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Effects of Packaging Materials and Storage Condition on White Rice Varieties Physico-Chemical and Cooking Traits

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Abstract: The study was carried out to explore some physical and cooking traits of coarse and aromatic white rice varieties namely DR-82, IR-6, Basmati-385 and Lateefy grown in Sindh and Punjab Provinces of Pakistan. The effects of packaging materials(Cotton, Gunny& Nylon) and storage time intervals were also determined on the varieties for physical and cooking parameters. The findings were accordingly established at Institute of Food Sciences and Technology, Sindh Agriculture University (SAU) Tando Jam, Pakistan. The selected samples of paddy rice varieties (DR-82, IR-6 and Lateefy) were procured from the Rice Research Institute (RRI) Dokri, Larkana, Sindh and Basmati-385 was collected from RRI Kala Shah Kaku, Punjab, Pakistan. Results revealed 1000-grain weight (g) values were high 21.30 (g) of Coarse IR-6 at initial stages although, it was lower 14.00g in aromatic Lateefyafter12 months period in Nylon Bags. High moisture content 20.00% was observed in coarse DR-82 kept in gunnybags at 06monthsperiod whereas, lowest moisture content was 6.90% in DR-82 in cotton bags at 12 months storage. The Gel consistency results revealed that all aromatic and coarse white rice varieties were medium and soft Gel length values was 99.00mm of BS-385 kept in nylon at 09monthsstorage period though, it was 60.00mm of IR-6 and Lateefy at initial stage. There was a significant difference among all varieties. Cooking quality parameter of water absorption ratio was high 4.47mm in Lateefy at 12 months in nylon bags and low 2.90mm in DR-82 at initial stages. The volume expansion ratio 5.40mm was found high in coarse IR-6 in gunnybag at 03 months storage however, 1.73mm low were in coarse IR-6 at 09months storage in gunnybags. This study concludes that packing materials, and storage temperature as well as duration significantly influence the physicochemical as well as cooking properties of the coarse and aromatic white rice varieties as the study revealed that the moisture (%) was decreased in all varieties during the storage period. There was a significant decrease in 1000-grain weight in all varieties. Physicochemical and cooking quality traits were also influenced by packages and storage environments. This research work can be useful in the collection of packaging material, storage period and temperature for suitable storage of white rice in bulk stores to keep its best superiority in maximum possible shelf life.

Keywords: Rice Varieties, Physicochemical Cooking Attributes and Packaging Material.

1. INDTRODUCTION

Rice (Oryza sativa L) is one of the utmost significant grains in human nourishment, accounting for around 75% of the worldwide population. It is the keynutritive component of public in most republics/regions. It is a staple food for a majority of the population of Asia, more than 90% of rice is consumed in this region. (Mohanty, 2013). Rice is second main staple food crop of Pakistan after wheat, it is key source of our foreign exchange earnings in food groups. It was cultivated on 2810 thousand hectares in 2018-19 and the production was7202 thousand tons (GoP, 2019). It consists of 80% carbohydrates, 7–8% protein, 3% fat and 3% fiber (Juliano, 1985). Different from other main grains, rice is usually the food directly consumed by humans, and it is also the food of whole grains. In Asia and Africa, its consumption is high, while in the European Union it is less (Vlachos and Arvanitoyannis, 2008). Due to its nutritional quality and high digestibility, rice is considered the queen of grains (Anjum *et al.,* 2007). Aromatic varieties have attracted the attention of consumers due to their excellent quality characteristics such as ultra-fine particles, excellent cooking value, nice fragrance and longitudinal elongation throughout cooking (Bhattacharjee *et al.,* 2002). Storage temperature affects the texture and sensory properties of the rice. Throughout the storage, temperature & humidity are main features that can explain the changes in the chemical and sensory properties of rice (Butt *et al.,* 2008). The sensory characteristics of the rice can be changed during the long storage period, in addition to changing the aroma of rice, the texture of rice often changes during aging (Tananuwong and Malila., 2011). To ensure the quality of rice, it is recommended to store it for a short time below room temperature (Park *et al.,* 2012). Studies have revealed that the physical and chemical characteristics of rice depend on storage circumstances and time period. It has been used to safely store rice with a moisture content greater than 15% in order to

