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Influence of Packaging and Storage Conditions on Proximate Composition of Paddy

D. Saida Naik[1*] and M. B. Chetti[2]

[1]Assistant Professor, Department of Crop Physiology, College of Agriculture, Rajendranagar, Hyderabad

[2]Assistant Director General (HRD), Educational Divison, ICAR, Pusa, New Delhi-110012

*Corresponding Author E-mail: saidanaik94@gmail.com

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ABSTRACT

The study was conducted to find out the influence of packaging and storage conditions on proximate composition of paddy. Paddy seeds were stored in different packaging materials viz; vacuum packed bags (C_1), polythene bags (C_2), cloth bags (C_3) and gunny bags (C_4) stored at room temperature (25 ± 2° C) and cold storage (4 ± 1° C) for a period of 18 months. Proximate composition includes crude protein content; fat content, ash content and carbohydrate content were decreased with an advancement of storage period. Among the containers, vacuum packed bags recorded higher protein, fat, ash and carbohydrate content compared to polythene bags followed by gunny bags and cloth bags.

Key words: *Paddy, Proximate Composition, Vacuum Packaging, Storage*

INTRODUCTION

The knowledge of seed storability is also essential to avoid the huge financial losses due to non selling of the seeds and to carry over the seed stock for use in next season. In storage, viability and vigour of the seeds is regulated by many physico-chemical factors as the seed is hygroscopic in nature, seed quality is affected by variation in moisture content, relative humidity and temperature. To combat these factors, it is better to store the seeds in moisture vapour proof containers like polythene bag, aluminum foil, tin or any sealed container to maintain the quality for longer period Paddy is the most important and extensively grown food crop in the world and is the staple food of more than 60 per cent of the world population. India has the largest area under paddy in the world and ranks second in production after China. In paddy, upon storage, many enzymatic changes, oxidation and respiration occur. If the viability and vigor is not maintained properly during storage period, it will be difficult to sell it as a seed material for the next season. Post harvest storage life of paddy largely depends on the genotypes, treatment, packaging material and storage conditions.

MATERIALS AND METHODS

A storage experiment was carried out for a period of 18 months at Department of Crop Physiology, University of Agricultural Sciences, Dharwad.

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Freshly harvested paddy seeds (BPT-5204) were dried under sun and stored under different storage conditions and containers. The temperature maintained in the cold storage was around (4 °C ± 1°C) and relative humidity was 85 to 90 per cent. For ambient storage, bags were stored in the laboratory at room temperature (25 ± 2 °C). Paddy seeds were packed in 100 g vacuum packed bags (The machine used for vacuum packaging of different seeds was OLPACK 501/V manufactured by INTERPRISE–BRUSSELS S.A., BRUXTAINER DIVISION, Belgium) and polythene bags while 5 kg paddy was packed in cloth bags and gunny bags. After packaging of all the seeds in different containers, 50% bags were stored properly in the iron racks without stacking so that all the bags were uniformly exposed to the particular treatment condition; while 50% bags were stored under cold storage. Fisher's method of analysis of variance was applied for the analysis and interpretation of the experimental data as suggested by (Panse and Sukhatme, 1967) and level of significance used in 'F' and't' test was P = 0.01. The treatment consisting of different containers viz., vacuum packed bags, polythene bags, cloth bags and gunny bags were replicated thrice in both cold and ambient storage conditions in completely randomized design with factorial concept. Bimonthly observations recorded on proximate composition of Paddy up to 18 months. Oven dried and finely ground samples were used for the estimation of crude protein. For the estimation of nitrogen, 1.0 g of powdered sample was digested with 10 ml of concentrated sulphuric acid in presence of 0.2 g of digestion mixture ($CuSO_4$ + K_2SO_4 + Selenium powder) in a 100 ml conical flask and kept it for overnight. Next day, contents were gently heated on hot plate using sand bath in digestion chamber till contents turned blue colour. The digested samples were distilled with excess 10 ml of 40 per cent sodium hydroxide (NaOH) and the ammonia released was trapped in 20 ml of 2.0 per cent of boric acid and titrated against 0.1N H_2SO_4 to get total nitrogen content in the samples. The amount of nitrogen present in a given sample was calculated by the following formula and expressed in per cent.

