaking, the rice kernels leach soluble materials and may burst, which often changes the color of the kernels. These changes are affected by soaking time and temperature (Thakur and Gupta 2006). With regard to colour scores, statistically significant difference was observed in the L*a*b* values in paddy, unpolished rice and polished rice between control and experimental samples, except a* value for paddy and b* value for unpolished rice.

Conclusion

The physical properties studied such as grain hardness, bulk density, 1000 kernel weight, kernel length, breadth and L/B ratio were statistically lower for flood affected rice (2.91 kg, 0.82 g/ml, 14.53 g, 5.19 mm, 1.56 mm and 3.32 mm respectively) compared to normal rice (4.20 kg, 0.85 g/ml, 15.55 g, 5.71 mm, 1.59 mm and 3.59 mm respectively). The colour scores of paddy, unpolished and polished rice were studied. The L* a* b* values for normal paddy were 51.16, 6.64 and 24.67 respectively, which were higher compared to flood affected paddy (47.08, 6.23 and 20.55 respectively). The L* a* b* values for unpolished normal rice were 55.35, 5.07 and 20.78 respectively. The L* a* b* values for unpolished flood affected rice were 59.58, 2.65 and 20.37 respectively. The L* a* b* values for polished normal rice were 69.75, -1.45 and 14.19 respectively. The L* a* b* values for polished flood affected rice were 65.27, 1.60 and 15.50 respectively. Statistically significant difference at P<0.05 in L* a* b* values was observed between the two samples.

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