keep the temperature of the rice at 5-12°C (Pomeranz 1992). The characteristics of aromatic and non-aromatic rice are based on certain unique characteristics, which can be classified as export quality of rice with good and unique nutritious value (Verma *et al.,* 2015). Aromatic features are key characteristics of basmati rice grown in different regions of India and Pakistan (charjee *et al.,* 2002). After harvesting, the rice is kept in different packages such as burlap, cloth and plastic bags. The quality of rice depends on various factors. One of these factors is the storage of rice, which is the normal phase among harvest and consumption. Cooking time is important because it largely determines the softness and stickiness of rice. The aging of rice milling limits the gelatinization of starch granules and explains why cooked rice needs extra water and additional time than fresh rice (Katekhong and Charoenrein, 2012. Based on the above findings, the study work was conducted to assess some important storage conditions which effects the physical & chemical properties and cooking quality traits of. coarse and white rice varieties.

2. MATERIALS AND METHODS

Collection of Samples

Four paddy Rice varietiesIR-6 and DR-82 (coarse) &Basmati-385 and Lateefy (aromatic) were collected from the Rice Research Institute (RRI) Dokri, Larkana, Sindh and from RRI Kala Shah Kaku, Punjab, Pakistan, during the crop year 2012-13. The Paddy rice were dried and cleaned before the next step.

Sample Preparation

The white rice was obtained after removing the husk and bran layer, each variety was de-hulled by passing through stake Sheller. Samples were dried for 24 hours at room temperature, subsequently samples were packed in 03 packages i.e,. Gunny, Cotton and Nylon bags. All the samples were stored in ambient temperature at Rice Research Institute, Dokri, Larkana, Sindh, Pakistan for a period of one year. The ambient temperature was recorded and the mean temperature during the study was remained average high/low 44±5/29±5°C. Physicochemical and cooking the observations were done for fresh and stored white rice at quarterly basis (3, 6, 9& 12 months), respectively.

Parameters evaluated

Thousand grain weight (TGW)

Samples of each variety randomly weighed 50g then the weight of 1000 kernel of each sample was recorded in grams/1000 by counting the grains and weighing.

Moisture (%)

The Moisture content was determined by Moisture - Air-Oven Method. 100g sample of white rice of each variety was dried in oven at105±5°C temperature. Followed by the procedure described in AOAC (2000) method No.44-15A.

Gel Consistency (mm)

Procedure recommended by the Cagampang *et al.* (1973) was adopted for Gel consistency mm measurement. White rice grain was crushedinto flour, and 100 mg of the grinded flour was poured intothe test tube measuring 2x19.5 cm to which 0.2 mL ethanol with a 0.25% thymol blue and 2.0 mL solution of KOH having 2.8 g KOH compound in 250 mL distilled water was added. This was homogeneously mixed using vortex mixture. This mixture was kept for 8 minutes in the boiling water bath. Thereafter, it was kept for 5 min for normal cooling and then finally put for 20 minutes in the ice bath. After that test tubes were removed from ice bath and kept in horizontal form for an hour and graph paper was used for measurements.

Cooking Quality Evaluation

Cooking traits of each white rice variety was concluded/evaluated as explained below:

Volume expansion and Water absorption ratio

It was observed by adopting the technique of Juliano (1971). The volume expansion ratio was worked out by dividing the boiled rice volume over that of the raw one. Though, the water absorption ratio was achieved by dividing the weight of boiled rice over that of uncooked one. To measure the volume expansion ratio of white rice in the first group, 10 grams of each sample was taken in 3 cylinders measuring 100 ml each and containing 50 ml water. The volume of water and rice jointly increased in the cylinder. The rise in volume was observed that was the volume of raw white rice. In the second group each rice sample was soaked in water. After 30 minutes it was cooked for 10 minutes in boiling water in glass beaker. Thereafter water was immediately filtered out and cold water was mixed to cool down the cooked rice grains. To get water totally filtered out, the cooked rice was first passed through sieve and then put over the filter paper when water was completely drained increase in volume of cooked rice was recorded using the same procedure as for raw rice.

Statistical analysis

Experiments were carried out using three replicates. All the results were statistically analyzed by using the software package Statistix 8.1. (2003).