Per cent Nitrogen = (T-B) x 14 x N Acid x 100 / wt. of samples

Crude protein (%) = 5.95 x per cent Nitrogen

Fat content in seeds was estimated by the method of Randall (1974) with some modifications. Two-gram oven dried paddy as well as rice flour samples were wrapped in filter paper and then placed in main extraction chamber of Soxhlet apparatus and fat was extracted by refluxing with 60 to 80 ºC petroleum ether for 4-5 hours at 60 ºC. Thereafter, the samples were removed from the apparatus and kept between the blotting paper to remove excess petroleum ether. Then the samples were oven dried for 30 minutes and the final dry weight was recorded. The fat content of samples was calculated using the following formula and expressed in per cent.

$$\text{Fat (\%)} = \frac{W_1 - W_2}{W_1} \times 100$$

Where,

W_1 = Initial weight of seed (oven dried powder)

W_2 = Final weight of seed

Three grams of paddy as well as rice flour were taken in a crucible and heated on oxidizing flame till smoke subsided. The crucible was transferred to muffle furnace at 550 ^{O}C for 5 hours. The samples were cooled in a desiccator and weighed. The difference in the weight was considered as weight of ash. The ash in the sample was calculated and expressed in per cent[4].

$$\text{Ash (\%)} = \frac{\text{Wt. of the ash (g)}}{\text{Wt. of the sample (g)}} \times 100$$

Total per cent of carbohydrate content in the rice samples were determined by the difference method as reported by Onyeike *et al.* (1995). This method involved adding the total values of crude protein, fat, moisture and ash constituents of the sample and subtracting it from 100. Carbohydrate (%) = 100 – (per cent moisture + per cent crude protein+ per cent fat+ per cent ash)

