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EFFECT OF AGEING, MOISTURE CONTENTS AND STORAGE STRUCTURES ON COLOR PARAMETERS OF BROWN RICE DURING AMBIENT CONDITION

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ABSTRACT

Brown rice (Sugandha) used for experiment were stored for four months at different moisture contents i.e. 16, 14 and 12 percent (w.b) with different storage structures used i.e. mud bin, gunny bag and polypropylene bag at ambient condition such as analyzed color parameters is defined in terms of lightness (L), a and b values. These are very significant in determination of chroma values. A different trend was observed in lightness value during storage. The ageing improves the lightness. Maximum lightness values were observed in mud bin (56.84, 56.02 and 55.32) followed by gunny bag (56.38, 55.78 and 54.98) and polypropylene bag (56.13, 55.18 and 54.52) at 12, 14 and 16 percent moisture content respectively. However chroma values increase with storage periods the highest value of chroma found in gunny bag (24.81) followed by mud bin and polypropylene bag (24.24) has the lowest value in all storage structures irrespective to moisture contents. When moisture contents were taken into consideration, chroma values has not seen more effected with moisture contents.

KEY WORDS
Brown rice
Ageing
Indigenous storage structures
Moisture contents

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INTRODUCTION

Rice (*Oryza sativa L.)* is the staple food for more than half of the world's population. About 90% of the world's rice is grown and consumed in Asia (Tyagi *et al.* 2004). India is one of the world's largest producers of rice, accounting for 20 percent of all world rice production. The process that produces brown rice removes only the outermost layer the hull, of the rice kernel and is the least damaging to its nutritional value. The complete milling and polishing that converts brown rice into white rice destroys 67 percent of the vitamin B3, 80 percent of the vitamin B1, 90 percent of the vitamin B6, half of the manganese, half of the phosphorus, 60 percent of the iron and all of the fiber and essential fatty acids (Babu *et al.* 2009).

Color of the food is considered as the prime qualities evaluated by the consumers either by perception or consumption (Dhanapal *et al.,* 2013*)*. Rice yellowing is a problem for the rice industy (Dillahunty *et al.,* 2001). The color of rice is an important sensory parameter, generally the brightness rice has more value in the market place (Lamberts *et al*., 2007). And also the yellowness of rice has adverse effect on cost of rice. Temperature or moisture enhances the color fading in storage (Primo *et al.,* 1970). Color is an important primary factor for characterization and grading, trade and processing of grain. In color parameters is defined in terms of lightness (L), a and b values. Value of a and b are very significant in determination of color parameters. It was hypothesized that ageing of rice in traditional air tight storage structures improves the lightness and chroma value.

Yellowing does not necessarily refer to yellow-colored kernels. Colors range from yellow to orange to reddish. Factors responsible for yellowing include fungi or mold (Schroeder 1963), grain water activity, and surrounding air temperature, oxygen, and carbon dioxide content (Bason *et al.,* 1990). Some of these factors may work in conjunction to cause yellowing. However, none of the existing theories on the causes of yellowing are conclusive.

In India, the types of storage structures vary from area to area depending on the climatic condition, requirement and availability of materials. The storage structures are made of locally available materials. Rice like other food grains is grown only once or twice in a year. But it has to be eaten the year round. So rice has to be stored.

Limited research work has been done on storage of brown rice at ambient condition at various moisture contents in different traditional storage structures so the study was conducted to determine change in color parameters of stored brown rice.

MATERIALS AND METHODS

The brown rice sample were obtained from the paddy (sugandha variety) procured from krishi upaj mandi, Jabalpur. The moisture content at the time of procurement was 16 percent (wet basis), Since 14 percent and 12 percent samples were also required so paddy was sun dried in the floor of Agricultural Engineering farms for limited period of time and samples of 12 percent and 14 percent moisture content were prepared. The procured paddy was converted into brown rice by rubber roll sheller at Saarda Rice Mill, Panager, Jabalpur. The rice obtained by dehusking of paddy is called as brown rice. The paddy milled at 16, 14 and 12 percent moisture content produced brown rice of 15, 13 and 11 percent moisture respectively. This is because friction in rubber rolls during shelling and exposure to atmosphere during cleaning, blowing, grading and separation etc. This brown rice was stored into three different storage structures namely gunny bag, mud bin and polypropylene bag. Mud bin was prepared with clay, paddy straw and cow dung. Polypropylene and gunny bag were equipped with movable zip for inspection and withdraw of samples. Brown rice was stored in each storage structures of different moisture contents for four months (February, March April and May). Samples were taken out from each storage structure at 30 days interval to determine the color parameters.

Color analysis

Color was analyzed by measuring the reflectance. A Hunter Color lab Colorimeter (45/O-L; 10^o/D65, Hunter Associates Laboratory Inc., Reston, Virginia, USA) 10^o was used as the light source. The colorimeter was calibrated against standard white plate (L = 91.78, a = -0.28, b = 0.07) before the sample measurement.