3. RESULTS

Storing temperature influence the textural & sensory features of the cooked rice. Brief stowage time under room temperature is suggested for the rice quality (Park *et al.,* 2012). Afterward lengthy stowage of rice, changes in the sensory qualities of the cooked rice can be perceived. Apart from rice aroma alteration, textural changes throughout rice aging usually occur (Tananuwong and Malila, 2011). The data on 1000-

grain weight (g) is shown at (**Table-1)**. Result revealed the significant differences among all the white rice varieties. The 1000-grain weight content of the aromatic variety BS-385 was reduced in the storage time, it was 16.07g at initial stage in all packages whereas, after 12 months, 14.47g in cotton, 14.10g in gunny and 14.15g in nylon was noted respectively. Coarse variety DR-82 showed reduction in the grain weight, 20.70g was found at initial level while after 12 months it was 16.50g, 16.80g, 15.50g in cotton, gunny and nylon. Significant decrease was observed in coarse IR-6 at fresh level it was 21.30g however, after one year 14.30g in cotton, 14.70g in gunny and 17.60g was determined in nylon. 1000-grain weight of aromatic Lateefy was reduced and after 12 month it was 14.60g in cotton, 14.20g in gunny and 14.00g in nylon whereas, at initial level it was 14.90g. Among all the varieties (20.13g) high 1000-grain weight at 06 months stowage in nylon bags was gotten in coarse IR-6. Though,(19.60g) was found in gunny & nylon bags at 03 months and lower (14.00g) was determined in Lateefy an aromatic variety at 12 months stowage in gunny. Overall high mean value 19.32% was observed in coarse IR-6 kept in nylon while low 14.44% was of Lateefy in nylon bag.

Table-1. 1000-Grain weight (g) of the white rice varieties affected by the different packaging materials and storage period

Varieties	Packaging material	Storage Intervals (months)					Mean**	Mean***
		Fresh (0 days)	3 Months	6 Months	9 Months	12 Months		
BS-385	Cotton	16.07 J-p	13.50 w	17.20 ghi	15.00 q-v	14.70 r-v	15.23 e	15.32 c
	Gunny	16.10 J-p	15.70 l-r	16.63 h-l	14.33 uvw	14.10 vw	15.37 e	
	Nylon	16.10 J-p	15.53 m-s	15.83 k-q	14.70 s-v	14.50 tuv	15.32 e	
DR-82	Cotton	20.70 ab	17.03 g-j	18.33 ef	16.50 i-n	16.40 i-o	17.78 bc	15.32 c
	Gunny	20.70 ab	17.30 ghi	18.95 de	16.80 h-k	16.50 i-o	18.04 b	
	Nylon	20.70 ab	18.00 efg	17.30 ghi	15.50 n-t	15.40 o-t	17.36 cd	
IR-6	Cotton	21.30 a	19.60 cd	15.40 p-t	14.60 s-v	14.30 uvw	17.02 d	17.99 a
	Gunny	21.30 a	18.50 ef	18.93 de	14.90 q-v	14.70 r-v	17.64 ab	
	Nylon	21.33 a	19.60 cd	20.13 bc	17.93 efg	17.60 fgh	19.32 a	
Lateefy	Cotton	14.90 q-v	15.20 p-u	16.53 i-m	14.70 r-v	14.60 s-v	15.18 e	14.73 d
	Gunny	14.93 q-v	14.20 uvw	15.00 q-v	14.50 s-v	14.20 uvm	14.57 f	
	Nylon	14.90 q-v	14.33 uvw	15.00 q-v	14.03 vw	14.00 vw	14.44 f	
Mean*		**18.24 a**	**16.53 c**	**17.09 b**	**15.28 d**	**15.08 d**		
SE	**0.5166**						**0.2311**	
LSD 5%	1.0229						0.4575	