RESULTS AND DISCUSSION

The observations on crude protein influenced by storage containers and storage conditions showed significant differences up to 18 months of storage (Table 1). Among the containers, vacuum packaged bags (C_1) recorded significantly higher crude protein, while, significantly lower crude protein was observed in gunny bags (C_4) under both ambient storage (S_1) and cold storage (S_2). Up to 4 months of storage, no significant differences were observed between storage containers, storage conditions and their interaction. It was observed that, no significant differences were within the treatments under both ambient storage (S_1) and cold storage (S_2) throughout the storage period. Crude protein content was decreased with an advancement of storage period among all the storage containers at all the stages of storage period. At 8th months of storage, the higher crude protein content was observed in vacuum packed bags stored under cold storage (C_1S_2) (7.48%) followed by vacuum packed bags stored under ambient condition (C_1S_1) (7.43%), which was superior over all other treatments. The lower crude protein content was observed in gunny bags stored under ambient storage (C_4S_1) (7.22%) followed by gunny bags stored under cold storage (C_4S_2) (7.29%), which was lower compared to all other treatments. A similar trend continued from 10 months of storage and upto 18 months of storage. The treatments polythene bags stored under ambient storage (C_2S_1), polythene bags stored under cold storage (C_2S_2), cloth bags stored under ambient storage (C_3S_1), cloth bags stored under cold storage (C_3S_2) and gunny bags stored under cold storage (C_4S_2) were on par with each other. At 18 months of storage, significantly higher crude protein content (%) was found in vacuum packed bags (C_1) (7.39%), which was significantly higher over all other treatments. The lower crude protein content was observed in gunny bags stored under ambient storage (C_4S_1) (6.94%), followed by gunny bags stored under cold storage (C_4S_2) (7.02%), which was lower over all other treatments. It was further observed that, cold storage (S_2) recorded significantly higher crude protein content in polythene bags (C_2), cloth bags (C_3) and gunny bags (C_4) compared to ambient storage (S_1) throughout the storage period. The soluble protein content decreased with increased storage period. This indicates that the protein content in the seeds is also subjected for deterioration depending on the storage conditions indicating sensitivity to moisture, light, temperature and oxygen[15]. Loss of protein content was maximum in gunny bags stored at room temperature which could be mainly attributed to property of protein chains forming loose mesh when the moisture content is more. With loss in moisture content, they become disorganized resulting in nutrients loss. In addition, the reaction between simple sugars and amino acids leads to breakdown of protein molecules[14]. The reduction of protein, rehydration ratio and increase in moisture content was comparatively higher in ordinary heat sealed storage against vacuum packaging, which was attributed to the lower activity of proteinase[5]. The data on fat content as influenced by storage containers and storage conditions measured up to 18 months of storage presented in Table 2 revealed significant differences between storage containers and conditions. In general, decreased trend was observed in fat content with an advancement in storage period among all the treatments, but lesser decrease was observed in vacuum packaged bags (C_1) and greater decrease was found in gunny bags (C_4) followed by cloth bags (C_3) throughout the storage period. Up to 6 months of storage, no significant differences were observed between storage containers and storage conditions and their interaction. Among the containers, vacuum packaged bags (C_1) recorded significantly higher fat content compared to all other treatments under both cold storage (S_2) and ambient storage (S_1), which was significantly superior over all other treatments. The lower fat content was observed in gunny bags (C_4) under both ambient storage (S_1) and cold storage (S_2), which was significantly lower compared to all other treatments. At 8 months of storage, the lower fat content was observed in gunny bags stored under ambient storage (C_4S_1) (1.92%) followed by gunny bags stored under cold storage (C_4S_2) (1.93%), which was lower compared to all other treatments. The higher fat content was found in vacuum packed bags stored under cold storage (C_1S_2) (2.16%) followed by vacuum packed bags stored under ambient condition (C_1S_1)(2.05%), which was superior over all other treatments. The treatments polythene bags stored under ambient storage (C_2S_1), polythene bags stored under cold storage (C_2S_2) and cloth bags stored under ambient storage (C_3S_1), cloth bags stored under cold storage (C_3S_2), gunny bags stored under cold storage (C_4S_2) were at par with each other. Similar trend was continued from 10 months of storage and up to 18 months of storage. At 18 months of storage, vacuum packaged bags (C_1) recorded significantly higher fat content (1.93%), which was significantly superior over all other treatments. The lower fat content was observed in gunny bags stored under ambient storage (C_4S_1) (1.48%) followed by gunny bags stored under cold storage (C_4S_2) (1.53%), which was lower over as compared to all other treatments. Similarly, cloth bags stored under ambient storage (C_3S_1), cloth bags stored under cold storage (C_3S_2) and gunny bags stored under cold storage (C_4S_2) did not differ significantly among themselves. It was further noticed that cold storage (S_2) recorded significantly higher fat content among all the containers compared to ambient storage (S_1). It is clear from the results that, vacuum packaged bags (C_1) maintained significantly higher fat content compared to all other treatments throughout the storage period. The results of proximate composition showed the decreased trend with an increased storage period. The nutrients are lost due to changes in carbohydrate, protein, lipids and vitamins[1]. Among the containers, vacuum packed bags recorded higher protein, fat, ash and carbohydrate content compared to polythene bags followed by gunny bags and cloth bags, respectively. This may be either due to extensive damage of protein synthesizing system, synthesis or activation of large quantities of proteolytic enzymes during seed deterioration[3].The fat content was less in gunny bags and cloth bags, while higher in vacuum packed bags and poly thene bags. Fat content decreased as storage progressed which may be due to the fact that lipase act on hydrolysis of fat over a prolonged period which is the main cause for seed deterioration. Similar results were reported by Lawal[7]. The results of ash content as influenced by storage containers, storage conditions and their interactions presented in Table 3. Ash content differed significantly between storage conditions and storage containers from 6 months of storage and continued upto 18 months of storage. Significantly higher ash content was observed in vacuum packaged bags (C_1) followed by polythene bags (C_2), under both ambient storage (S_1) and cold storage (S_2), which was significantly higher over all other treatments. Among the containers, gunny bags (C_4) recorded significantly lower ash content followed by cloth bags (C_3), which was significantly lower compared to all other treatments. The decreased trend was seen in ash content with a progress in storage period among all the treatments, but gradual decrease was found in vacuum packaged bags (C_1) and faster decrease was observed in gunny bags (C_4) under both ambient storage (S_1) and cold storage (S_2).

