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Study the Effect of Packaging Material and Storage Duration on Qualities of Multigrain Mixes from Finger millet (*Eleusine coracana*) Malt, Moth Bean (*Vigna aconitifolia*) Malt and Drumstick (*Moringa oleifera*) Leaf Powder

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

In present study the multigrain mixes prepared from finger millet malt, moth bean malt and drumstick leaf powder stored in packaging material i.e., polythene pouch and aluminium laminated pouches. The stored multigrain mixes were observed during each day from 0, 15, 30, 45, 60, 75

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and 90 days. Nutritional analysis indicated that both multigrain mixes packed packaging material and during storage period moisture content increases from 7.0 to 8.745%, protein content decreases from 14.97 to 12.85%, fat decreases 2.15 to 1.23%, fiber content decreases from 0.95 to 0.31%, ash content decreases from 2.24 to 1.67% carbohydrate increases from 70.13 to 72.159 %, whiteness index decreases from 24.19 to 21.187. Storage in plastic pouch is less than 90 days, based on the growth of yeast and mold.

Keywords: Packaging; polythene pouch and aluminium laminated pouches; thalipeeth; protein; fat; carbohydrate; calorific value; multigrain mixes.

1. INTRODUCTION

Multigrain products must be of course whole grain to offer maximum nutritional benefits. The use multigrains are well established in other food sectors particularly bakery and breakfast cereals [1]. Multigrain products can contribute to a healthy digestive system, help in weight control, reduce the risk of diabetes reduce the risk of cardiac failures and prevent the chances of bowel cancer [2]. Multigrain food products are rich in micronutrients and dietary fibers [3]. Multigrain flour is a medley of cereal and legume flours. The whole grains (two or more) are dry roasted on low flame in a pan and ground to form fine flour. Blending of whole grains which are rich in protein, dietary fiber as well as with the low glycemic index in staple and breakfast food items considered beneficial for health [4].

Food is packaged for storage, preservation, and protection traditionally for a long time. These three are the basic functions of food packaging that are still required today for better maintenance of quality and handling of foods [5]. The quality of the packaged food is directly related to the food and packaging material attributes [6,7]. Most food products deteriorate in quality due to mass transfer phenomena, such as moisture absorption, oxygen invasion, flavour loss, undesirable odour absorption, and the migration of packaging components into the food [8].

Polyethylene is widely used as a packaging material because of its good mechanical properties and low cost. However, these qualities have been overshadowed by its high non-biodegradable nature, leading to waste disposal problems, particularly in short-term packaging applications (Sailaja and Chanda, 2001). Polythene pouch are useful for dry products such as gari, sugar, coffee, and cocoa power, as the items remain dry for a long time if properly sealed [9].

The purpose of the present study was to study effect of two different packaging materials i.e. polythene pouch and Aluminium laminated pouches and storage duration up to 0, 15, 30, 45, 60, 75, 90 days on developed multigrain mixes for *thalipeeth* and *sev* from finger millet malt, moth bean malt and drumstick leaf powder storage at ambient temperature and its physicochemical and sensorial characteristics.

2. MATERIALS AND METHODS

2.1 Preparation of Multigrain Mixes from Finger Millet Malt, Moth Bean Malt, Drumstick Leaf Powder

The dried flour of finger millet malt and moth bean malt were used to formulate multigrain mixes. The formulations were made with finger millet malt and moth bean malt the concentration of finger malt: moth bean malt (W/W) was 26:26 respectively. The other ingredient with seasoning of spices i.e cumin 3%, chilli 1%, salt 2.6%, garlic 1%, drumstick leaf powder 1% and grain like gram flour 10%, wheat flour 10%, rice flour 18 % respectively were considered 48 % remains the same in all formulations is present in Fig.1.

2.2 Packaging and Storage Study of Multigrain Mixes from Finger Millet Malt and Moth Bean Malt

The best treatment of multigrain mixes from finger millet malt, moth bean malt and drumstick leaf powder was prepared with the finger millet malt (26%) and moth bean malt (26%) was used for the packaging and storage study. The multigrain mixes was prepared as discussed above and taken in two different packaging material i.e. polythene pouch and aluminium laminated pouches the details of the packaging material are given in Table 1. Fig. 2 (a) and 2 (b) shows the packaging material i. e. polythene pouch and Aluminium laminated pouches used for packaging and storage of the multigrain mixes for 90 days duration.

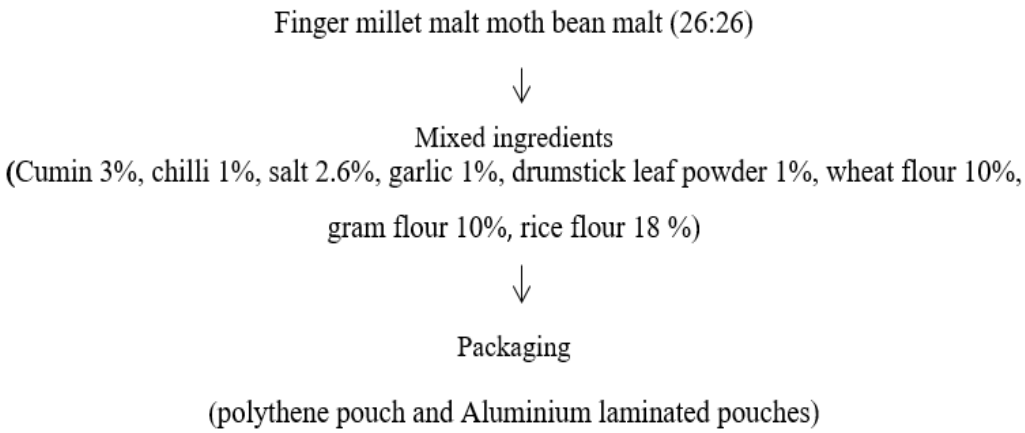

Fig. 1. Process flow chart for preparation of multigrain mixes from finger millet malt and moth bean malt