* Time Interval, ** Packaging, ***Variety

The results of moisture (%) currently surveyed in are at (**Table 2)** shows that the moisture content of aromatic BS-385 was reduced in all packages, at fresh level it was 10.78, 10.76, and 10.77 % in cotton, gunny and nylon bags whereas, after 12 months 7.13% was noted in cotton, 7.20% in gunny and 7.40 nylon. Coarse variety DR-82 showed decrease in moisture content in all packages, 11.60% was observed in cotton at fresh level while 6.90% was determined after one year. In the gunny bag at initial stage, it was 11.57% however, 7.50% was observed after 12 months period. Increase was found in nylonbags; at fresh level it was 11.60% whereas 12.13% was noted after 12 months. The aromatic Lateefy's moisture content was reduced, at fresh level it was 11.10% in all packages whereas, 7.07, 7.30 and 6.50% in cotton, gunny and nylon was determined respectively. Among all varieties the maximum moisture content (12.00%) of DR-82 a coarse rice variety in gunny bag at 06 months period, whereas, medium (11.60%) was observed in aromatic BS-385 at06 months in Gunny, the lowest (6.50%) was detected in Lateefy at 12 months period in nylon bags respectively. High mean value 10.00% was noted in coarse IR-6 in kept in gunny and low 8.76 was determined in aromatic Lateefy in nylon.

Table-2. Moisture content (%) of the white rice varieties affected by the different packaging materials and storage period

Varieties	Storage Intervals (months)						Mean**	Mean***
	Packaging material	Fresh (0 days)	3 Months	6 Months	9 Months	12 Months		
BS-385	Cotton	10.78 cde	8.40 f-k	10.40 cde	7.20 j-n	7.13 k-n	8.78 d	9.02 b
	Gunny	10.76 bcd	8.80 f-i	11.60 abc	7.40 j-n	7.20 j-n	9.16 cd	
	Nylon	10.77 bcd	8.80 f-i	11.00 abc	7.73 hi-n	7.40 j-n	9.14 cd	
DR-82	Cotton	11.60 abc	9.23 efg	11.00 abc	7.00 mn	6.90 mn	9.14 cd	9.28 b
	Gunny	11.57 abc	7.33 j-n	12.00 ab	7.60 i-n	7.50 i-n	9.20 cd	
	Nylon	11.60 abc	9.20 efg	11.00 abc	8.00 g-m	12.13 h-n	9.51 abc	
IR-6	Cotton	12.13 a	9.60 def	10.90 acd	7.27 j-n	7.50 i-n	9.48 ab	9.80 a
	Gunny	12.13 a	10.40 cde	11.00 abc	8.50 f-j	8.30 g-l	10.00 a	
	Nylon	12.13 a	9.68 def	11.00 abc	8.40 f-k	8.20 g-m	9.87 ab	
Lateefy	Cotton	11.10 a	9.30 efg	11.50 abc	7.40 j-n	7.07 lmn	9.26 cd	9.07 b
	Gunny	11.10 abc	9.20 efg	11.00 abc	7.40 j-n	7.30 j-n	9.20 cd	
	Nylon	11.10 abc	8.90 fgh	10.60 cd	6.70 n	6.50 n	8.76 d	
Mean*		**11.39 a**	**9.06b**	**11.08 a**	**7.54 c**	**7.40 c**		
SE	**0.6433**						**0.2877**	
LSD 5%	1.2738						0.5696	

* Time Interval, ** Packaging, ***Variety

Moreover, Gel Consistency (mm) is defined as a measure of the flow characteristics of milled rice gel (100 mg) in 2 ml of 0.2 N KOH and is indexed by the length of the horizontal gel in mm in a 13 x 100ml test tube. The test divides the rice into hard (no more than 36 mm or less in length) intermediate (36 to 50 mm in length) and soft (more than 50 mm in length) gel. Data on the (**Table 3**) revealed that the increase was observed in the Gel consistency (GC) of the aromatic rice variety BS-385. The Gel consistency of BS-385 at the fresh level in all packages was 80.00 however after one year it was increased 94.00, 92.00 and 92.66 in cotton, gunny and nylon respectively. DR-82 showed increase in all packages during the study period, 65.00 was observed at fresh level whereas, 80.00, 79.00 and 88.00 was determined in cotton, gunny and nylon. While, GC of coarse IR-6 was60.00 at fresh level, while 88.00 was noted in cotton & gunny and 82.00 in nylon after the 12 months period. Increase was found in aromatic Lateefy, GC 60.00 was noted at initial stage whereas, 90.00 was found after one year in cotton, gunny and nylon respectively. Among all varieties Gel consistency (99.00) was observed higher in BS-385 aromatic variety packed in gunny bag at 09months period. Whereas, (96.00) medium in Lateefy kept in nylon bag at 09 months and (60.00) was DR-82, IR-6, and Lateefy at 03 months in all three packages. The overall high mean value 8.00 was observed in aromatic BS-385 kept in gunny bag, and low 71.40 was noted in coarse DR-82 packed gunny