During eighth months of storage, higher ash content (1.36%) was recorded in vacuum packed bags stored under cold storage (C_1S_2) followed by vacuum packed bags stored under ambient condition (C_1S_1) (1.25%) and lower ash content were observed in gunny bags stored under ambient storage (C_4S_1) (1.12%). followed by gunny bags stored under cold storage (C_4S_2). A similar trend was continued from 10 months of storage and up to 18 months of storage. The treatments vacuum packaged bags (C_1) was on par with polythene bags (C_2) and cloth bags (C_3) on par with gunny bags (C_4) under both ambient storage (S_1) and cold storage (S_2). The treatments polythene bags stored under ambient storage

(C_2S_1), polythene bags stored under cold storage (C_2S_2), cloth bags stored under ambient storage (C_3S_1) and gunny bags stored under cold storage (C_4S_2) did not differ significantly among themselves. At 18 months of storage, vacuum packaged bags (C_1) recorded significantly higher ash content over all other treatments under both ambient storage (S_1) and cold storage (S_2). The lower values of ash content were recorded in gunny bags stored under ambient storage (C_4S_1) compared to all other treatments. It was further observed that cold storage (S_2) showed higher ash content compared to ambient storage (S_1) among all storage containers at all the stages of storage period. The ash content constitutes inorganic part of the solid matter. It was lowest in the gunny and cloth bags stored under room temperature followed by cold storage. While, no appreciable changes were observed in the samples stored under vacuum packed bags, irrespective of storage conditions. It could be mainly attributed to increased respiration as a result of higher moisture content in the gunny and cloth bags, while, there was no exchange of gases in vacuum packed bags. Similar results were observed in cheese by Abdulla and Nusr[2]. The data on carbohydrate content as influenced by different packaging and storage conditions differed significantly between treatments from 4 months of storage and up to 18 months of storage due to the storage period presented Table 4. Up to 6 months of storage no significant differences were found between storage containers, storage conditions and their interaction. Among the storage containers, the carbohydrate content was higher in vacuum packaged bags (C_1), which was significantly higher over all other treatments, while lower in gunny bags (C_4), which was significantly lower compared to all other containers under both ambient storage (S_1) and cold storage (S_2). At 8th months of storage, higher carbohydrate content (81.2%) was observed in vacuum packed bags stored under ambient condition (C_1S_1) followed by vacuum packed bags stored under cold storage (C_1S_2) (80.9%), which was superior over all other treatments. Lower carbohydrate content (79.8%) was observed in gunny bags stored under ambient storage (C_4S_1)) followed by gunny bags stored under cold storage (C_4S_2), which was lower compared to all other treatments throughout the storage period. Among interactions cloth bags stored under ambient storage (C_3S_1), gunny bags stored under ambient storage (C_4S_1) and cloth bags stored under cold storage (C_3S_2), gunny bags stored under cold storage (C_4S_2) did not differ significantly among themselves. Similar trend continued at 10, 12, 14, 16 and 18 months. At 18 months of storage, vacuum packaged bags (C_1) recorded significantly higher carbohydrate content (81.7%), which was significantly higher compared to all other treatments. Among the containers, vacuum packaged bags (C_1) was on par with polythene bags (C_2) and cloth bags (C_3) on par with gunny bags (C_4) under both ambient storage (S_1) and cold storage (S_2). The lower carbohydrate content was observed in gunny bags stored under cold storage (C_4S_2) (77.9%), which was lower over all other treatments. It is clear from the results that, ambient storage (S_1) recorded higher values of carbohydrate content compared to cold storage (S_2) among all the treatments at all the stages of storage period. Carbohydrate content decreased significantly (63.5%) in gunny bags under ambient condition at the end of the storage period compared to initial value (Fig. 20). While, vacuum packed bags recorded carbohydrate content of 81.8 per cent. It clearly indicates the influence of storage conditions on the stability of sugars. These changes could be attributed to the balance between anabolic and catabolic processes. Inter conversions between the carbohydrates during the storage are greatly influenced by O_2, temperature, CO_2 and light. Sanchez Mata *et al.*[13] opined that respiration involves a high consumption of simple sugars and both respiration and degradation processes are intensified during later stages of storage. At 18 months of storage, vacuum packed bags recorded significantly higher per cent of crude protein, fat content, ash content and carbohydrate content compared to polythene bags.