Table 1. Specifications of packaging material for storage of multigrain mixes

Sr.no	Packaging Material	Size	Gauge	Capacity
1	Polythene pouches	10.15cm × 15.25 cm	393	100g
2	Aluminium laminated pouches	10.15cm×15.25cm	157	100g

(a) P_1 (b) P^2

Fig. 2. Packaging material used for packaging of multigrain mixes (a) Polythene pouches (b) Aluminium laminated pouches

100g of multigrain mixes for *thalipeeth* and *sev* weight was filled separately in polythene pouches and aluminium laminated pouch sealed properly. These packets were kept at ambient temperature up to 90 days. The stored samples were analysed at 15 days interval up to 90 days. The observations for the Sensory analysis, Moisture (%), Protein (%), Fat (%), Fibre (%), Ash (%), Carbohydrates (%),colour, calorific value and microbial analysis of stored sample were carried out up to 90 days (0, 15, 30, 45, 60, 75, 90 days) i.e. total no. of samples for all the trials were, 7 duration × 2 packaging material ×3 replication = 42 samples of multigrain mixes prepared from finger millet malt and moth bean malt were kept for storage study. The microbial analysis of the stored sample was carried out at each 30 days interval upto 90 days.

2.3 Storage Studies

The multigrain mixes from finger millet malt, moth bean malt and drumstick leaf powder packed in polythene and aluminium laminated pouches

samples were subjected to storage studies at ambient (30±1°C) temperature. The samples stored at ambient temperature were analysed at 0, 15, 30, 45, 60, 75, 90 days for physicochemical properties Moisture(%), Protein (%), Fat (%), Fibre (%), Ash (%), Carbohydrates (%), colour, calorific value and microbial analysis and daily analysis for microbial count i.e. standard plate counts (SPC).

2.4 Evaluation of Quality Parameter for the Multigrain Mixes

2.4.1 Moisture content

The moisture content of multigrain mixes for *thalipeeth* and *sev* from finger millet malt, moth bean malt and drumstick leaf powder for treatment P_1 and P_2 for 0, 15, 30, 45, 60, 75, 90 days were determined by oven dry method [10]. The samples were exposed to 105˚C ± 1˚C for 24 hr in a hot air oven (Make M/s: Aditi Associate, Mumbai. Model: ALO-136) as per the procedure. The experiment was repeated three times and average value was reported.

$$\text{Moisture content (\% db)} = \frac{W_2 - W_1}{W_3 - W_1} \times 100 \qquad (1)$$

Where,

W_1 = Weight of moisture box, g
W_2 = Weight of moisture box + sample
W_3 = Weight of moisture box + oven dried sample

2.4.2 Protein

Protein content in the multigrain mixes for *Thalipeeth* and *sev* from finger millet malt, moth bean malt and drumstick leaf powder for treatment P_1 and P_2 for 0, 15, 30, 45, 60, 75, 90 days were determined by using micro-Kjeldahl distillation method [11]. The samples were digested by heating with concentrated sulphuric acid (H_2SO_4) in the presence of digestion mixture, potassium sulphate (K_2SO_4) and copper sulphate (C_uSO4). The mixture was made alkaline with 40% NaOH. Ammonium sulphate thus formed. released ammonia which was collected in 4% boric acid solution and titrated again with standard HCL. The experiment was repeated three times and average value was reported.

$$\% (N) = 1.4 \times (\text{ml HCl} - \text{ml blank}) \times \text{Conc. of } \frac{HCL}{Weight} \text{ of sample (g)} \qquad (2)$$

% Protein = % N × Factor (6.25).

2.4.3 Fat (%)

Fat contain in the multigrain mixes for *thalipeeth* and *sev* from finger millet malt, moth bean malt and drumstick leaf powder for treatment P_1 and P_2 for 0, 15, 30, 45, 60, 75, 90 days were determined using soxhlet fat extraction system [10]. In this method, initially weight of empty flask was weighed. 2g of sample was wrapped in filter paper. It was kept in siphoning tube and condenser was fixed above it and siphoned for 9 to 12 times with the petroleum ether in soxhlet apparatus. After removing assembly, evaporation of petroleum ether was allowed by heating round bottom flask. Residue reminder at the bottom of the flask and was reweighed with flask. The quantity of residue was determined as fat content of multigrain mixes. The experiment was repeated three times and average ready was reported.

$$\% \text{ Fat} = \frac{final\ weigh - Initial\ weight}{weight\ of\ sample} \times 100 \qquad (3)$$

Where:

W_1 = weight of oven dried thimble,
W_2 = weight of sample used,
W_3= weight of round bottom flask,
W_4 = weight of round bottom flask with fat residue.