Table 3. Gel consistency (mm)of the white rice varieties affected by the different packaging materials and storage period

Varieties	Packaging Material	Storage Intervals (months)					Mean**	Mean***
		Fresh (0 days)	3 Months	6 Months	9 Months	12 Months		
BS-385	Cotton	80.00 fg	82.00 efg	90.00 bcd	94.00 abc	94.00 abc	88.00 a	87.02 a
	Gunny	80.00 fg	80.00 fg	90.00 bcd	92.00 a-d	92.00 a-d	86.80 a	
	Nylon	80.00 fg	68.33 ijk	91.33 bcd	99.00 a	92.66 abc	86.26 a	
DR-82	Cotton	65.00 jkl	60.00 l	77.66 gh	80.00 fg	80.00 fg	72.53 e	72.31 d
	Gunny	65.00 jkl	60.00 l	75.00 ghi	78.00fgh	79.00 fg	71.40 e	
	Nylon	65.00 jkl	65.00 jkl	71.33 hij	75.00 gh	88.00 cde	73.00 e	
IR-6	Cotton	60.00 l	60.00 l	88.00 cde	88.00 cde	88.00 cde	76.46 cd	76.15 c
	Gunny	60.00 l	68.00 ijk	85.00 def	89.00 b-e	88.00 cde	78.00 bc	
	Nylon	60.00 l	68.00 ijk	80.00 fg	80.00 fg	82.00 efg	74.00 de	
Lateefy	Cotton	60.00 l	65.00 jkl	95.00 abc	92.00 a-d	90.00 bcd	80.40 b	79.91 b
	Gunny	60.00 l	62.00 kl	95.00 abc	96.00 ab	90.00 bcd	80.60 b	
	Nylon	60.00 l	60.00 l	91.66 bcd	92.00 a-d	90.00 bcd	78.73 bc	
Mean		**66.25 c**	**66.36 c**	**85.83 ab**	**87.83 ab**	**87.92 a**		
SE	**3.61**						**1.6157**	
LSD 5%	7.15						3.1989	

* Time Interval, ** Packaging, ***Variety

The volume expansion ratio (VER) results show (**Table 4**), significant variation in all varieties. BS-85 an aromatic result revealed decrease in VER, it was noted 4.20 at fresh level whereas after one year it was 3.53, 3.60 and 3.73 in cotton, gunny and nylon respectively. The coarse DR-82 showed 3.23 VER at initial stage whereas after 12 months it was observed 3.40 in cotton, 1.50 gunny and 3.40 in nylon. Decrease was also found in coarse IR-6, 4.20 VER was at fresh level whereas, after one year it was 3.73, 1.73, 2.73 in cotton, gunny and nylon respectively. The volume expansion of aromatic variety Lateefy was increased in all packages. At fresh level, it was 3.40 whereas after 12 months it was observed 4.90, 5.10, 3.70 in cotton, gunny and nylon. Among all varieties higher (5.40) volume expansion ratio was of Lateefy kept in cotton at 03 months storage, medium (5.30) was of Lateefy in nylon bag. Though, the lower (1.40) was of IR-6 packed in gunny at 09 months time. High mean 4.11 was noted in aromatic in gunny, and low 2.18 was observed in DR-82 in gunny bag.

Table-4. Volume expansion ratio of the white rice varieties affected by the different materials and storage period