Table 1: Influence of packaging and storage conditions on crude protein (%) at different periods of storage in paddy

Treatments	Storage period (months)									
	0	2	4	6	8	10	12	14	16	18
Storage conditions mean (S)										
S_1	7.49	7.39	7.37	7.36	7.33	7.30	7.28	7.25	7.22	7.15
S_2	7.53	7.43	7.40	7.39	7.37	7.35	7.32	7.30	7.26	7.22
Storage containers mean (C)										
C_1	7.54	7.49	7.47	7.47	7.46	7.45	7.44	7.43	7.41	7.39
C_2	7.53	7.43	7.43	7.42	7.41	7.39	7.38	7.37	7.35	7.33
C_3	7.47	7.39	7.34	7.32	7.29	7.25	7.20	7.17	7.13	7.06
C_4	7.50	7.34	7.32	7.30	7.26	7.20	7.17	7.13	7.09	6.98
Interaction mean (S x C)										
S_1 x C_1	7.50	7.47	7.45	7.44	7.43	7.42	7.41	7.40	7.38	7.36
S_1 x C_2	7.57	7.43	7.42	7.41	7.40	7.39	7.37	7.35	7.33	7.31
S_1 x C_3	7.44	7.35	7.33	7.31	7.27	7.22	7.18	7.15	7.11	7.00
S_1 x C_4	7.45	7.32	7.30	7.28	7.22	7.17	7.13	7.09	7.06	6.94
S_2 x C_1	7.58	7.51	7.50	7.49	7.48	7.47	7.46	7.45	7.43	7.41
S_2 x C_2	7.48	7.44	7.43	7.42	7.41	7.40	7.39	7.38	7.36	7.34
S_2 x C_3	7.51	7.43	7.35	7.33	7.31	7.28	7.22	7.18	7.14	7.11
S_2 x C_4	7.54	7.36	7.34	7.32	7.29	7.23	7.20	7.16	7.11	7.02
Grand Mean	7.5	7.4	7.4	7.4	7.4	7.3	7.3	7.3	7.2	7.2
S.Em$\pm$										
S	0.03	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.01	0.02
C	0.05	0.06	0.06	0.04	0.04	0.04	0.03	0.03	0.02	0.03
S×C	0.07	0.09	0.09	0.06	0.06	0.05	0.04	0.04	0.03	0.04
C.D. (1%)										
S	NS	NS	NS	NS	NS	NS	NS	NS	0.03	0.06
C	NS	NS	NS	0.13	0.13	0.11	0.08	0.08	0.06	0.08
S×C	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Storage conditions (S)
S_1= Ambient storage
S_2= Cold storage

Storage containers (C)
C_1= Vacuum packed bags
C_2= Polythene bags
C_3= Cloth bags
C_4= Gunny bags

Table 2: Influence of packaging and seed conditions on fat content (%) at different periods of storage in paddy