2.4.4 Fibre (%)

Fibre contain in the multigrain mixes for *Thalipeeth* and *sev* from finger millet malt, moth bean malt and drumstick leaf powder for treatment P_1 and P_2 for 0, 15, 30, 45, 60, 75, 90 days were determined using about 2–5 g of moisture and fat free sample was weighed into a 500 ml beaker and a 200 ml of boiling 0.25 N sulphuric acid was added to the mixture and boiled for 30 min keeping the volume constant by addition of water at frequent intervals. The mixture was filtered through a muslin cloth and then transferred to the same beaker and 200 ml of boiling 0.313 N (1.25 %) NaOH was added. After boiling for 30 min, the mixture was filtered through muslin cloth. The residue was washed with hot water till free from alkali, followed by washing with alcohol and ether. It was then transferred to crucible, dried overnight at 80ºC to 100ºC and weighed. The crucible was heated in muffle furnace at 525ºC for 2 – 3 hrs. Cooled and weighed again. The difference in the weights represented the weight of crude fibre equation

(4) Rangana [12]. The experiment was repeated three times and average ready was reported.

Crude Fiber (g/100g)=(100-(Moisture+ Fat)× Weight of FiberWeight)/(Weight of sample taken (Moisture+Fat free sample)×100 (4)

Where,

W_1 = Weight of material before ashing (g)
W_2 = Weight of material after ashing (g)

2.4.5 Ash (%)

Ash content of multigrain mixes for *Thalipeeth* and *sev* from finger millet malt, moth bean malt and drumstick leaf powder for treatment P_1 and P_2 for 0, 15, 30, 45, 60, 75, 90 days were determined using muffle furnance. 5 g. of multigrain mixes sample was taken in crucible. Weight of crucible and sample was recorded and kept in muffle furnace at 525 ºC for 4 -5 hrs till constant weight was achieved. The crucible was cooled in desiccators and final weight of ash and crucible was recorded. Ash content was calculated by using equation (5). The experiment was repeated three times the average ash content was reported.

$$\text{Ash content (\%)} = \frac{(W_2 - W_1)}{(weight\ of\ sample)} \times 100 \quad (5)$$

Where,

W_2 = weight of crucible + ash,
W_1 = weight of empty crucible.

2.4.6 Carbohydrates (%)

The carbohydrate content of multigrain mixes for *thalipeeth* and *sev* from finger millet malt, moth bean malt and drumstick leaf powder for treatment P_1 and P_2 for 0, 15, 30, 45, 60, 75, 90 days were calculated by substremely moisture content, protein, fat, fibre and ash content from 100 Adegunawa *et al*., [13].

$$Carbohydrates = 100 - (\%moisture\ content + \%protein + \%\ fat + \%fibre + \%\ ash) \quad (6)$$

2.4.7 Colour

The colour of multigrain mixes from finger millet malt, moth bean malt and drumstick leaf powder for treatment P_1 and P_2 for 0, 15, 30, 45, 60, 75, 90 days were determined by used to measure the colour value using a colorimeter (M/S Konica Minolta, Japan Model- Meter CR-400). The equipment was calibrated against standard white tile. Multigrain mixes were taken in the petri dish, the petri dish was placed at the aperture of the instrument. The colour was recorded in terms of L= lightness to darkness; a = Redness to Greeness; b= yellowness to blueness. The whiteness index (WI) was determined for multigrain mixes.Whiteness index was calculated by the following equation (8) of Park, (1994):

$$Whiteness\ index = [(100 - L)]^2 + a^2 + b^2]^{1/2} \quad (7)$$

2.4.8 Calorific value (kcal/100g)

Calorific value of multigrain mixes from finger millet malt, moth bean malt and drumstick leaf powder for treatment P_1 and P_2 for 0, 15, 30, 45, 60, 75, 90 days were determined Calculation method involved multiplication of percent fat, protein and carbohydrates (excluding dietary fiber) by their physiological energy change coefficients (as full energy of combustion is not available in human body), i.e., 9.0, 4.0 and 4.0 kcal/g, respectively, followed by their subsequent addition [14]. Total calories of the multigrain mixes were calculated by the formula of James as follows:

Total calories = Fat ×9+protein×4+Total carbohydrate× 4 (11)

2.4.9 Microbial analysis:

The microbial analysis of multigrain mixes from finger millet malt, moth bean malt and drumstick leaf powder packed in polythene pouches and aluminium laminated pouch was determined for storage period of 0, 15, 30, 45, 60, 75, 90 days i.e. daily analysis as per the procedure of APHA [15]. Multigrain mixes samples were analyzed for standard plate counts (SPC) and yeast and mould counts (YMC) using nutrient agar medium and potato dextrose agar medium (Himedia Laboratories Pvt. Ltd. Bombay).