Determination of lightness

A glass cylinder containing brown rice was placed above the light source and covered with a lid. Three Hunter parameters, namely L, a and b were measured. 'L' is known as the lightness and extends from 0 (black) to 100 (white). The other two coordinates 'a' and 'b' represents redness (+ a values) to greenness (- a values) and yellowness (+ b values) to blueness (-b values), respectively.

Determination of chroma

C* (chroma) is the attribute of color used to indicate the degree of departure of the color from gray of the same lightness. The chroma represents color saturation which varies from dull at low chroma values to vivid color at high chroma values. chroma were calculated from a* and b* values according to the following formulae (Wrolstad and Smith, 2010):

$$C^* = (a^2 + b^2)^{1/2}$$

RESULTS AND DISCUSSION

In this analysis color is defined in terms of L, a and b values. These are very significant in determination of lightness and chroma.

Lightness value (L)

The effect of different storage structures and storage periods on lightness when materials stored at 12, 14 and 16 percent moisture are shown in table 1

Result revealed from table-1 that trend of lightness increased with storage periods in different storage structures. It has been observed that the trend of lightness increased with respect to the storage structures (Mud bin > Gunny bag > Polypropylene bag) irrespective of moisture contents. Highest lightness value was observed at 12% moisture content. Initial lightness value observed for mud bin was 53.55 which were increased to 56.84 after 120 day of storage period. Similar trend of lightness value observed for gunny bag (53.55 to 56.38) and polypropylene bag (53.55 to 56.13).

It has also been observed that the lightness decreasing with increasing moisture content. i.e lightness minimum at 16 percent moisture (51.59) followed by 14 percent moisture (51.73) and maximum at 12 percent moisture content (53.55) in different storage structures during the storage periods

It was observed from ANOVA that the interaction among three factor (Storage structures X Moisture content X Number of days) was highly significant at 1 % level of significance.

It was reported that rice stored with low moisture content exhibits higher lightness whereas rice with high moisture

Table 1: Lightness of samples with different storage structures at different moisture contents

Storage structure	Storage period, Days	Moisture content, percent (w.b)		
		12	14	16
Mud bin	0	53.55	51.73	51.59
	30	54.46	52.23	52.19
	60	55.41	54.31	54.06
	90	55.88	55.20	54.98
	120	56.84	56.02	55.32
Gunny bag	0	53.55	51.73	51.59
	30	54.12	52.04	51.92
	60	55.28	54.01	53.83
	90	55.62	54.98	54.78
	120	56.38	55.78	54.98
Polypropylene bag	0	53.55	51.73	51.59
	30	53.98	51.89	51.80
	60	54.96	53.79	53.17
	90	55.22	54.02	53.72
	120	56.13	55.18	54.52

Table 2: Chroma values of samples with different storage structures at different moisture contents

Storage structure	Storage period, Days	Moisture content, percent (w.b)		
		12	14	16
Mud bin	0	23.06	23.22	23.37
	30	23.53	23.75	23.92
	60	23.66	23.85	24.08
	90	24.02	24.12	24.23
	120	24.16	24.36	24.57
Gunny bag	0	23.06	23.22	23.37
	30	23.85	24.03	24.13
	60	23.95	24.15	24.28
	90	24.17	24.34	24.48
	120	24.33	24.60	24.81
Polypropylene bag	0	23.06	23.22	23.37
	30	23.37	23.56	23.80
	60	23.59	23.70	23.92
	90	23.75	23.96	24.06
	120	24.07	24.13	24.24

content exhibits lower lightness. Thus the results of this study is in agreement with the results reported by (Dillahunty *et al.,* 2001). And results reveals from table-1 indicates that lightness gradually increase with increase in number of storage days. It might be due to temperature rise. Results were in agreement as reported by (Jang *et al.,* 2009).

Chroma values (C*)

Chroma is an aspect of color in the Munsell color system by which a sample appears to different grey of the same lightness or brightness and that corresponds to saturation of the perceived color (Loughrey, 2002).

The effect of storage periods on chroma when material stored at 12, 14 and 16 percent moisture in different storage structures are shown in table 2

As evident from table 2, ageing improves chroma value. Brown rice stored in gunny bag exhibits highest value of chroma (23.37 to 24.81) followed by mud bin (23.37 to 24.57) and polypropylene bag (23.37 to 24.24) at 16 % moisture content for storage duration of 120 days. When moisture contents were taken into consideration, it has not seen more effect on chroma value.

The analysis of variance (ANOVA) for chroma values indicated that the interaction among three factor (Storage structures X Moisture content X Number of days) was significant at 1 % level of significance.

The result of this study are in agreement with earlier results reported by (Netravati *et al.,* 2015), who studied on effect of various pre-storage treatments and storage duration on chroma value of mango.

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