Treatments	Storage period (months)									
	0	2	4	6	8	10	12	14	16	18
Storage conditions mean (S)										
S_1	2.24	2.17	2.11	2.02	1.98	1.92	1.87	1.81	1.75	1.69
S_2	2.29	2.26	2.19	2.13	2.06	2.00	1.93	1.88	1.82	1.76
Storage containers mean (C)										
C_1	2.29	2.25	2.20	2.15	2.10	2.07	2.04	2.01	1.97	1.93
C_2	2.28	2.23	2.18	2.13	2.08	2.03	2.00	1.98	1.95	1.90
C_3	2.26	2.20	2.12	2.03	1.96	1.88	1.80	1.72	1.64	1.56
C_4	2.23	2.17	2.09	1.99	1.93	1.85	1.77	1.68	1.59	1.51
Interaction mean (S x C)										
S_1 x C_1	2.26	2.20	2.15	2.10	2.05	2.03	2.02	1.97	1.92	1.89
S_1 x C_2	2.25	2.17	2.12	2.07	2.02	1.97	1.95	1.93	1.92	1.87
S_1 x C_3	2.24	2.16	2.08	1.97	1.92	1.84	1.76	1.68	1.60	1.52
S_1 x C_4	2.22	2.16	2.08	1.96	1.92	1.84	1.76	1.67	1.57	1.48
S_2 x C_1	2.32	2.31	2.26	2.21	2.16	2.11	2.07	2.05	2.02	1.96
S_2 x C_2	2.31	2.30	2.25	2.20	2.15	2.10	2.05	2.02	1.98	1.93
S_2 x C_3	2.28	2.24	2.16	2.08	2.00	1.92	1.84	1.76	1.68	1.60
S_2 x C_4	2.25	2.17	2.09	2.01	1.93	1.85	1.77	1.69	1.61	1.53
Grand Mean	2.3	2.2	2.1	2.1	2.0	2.0	1.9	1.8	1.8	1.7
S.Em$\pm$										
S	0.02	0.05	0.03	0.04	0.03	0.03	0.02	0.02	0.02	0.02
C	0.02	0.06	0.05	0.06	0.04	0.04	0.03	0.03	0.03	0.03
S×C	0.03	0.09	0.07	0.08	0.06	0.05	0.04	0.04	0.04	0.04
C.D. (1%)										
S	NS	NS	NS	NS	NS	0.08	0.05	0.05	0.06	0.06
C	NS	NS	NS	NS	0.13	0.11	0.09	0.09	0.09	0.08
S×C	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Storage conditions (S)
S_1= Ambient storage
S_2= Cold storage

Storage containers (C)
C_1= Vacuum packed bags
C_2= Polythene bags
C_3= Cloth bags
C_4= Gunny bags

Table 3: Influence of packaging and storage conditions on ash content (%) at different periods of storage in paddy

Treatments	Storage period (months)									
	0	2	4	6	8	10	12	14	16	18
Storage conditions mean (S)										
S_1	1.51	1.39	1.31	1.23	1.18	1.12	1.07	1.01	0.94	0.89
S_2	1.50	1.46	1.39	1.33	1.26	1.20	1.13	1.08	1.02	0.95
Storage containers mean (C)										
C_1	1.52	1.49	1.41	1.37	1.31	1.27	1.25	1.21	1.17	1.12
C_2	1.54	1.44	1.39	1.35	1.29	1.25	1.20	1.17	1.15	1.10
C_3	1.52	1.40	1.32	1.23	1.16	1.08	1.00	0.92	0.82	0.74
C_4	1.45	1.37	1.29	1.19	1.12	1.04	0.97	0.88	0.79	0.71
Interaction mean (S x C)										
S_1 x C_1	1.50	1.47	1.35	1.32	1.25	1.23	1.22	1.17	1.12	1.09
S_1 x C_2	1.53	1.37	1.32	1.27	1.22	1.17	1.15	1.13	1.12	1.07
S_1 x C_3	1.56	1.36	1.28	1.17	1.12	1.04	0.96	0.88	0.75	0.72
S_1 x C_4	1.47	1.36	1.28	1.16	1.12	1.04	0.96	0.87	0.77	0.68
S_2 x C_1	1.54	1.51	1.46	1.41	1.36	1.31	1.27	1.25	1.22	1.16
S_2 x C_2	1.55	1.51	1.45	1.43	1.35	1.32	1.25	1.22	1.18	1.13
S_2 x C_3	1.48	1.44	1.36	1.28	1.20	1.12	1.04	0.96	0.88	0.76
S_2 x C_4	1.42	1.37	1.29	1.21	1.13	1.05	0.97	0.89	0.81	0.73
Grand Mean	1.5	1.4	1.3	1.3	1.2	1.2	1.1	1.0	1.0	0.9
S.Em±										
S	0.01	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02
C	0.02	0.05	0.04	0.04	0.04	0.04	0.03	0.03	0.02	0.02
S×C	0.03	0.06	0.06	0.06	0.06	0.05	0.04	0.04	0.03	0.03
C.D. (1%)										
S	NS	NS	NS	0.09	0.07	0.07	0.06	0.05	0.05	0.05
C	NS	NS	NS	0.13	0.12	0.11	0.08	0.08	0.07	0.07
S×C	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Storage conditions (S)
S_1= Ambient storage
S_2= Cold storage