The sample was crushed finely in mortar and pestle. 1g of sample was mixed thoroughly in 10 ml autoclaved distilled water and mixed thoroughly by vortexing. Serial dilutions from the above suspension were prepared up to 10^{-6}. 1 ml serially diluted sample was plated by pour plate technique on nutrient agar (for total viable count), Potato Dextrose Agar (for yeast and mold count. All plates were incubated at 37°C for 24-48 hrs. After 24-48 hours of incubation the plates were observed for typical colonies of each

microorganism and colonies were counted with the help of colony counter. The results were recorded as CFU/g methods prescribed by Bureau of Indian Standards, [16].
Formula for calculating CFU/g

$$CFU = \frac{Average\ plate\ count \times Dilution}{Weight\ of\ sample} \quad (8)$$

2.4.10 Sensory analysis

The sensory attribute of *thalipeeth* and *sev* prepared from multigrain mixes were carried out for Treatment packaging material P_1 and P_2 for 0, 15, 30, 45, 60, 75, 90 days with trained panellists as per nine point hedonic scale. The Panellists were trained for the product testing and were familiar with product sensory evaluation. The *thalipeeth* and *sev* samples were placed into plastic dish. The multigrain samples packed in polythene pouches and aluminium pouch. The *thalipeeth* and *sev* were coded as A and B for Treatment P_1 and P_2 evaluation of sensory parameter i.e. colour, texture, taste, overall acceptability attributes on 09 scale for texture attribute were summed up for total score 36 for each panellist for each treatment. The 14 panel member divided into three groups as five, five and four members. The data were analysed statistically for the significance of each attributes by ANOVA.

2.4.11 Statistical analysis

Statistical analysis was performed using Factorial completely randomized design (FCRD) for stored sample properties of Moisture (%), Protein (%), Fat (%), Fibre (%), Ash (%), Carbohydrates (%), colour, microbial analysis and microbial analysis packed in polythene pouches and aluminium laminated pouch for 0, 15, 30, 45, 60, 75, 90 days was carried out by Microsoft Excel 2007.

3. RESULTS AND DISCUSSION

3.1 Moisture Content

Fig. 3 are shows the effect of packaging material and storage duration (0, 15, 30, 45, 60, 75, 90 days) and packaging material on Moisture content (%) of multigrain mixes for *Thalipeeth* and *sev* from finger millet malt and moth bean malt. The Moisture content (%) of multigrain mixes which was packed in polythene pouches (P_1) was increases from 7.00 to 8.74 (%) for 0 to 90 days of storage period respectively and for aluminium pouches (P_2) moisture content (%) was increases from 7.00 to 8.13 (%) for 0 to 90 days of storage period respectively. From Fig. 3 it is clear that as storage period increases, the Moisture content (%) of multigrain mixes packed in polythene pouches (P_1) and aluminium pouches (P_2) increases.

Table 2 shows the effect of packaging material on moisture content indicated that the better retention of moisture was observed in P_2 (118.532 %) followed by P_1 124.929 %.The Table 2 shows the ANOVA for the effect of packaging material and storage duration on moisture content (%) of multigrain mixes w.r.t. packaging material, storage duration and their interaction. From Table 2 it is indicated that packaging material had significant influence on moisture content (%) of multigrain mixes at $p \leq 0.05$. The storage duration had significant influence on moisture content (%) of multigrain mixes from finger millet malt and moth bean malt at $p \leq 0.05$. The interaction effect of packaging material and storage duration also shows the influence on Moisture content of multi grain mixes from finger millet malt and moth bean malt significant at $p \leq 0.05$. Rana *et al*., [17] reported that the multigrain dalia mixes from wheat, green gram and oat, moisture content increases from 10.03 to 11.74 % during 90 days storage period. Increase in moisture content was due to the hygroscopic nature of the product (Butt *et al* ., 2009). Mridula *et al*., [18] reported that *sattu* prepared from Bengal gram increase in the moisture content up to 90 days storage period.

3.2 Protein

Fig. 4 shows the effect of packaging material and storage duration (0, 15, 30, 45, 60, 75, 90 days) and packaging material on protein content (%) of multigrain mixes from finger millet malt and moth bean malt. The protein content (%) of multigrain mixes which was packed in polythene pouches (P_1) was decreases from 14.976 to 12.857 (%) for 0 to 90 days of storage period respectively and for aluminimum pouches (P_2) protein content (%) was decreases from 14.976 to 10.437 (%) for 0 to 90 days of storage period respectively. From Fig. 4 it is clear that as storage period increases, the protein content (%) of multigrain mixes packed in polythene pouches (P_1) and aluminimum pouches (P_2) decreases.

Table 3 shows the effect of packaging material on protein content indicated that the better retention of 85.855 % was observed in P_1 followed by P_2 69.691 %. The Table 3 shows the

ANOVA for the effect of packaging material and storage duration on protein content (%) of multigrain mixes w.r.t. packaging material, storage duration and their interaction. From Table 3 it is indicated that packaging material had significant influence on protein content (%) of multigrain mixes at *p≤0.05*. The storage duration had significant influence on protein content (%) of multigrain mixes from finger millet malt and moth bean malt at *p≤0.05*. The interaction effect of packaging material and storage duration also shows the significant influence on protein content of multi grain mixes from finger millet malt and moth bean malt significant at *p≤0.05*.The protein content decreased (12.21-12.01%) with storage period in wheat flour sample during storage period of 60 days (Nasir *et al*., 2003). Pathania *et al*., [19]. reported that the multigrain mixes prepared from chickpea flour, fenugreek powder and onion flakes protein content decreases from 16.52 to 16.36 % during 90 days storage period. Obadina *et al*., [20] reported that cocoyam flour decrease protein content during 90 days storage period.