Varieties	Packaging Material	Storage Intervals (months)					Mean**	Mean***
		Fresh (0 days)	3 Months	6 Months	9 Months	12 Months		
BS-385	Cotton	4.20 cd	4.20 cd	2.00 hi	3.30 e	3.53 e	3.44 de	3.68 a
	Gunny	4.20 cd	3.40 e	3.70 de	3.70 de	3.60 e	3.64 cd	
	Nylon	4.20 cd	4.47 bc	3.70 de	3.73 de	3.73 de	3.96 ab	
DR-82	Cotton	3.23 ef	3.40 e	4.20 cd	3.30 e	3.40 e	3.50 de	3.01 c
	Gunny	3.23 ef	2.67 g	2.00 hi	1.50 ij	1.50 ij	2.18 g	
	Nylon	3.23 ef	3.50 e	3.30 e	3.30 e	3.40 e	3.34 ef	
IR-6	Cotton	4.20 cd	4.27 c	3.70 de	3.30 e	3.73 e	3.84 bc	3.52 b
	Gunny	4.20 cd	5.40 a	3.70 de	1.40 j	1.73 ij	3.28 ef	
	Nylon	4.20 cd	5.30 a	2.57 g	2.57 gh	2.73 fg	3.46 de	
Lateefy	Cotton	3.40 e	3.40 e	3.73 de	4.50 bc	4.90 ab	3.98 ab	3.79 a
	Gunny	3.40 e	5.30 a	2.87 fg	4.90 ab	5.10 a	4.11 a	
	Nylon	3.40 e	3.53 e	2.00 hi	3.40 e	3.70 de	3.20 f	
Mean*		**3.75a**	**4.06a**	**3.04e**	**3.20d**	**3.42c**		
SE	**0.2615**						**0.1169**	
LSD 5%	0.5177						0.2315	

* Time Interval, ** Packaging, ***Variety

Water Absorption Ratio (WAR) at**Table5**showed the variation in WAR, in aromatic variety BS-385, it was 3.80 at fresh level whereas, after 12 months 3.90, 4.10 and 3.87 was observed in cotton, gunny and nylon bags respectively. Increase was also determined in coarse variety DR-82, 2.90 WER was noted at fresh level while after one year period it was found 4.00 in cotton, 3.87 in gunny and 4.20 in nylon. Coarse IR-6 WER at fresh level was 3.20 though, 3.87, 4.47 and 3.70 was determined after 12 months period. The water absorption ratio of aromatic Lateefy was increased in all packages, 3.50 WER was observed at fresh level whereas, 4.30, 3.90 and 4.20 was noted in cotton, gunny and nylon respectively. Among all the rice varieties high (4.47) absorption ratio was determined in IR-6 coarse variety keptin gunny at 12 months, whereas, medium (4.30) was noted in aromatic Lateefypacked in cotton bag at 12 months time period. Whereas, (2.90) was observed in coarse DR-82 at 06 months period packed in nylon bag. However, mean value (3.72) was notedhigh in aromatic variety BS-385 packed in cotton bag, (3.70) packed in gunny low mean (3, 32) was observed in coarse variety IR-6 kept in gunny bag.

Table-5. Water absorption ratio of the white rice varieties affected by the different materials and storage period

Varieties	Packaging Material	Storage Intervals (months)					Mean**	Mean***
		Fresh (0 days)	3 Months	6 Months	9 Months	12 Months		
BS-385	Cotton	3.80 c-h	3.70 d-h	3.40 g-l	3.80 g-l	3.90 b-f	3.72 a	3.70 a
	Gunny	3.80 c-h	3.50 f-k	3.20 i-m	3.90 b-f	4.10 a-d	3.70 a	
	Nylon	3.80 c-h	3.80 f-k	3.50 f-k	3.67 d-i	3.87 b-g	3.69 a	
DR-82	Cotton	2.90 m	3.50 f-k	3.10 klm	3.80 c-h	4.00 a-e	3.46 bc	3.44 b
	Gunny	2.90 m	3.10 klm	3.50 f-k	3.73 c-h	3.87 b-g	3.42 bc	
	Nylon	2.90 m	2.90 m	3.50 f-k	3.83 b-g	4.20 abc	3.46 bc	
IR-6	Cotton	3.20 i-m	3.17 j-m	3.33 h-m	3.67 d-i	3.87 b-g	3.44 bc	3.40 b
	Gunny	3.20 i-m	3.00 lm	3.00 lm	3.50 f-k	4.47 a	3.43 bc	
	Nylon	3.20 i-m	3.40 g-l	3.10 klm	3.20 i-m	3.70 d-h	3.32 c	
Lateefy	Cotton	3.50 f-k	3.10 klm	3.10 klm	3.83 b-g	4.30 ab	3.56 ab	3.61 a
	Gunny	3.50 f-k	3.50 f-k	3.40 g-l	3.40 e-j	3.90 b-f	3.58 ab	
	Nylon	3.50 f-k	3.80 c-h	3.10 klm	3.90 b-f	4.20 abc	3.70 a	
Mean*		**3.50c**	**3.35c**	**3.26c**	**3.70b**	**4.03a**		
SE	**0.2486**						**0.1112**	
LSD 5%	0.4921						0.2201	