Storage containers (C)
C_1= Vacuum packed bags
C_2= Polythene bags
C_3= Cloth bags
C_4= Gunny bags

Table 4: Influence of packaging and storage conditions on carbohydrate content (%) at different periods of storage in paddy

Treatments	Storage period (months)									
	0	2	4	6	8	10	12	14	16	18
Storage conditions mean (S)										
S_1	80.7	80.3	80.2	80.4	80.5	80.3	80.4	80.7	80.8	80.7
S_2	80.6	78.4	78.4	78.6	78.8	79.0	79.1	79.4	79.5	79.8
Storage containers mean (C)										
C_1	80.6	80.7	80.8	80.9	81.1	81.2	81.3	81.4	81.5	81.7
C_2	80.5	80.5	80.6	80.7	80.9	81.1	81.2	81.3	81.4	81.6
C_3	80.6	78.1	77.9	78.0	78.3	78.2	78.4	78.7	78.9	78.8
C_4	80.7	77.8	77.8	78.1	78.4	78.1	78.3	78.6	78.8	78.8
Interaction mean (S x C)										
S_1 x C_1	80.8	80.8	81.0	81.1	81.2	81.3	81.4	81.5	81.6	81.8
S_1 x C_2	80.4	80.7	80.7	80.9	81.1	81.2	81.3	81.4	81.5	81.7
S_1 x C_3	80.7	80.2	79.5	79.6	79.9	79.3	79.5	79.9	80.1	79.7
S_1 x C_4	80.6	79.3	79.4	79.5	79.8	79.2	79.4	79.9	80.1	79.6
S_2 x C_1	80.4	80.6	80.7	80.8	80.9	81.0	81.2	81.2	81.4	81.7
S_2 x C_2	80.7	80.3	80.4	80.6	80.7	80.9	81.1	81.2	81.3	81.6
S_2 x C_3	80.6	76.1	76.2	76.4	76.6	77.0	77.2	77.5	77.7	77.9
S_2 x C_4	80.7	76.3	76.3	76.5	76.8	76.9	77.1	77.4	77.6	77.9
Grand Mean	80.6	79.3	79.3	79.4	79.6	79.6	79.8	80.0	80.2	80.2
S.Em±										
S	0.17	0.69	0.66	0.59	0.60	0.46	0.41	0.44	0.45	0.31
C	0.26	0.98	0.94	0.83	0.84	0.65	0.58	0.63	0.63	0.44
S×C	0.35	1.38	1.33	1.17	1.20	0.92	0.82	0.89	0.90	0.63
C.D. (1%)										
S	NS	NS	NS	NS	NS	NS	1.24	1.34	1.36	0.91
C	NS	NS	NS	2.52	2.54	1.98	1.76	1.90	1.92	1.35
S×C	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Storage conditions (S)
S_1= Ambient storage
S_2= Cold storage

Storage containers (C)
C_1= Vacuum packed bags
C_2= Polythene bags
C_3= Cloth bags
C_4= Gunny bags

CONCLUSION

Proximate composition includes crude protein content; fat content, ash content and carbohydrate content were decreased with an advancement of storage period. Vacuum packaging has been found to be a highly useful in storing the paddy compared to polythene bags followed by gunny bags and cloth bags under both ambient and cold storage. Among the containers, vacuum packed bags recorded higher protein, fat, ash and carbohydrate content compared to polythene bags followed by gunny bags and cloth bags.

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