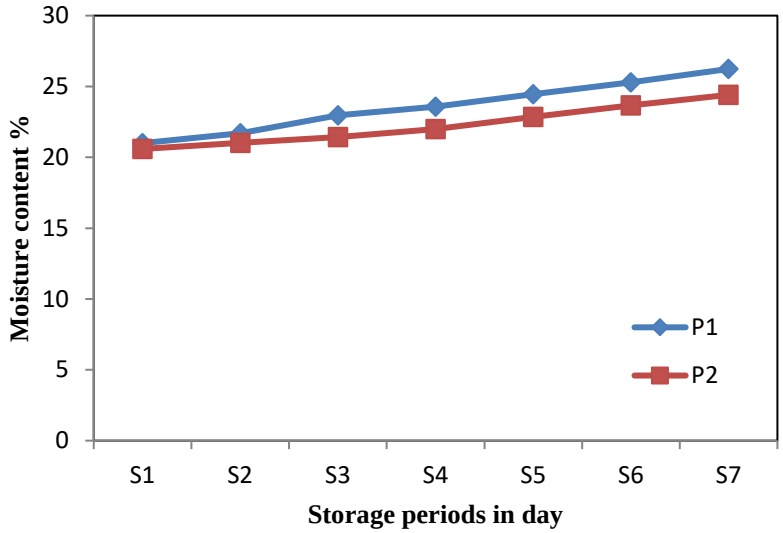

Fig. 3. Effect of packaging material and storage duration on moisture content of multigrain mixes from finger millet malt and moth bean malt

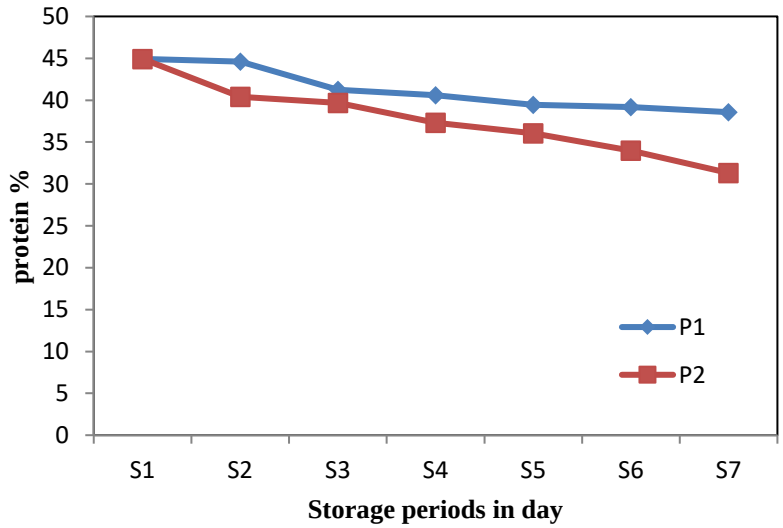

Fig. 4. Effect of packaging material and storage duration on protein content of multigrain mixes from finger millet malt and moth bean malt

Table 2. F– test for effect of moisture content on storage life of multigrain mixes packed in different packaging material

Treatment	Storage duration (days)								% retention
	0 day	15 day	30 days	45 days	60days	75 days	90days	Avg.	
P_1	7.000±0.00	7.231±0.005	7.653±0.005	7.856±0.007	8.152±0.006	8.433±0.002	8.745±0.002	6.834	124.929
P_2	7.000±0.00	7.006±0.005	7.141±0.010	7.332±0.012	7.618±0.005	7.889±0.005	8.135±0.012	6.772	118.532
Mean	7.000	7.118	7.397	7.594	7.885	8.161	8.440	7.646	
		SEm(±)			**CD at 5%**				
Treatment (T)		0.001			0.004				
Storage Duration (S)		0.002			0.008				
Interaction (T×S)		0.004			0.011				

Table 3. F– test for effect of protein content on storage life of multigrain mixes packed in different packaging material

Treatment	Storage duration (days)								% retention
	0 day	15 day	30 days	45 days	60days	75 days	90days	Avg.	
P_1	14.976±0.019	14.875±0.005	13.752.±0.033	13.528±0.014	13.151±0.025	13.056±0.033	12.857±0.014	13.742	85.855
P_2	14.976±0.019	13.473±0.017	13.231±0.010	12.436±0.017	12.016±0.006	11.329±0.022	10.437±0.017	12.556	69.915
Mean	14.976	14.174	13.491	12.982	12.583	12.192	11.647	13.149	
		SEm(±)			**CD at 5%**				
Treatment (T)		0.004			0.011				
Storage Duration (S)		0.008			0.023				
Interaction (T×S)		0.011			0.032				

3.3 Fat

Fig. 5 shows the effect of packaging material and storage duration (0, 15, 30, 45, 60, 75, 90 days) and packaging material on fat content (%) of multigrain mixes from finger millet malt and moth bean malt. The fat content (%) of multigrain mixes which was packed in polythene pouches (P_1) was decreases from 2.158 to 1.230 (%) for 0 to 90 days of storage period respectively and for aluminium pouches (P_2) fat content (%) was decreases from 2.158 to 0.855 (%) for 0 to 90 days of storage period respectively. From Fig. 5 it is clear that as storage period increases, the fat content (%) of multigrain mixes packed in polythene pouches (P_1) and aluminium pouches (P_2) decreases.