* Time Interval, ** Packaging, ***Variety

4. DISCUSSION

Significant change was noted in all parameters during the study period. 1000-grain weight was decreased due to the moisture content reduction of the white rice varieties. Variation of 1000- weight with the moisture content of Fagar white rice from 15.11 to 21.5g and for Tarom white rice from 16.96 to 21g as the moisture content increased from 5 to 37% w.b.was reported by the Gharekhani *et al.,* (2013).El-Kady *et al.,* (2013) have found significantly decrease in the 1000-pady grain by increasing storage time period. The earlier research pointed out that between 20g and 30g weighs of 1000 grains are measured better; whereas, the lower weight by 20g indicated the occurrence of immature damage grains. Findings of the present investigations **(Table 1)** revealed that high mean value(19.32g) was found IR-6 in nylon bag whereas, (18.04g) was of DR-82 in gunny bags and (14.44g) was observed in aromatic variety Lateefy in nylon. The 1000-grain weight of the coarse varieties was higher, whereas lower was observed in aromatic varieties. Kanchana *et al*. (2012) have found 1000-grain (w) ranges among (14.5g) to (18.5g), Thomas *et al*. (2013) (16.97), Shabir, (2008) (17.35g).Rice physical & mechanical attributes depend on its moisture content Kibar *et al*. (2010).The moisture content findings of the current investigations **(Table 2)** show maximum (12.00%) moisture content in DR-82 with gunny bag in 06months time period. The findings of the present investigation are consistent with the values reported by the Chen *et al.* (2004), Cameron and Wang (2005), Heinemann *et al.* (2005), Ebuehi and Oyewole (2008), Maisont and Narkrugsa (2009), and Oko and Onyekwere (2010).Literature indicates that medium amylose rice has a softer gel consistency and is preferred because of its tenderness. Gel consistency is the only reliable test that can distinguish this kind of rice. Shilpa and Sellappan, (2010) found GC ranging from 44% to 64%. Sagar *et al*. (1988) mentioned that the gel consistency ranges of crude and aromatic varieties 33-67. Wang *et al*. (2017) revealed that with the increase in stowage period, the elasticity and recovery of cooked rice gradually has reduced, and the hardness and adhesion showed a trend of first increasing and then declining. Gel consistency (mm) results of the present study **(Table 3)** revealed that all white rice varieties analyzed were medium and soft. cooking characteristics. Cooking attributes i,e Volume expansion and water absorption are significant for detecting the quality of rice. People in the middle or lower class generally believe that the volume expansion of high rice is high-quality rice, and they do not think that the width or length will increase. The volume expansion ratio **(Table 4)** was found higher (5.40) in Lateefy kept in

cotton bag at 03 months period however, it was detected lower (1.40) in IR-6 in gunny at 09 months period. Higher Water Absorption Ratio (4.47) determined IR-6 packed in gunny bag at 12 months storage period **(Table 4)**. Rachel Thomas *et al*. (2013) mentioned that the uptake ratio (2.99) of basmati rice whereas, (3.75) of domestic varieties. However, Oko and Ugwu (2012) studied ranges of values regarding the water uptake ratio varied from 1.13-3.35 with a mean value of 2.24±0.56. Shabbir, (2008), has determined VER 3.20, 3.64, 3.08 & 2.35 in Basmati-385, Basmati-370, IRRI-6 and KS-282 of the coarse and aromatic rice cultivars. Ge *et al*. (2005) has mentioned that the VER affected by both grain properties, Verma *et al.* (2015) has observed (2.20 and 4.00) VER in basmati and coarse rice varieties.

5. CONCLUSION

Present research work revealed that the water contents (moisture %) was decreased in both coarse and aromatic white rice varieties during the one year time period. The study found significant decree in 1000-grain weight in all varieties of rice. Physicochemical and cooking quality attributes were also influenced by packaging martial, storage period and temperature. Findings of this study can be beneficial in the selection of packing material, storage period and temperature for suitable storage of white rice in bulk stores to retain its best quality in maximum possible shelf life.

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