Table 4 shows the effect of packaging material on fat content indicated that the better retention of 56.972 % was observed in P_1 followed by P_2 39.525 %. The Table 4 shows the ANOVA for the effect of packaging material and storage duration on fat content (%) of multigrain mixes w.r.t. packaging material, storage duration and their interaction. From Table 4 it is indicated that packaging material had significant influence on fat content (%) of multigrain mixes at $p \leq 0.05$. The storage duration had significant influence on fat content (%) of multigrain mixes from finger millet malt and moth bean malt at $p \leq 0.05$. The interaction effect of packaging material and storage duration also shows the significant influence on fat content of multi grain mixes from finger millet malt and moth bean malt significant at $p \leq 0.05$. Pathania *et al*., [19]. reported that the multigrain mixes from chickpea flour, fenugreek powder and onion flakes fat content decreases from 7.11 to 7.04% during 90 days storage period. Decreases fat content may be attributed to the dilution effect due to increases in moisture and lipolytic activity of enzymes i.e. lipase and lipoxidase. Obadina *et al*., [20] reported that cocoyam flour decrease fat content up to 3.34 – 2.23% during 90 days storage period.

3.4 Fibre

Fig. 6 shows the effect of packaging material and storage duration (0, 15, 30, 45, 60, 75, 90 days) and packaging material on fiber content (%) of multigrain mixes from finger millet malt and moth bean malt. The fiber content (%) of multigrain mixes which was packed in polythene pouches (P_1) was decreases from 0.951 to 0.312 (%) for 0 to 90 days of storage period respectively and for aluminium pouches (P_2) fiber content (%) was decreases from 0.951 to 0.013 (%) for 0 to 90 days of storage period respectively. From Fig. 6 it is clear that as storage period increases, the fiber content (%) of multigrain mixes packed in polythene pouches (P_1) and aluminium pouches (P_2) decreases.

Table 5 shows the effect of packaging material on fiber content indicated that the better retention of 32.761 % was observed in P_1 followed by P_2 12.456 %. The Table 5 shows the ANOVA for the effect of packaging material and storage duration on fiber content (%) of multigrain mixes w.r.t. packaging material, storage duration and their interaction. From Table 5 it is indicated that packaging material had significant influence on fiber content (%) of multigrain mixes at $p \leq 0.05$. The storage duration had significant influence on fiber content (%) of multigrain mixes from finger millet malt and moth bean malt at $p \leq 0.05$. The interaction effect of packaging material and storage duration also shows the significant influence on fat content of multi grain mixes from finger millet malt and moth bean malt significant at $p \leq 0.05$. Obadina *et al*., [20] reported that cocoyam flour decrease fiber content during 90 days storage period.

3.5 Ash

Fig. 7 shows the effect of packaging material and storage duration (0, 15, 30, 45, 60, 75, 90 days) and packaging material on ash content (%) of multigrain mixes from finger millet malt and moth bean malt. The ash content (%) of multigrain mixes which was packed in polythene pouches (P_1) was decreases from 2.242 to 1.657 (%) for 0 to 90 days of storage period respectively and for aluminium pouches (P_2) ash content (%) was decreases from 2.242 to 1.223 (%) for 0 to 90 days of storage period respectively. From Fig. 7 it is clear that as storage period increases, the ash content (%) of multigrain mixes packed in polythene pouches (P_1) and aluminium pouches (P_2) decreases.

Table 6 shows the effect of packaging material on ash content indicated that the better retention of 73.922 % was observed in P_1 followed by P_2 62.976 %. The Table 6 shows the ANOVA for the effect of packaging material and storage duration on ash content (%) of multigrain mixes w.r.t. packaging material, storage duration and their interaction. From Table 6 it is indicated that packaging material had significant influence on fiber content (%) of multigrain mixes at $p \leq 0.05$. The storage duration had significant influence on

fiber content (%) of multigrain mixes from finger millet malt and moth bean malt at *p≤0.05*. The interaction effect of packaging material and storage duration also shows the significant influence on ash content of multi grain mixes from finger millet malt and moth bean malt significant at *p≤0.05*. Atti, [21] reported that the mixes prepared from millet, soybean and sesame flour ash content decreases from 8.56 to 4.23 % during 90 days storage period. Obadina *et al*., [20] reported that cocoyam flour decrease ash content up to 3.33 – 2.13 during 90 days storage period.

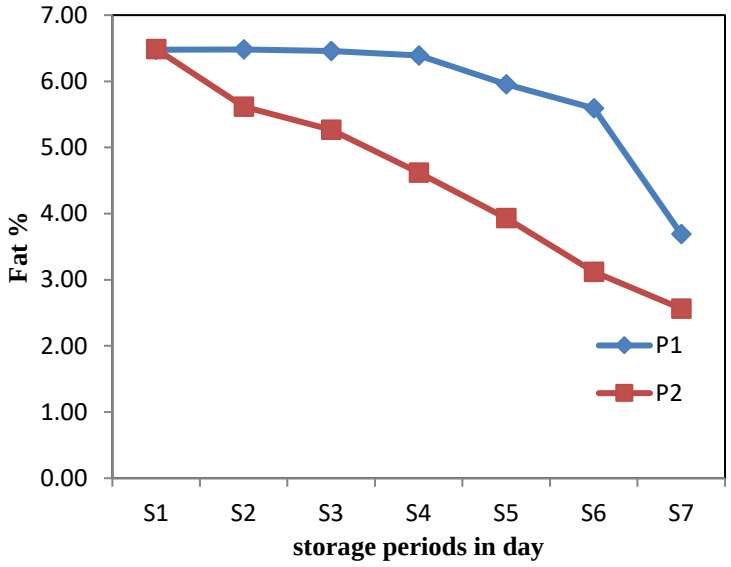

Fig. 5. Effect of packaging material and storage duration on fat content of multigrain mixes from finger millet malt and moth bean malt

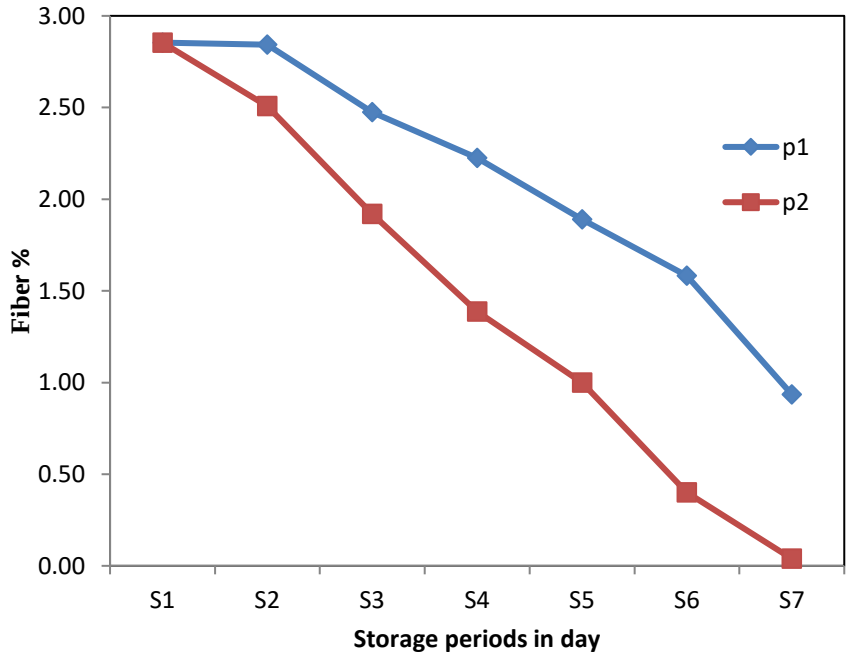

Fig. 6. Effect of packaging material and storage duration on fiber content of multigrain mixes from finger millet malt and moth bean malt

Table 4. F– test for effect of fat content on storage life of multigrain mixes packed in different packaging material

Treatment	Storage duration (days)								% retention
	0 day	15 day	30 days	45 days	60days	75 days	90days	Avg.	
P_1	2.158±0.189	2.160±0.184	2.152.±0.181	2.130±0.151	1.985±0.011	1.863±0.024	1.230±0.005	1.954	56.972
P_2	2.158±0.189	1.873±0.021	1.756±0.029	1.540±0.016	1.311±0.010	1.040±0.014	0.855±0.032	1.505	39.525
Mean	2.158	2.016	1.954	1.835	1.648	1.451	1.042	1.729	
		SEm(±)			**CD at 5%**				
Treatment (T)		0.022			0.063				
Storage Duration (S)		0.044			0.127				
Interaction (T×S)		0.063			0.180				

Table 5. F– test for effect of fiber content on storage life of multigrain mixes packed in different packaging material

Treatment	Storage duration (days)								% retention
	0 day	15 day	30 days	45 days	60days	75 days	90days	Avg.	
P_1	0.951±0.044	0.948±0.0.416	0.825.±0.021	0.742±0.019	0.630±0.021	0.528±0.030	0.312±0.005	1.954	32.761
P_2	0.951±0.044	0.836±0.014	0.640±0.017	0.462±0.034	0.333±0.018	0.133±0.082	0.013±0.001	1.505	12.456
Mean	0.951	0.892	0.732	0.602	0.481	0.330	0.162	0.592	
		SEm(±)			**CD at 5%**				
Treatment (T)		0.005			0.015				
Storage Duration (S)		0.011			0.031				
Interaction (T×S)		0.015			0.045				

Table 6. F– test for effect of ash content on storage life of multigrain mixes packed in different packaging material

Treatment	Storage duration (days)								% retention
	0 day	15 day	30 days	45 days	60days	75 days	90days	Avg.	
P_1	2.242±0.889	2.235±0.889	2.231±0.889	2.141±0.843	1.972±0.015	1.871±0.005	1.657±0.384	2.049	73.922
P_2	2.242±0.032	1.848±0.015	1.788±0.010	1.677±0.010	1.533±0.012	1.430±0.024	1.223±0.008	1.634	62.976
Mean	2.242	2.041	2.009	1.909	1.752	1.650	1.440	1.841	
		SEm(±)			**CD at 5%**				
Treatment (T)		0.0981			0.280				
Storage Duration (S)		0.196			0.560				
Interaction (T×S)		0.277			0.793				

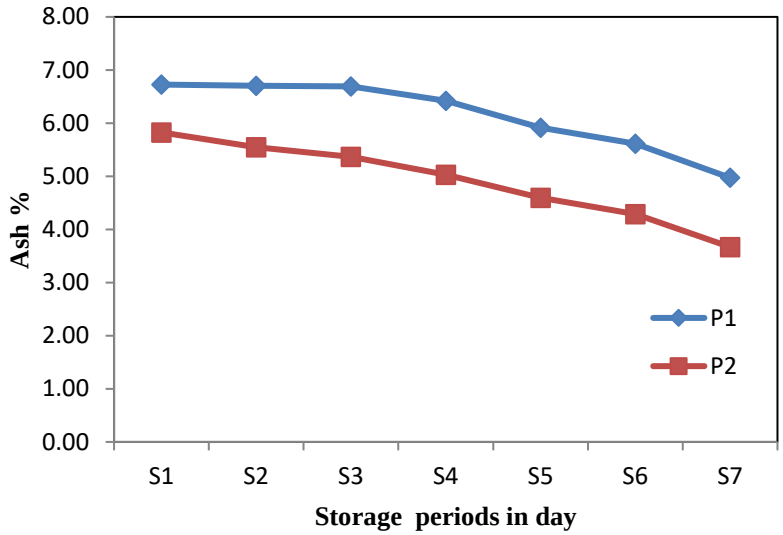

Fig. 7. Effect of packaging material and storage duration on ash content of multigrain mixes from finger millet malt and moth bean malt

3.6 Carbohydrate

Fig. 8 shows the effect of packaging material and storage duration (0, 15, 30, 45, 60, 75, 90 days) and packaging material on carbohydrate content (%) of multigrain mixes from finger millet malt and moth bean malt. The carbohydrate content (%) of multigrain mixes which was packed in polythene pouches (P_1) was increases from 70.136 to 72.159 (%) for 0 to 90 days of storage period respectively and for aluminium pouches (P_2) carbohydrate content (%) was increases from 70.136 to 76.376 (%) for 0 to 90 days of storage period respectively. From Fig. 8 it is clear that as storage period increases, the carbohydrate content (%) of multigrain mixes packed in polythene pouches (P_1) and aluminium pouches (P_2) increases.

Table 7 shows the effect of packaging material on carbohydrate content indicated that the better retention of 102.885 % was observed in P_2 followed by P_1 104.400 %. The Table 7 shows the ANOVA for the effect of packaging material and storage duration on carbohydrate content (%) of multigrain mixes w.r.t. packaging material, storage duration and their interaction. From Table 7 it is indicated that packaging material had significant influence on carbohydrate content (%) of multigrain mixes at $p \leq 0.05$. The storage duration had significant influence on carbohydrate content (%) of multigrain mixes from finger millet malt and moth bean malt at $p \leq 0.05$. The interaction effect of packaging material and storage duration also shows the significant influence on carbohydrate content of multi grain mixes from finger millet malt and moth bean malt significant at $p \leq 0.05$.

3.7 Calorific Value

Fig. 9 shows the effect of packaging material and storage duration (0, 15, 30, 45, 60, 75, 90 days) and packaging material on calorific value content (kcal/100g). of multigrain mixes from finger millet malt and moth bean malt. The calorific value content (kcal/100g) of multigrain mixes which was packed in polythene pouches (P_1) was decreases from 363.338 to 304.335 (kcal/100g) for 0 to 90 days of storage period respectively and for aluminium pouches (P_2) calorific value content (kcal/100g) was decreases from 363.338 to 354.711(kcal/100g) for 0 to 90 days of storage period respectively. From Fig. 9 it is clear that as storage period increases, the calorific value content (kcal/100g) of multigrain mixes packed in polythene pouches (P_1) and aluminium pouches (P_2) increases.

Table 8 shows the effect of packaging material on calorific value content indicated that the better retention of 95.232 (kcal/100g) was observed in P_2 followed by P_1 83.760 (kcal/100g). The Table 8 shows the ANOVA for the effect of packaging material and storage duration on calorific value content of multigrain mixes w.r.t. packaging material, storage duration and their interaction. From Table 8 it is indicated that packaging material had significant influence on calorific

value content (%) of multigrain mixes at *p≤0.05*. The storage duration had significant influence on calorific value content (%) of multigrain mixes from finger millet malt and moth bean malt at *p≤0.05*. The interaction effect of packaging material and storage duration also shows the significant influence on calorific value content of multi grain mixes from finger millet malt and moth bean malt significant at *p≤0.05*.

3.8 Whiteness Index

Fig. 10 shows the effect of packaging material and storage duration (0, 15, 30, 45, 60, 75, 90 days) and packaging material on whiteness index content (%) of multigrain mixes from finger millet malt and moth bean malt. The whiteness index content (%) of multigrain mixes which was packed in polythene pouches (P_1) was decrease from 24.197 to 21.187 (%) for 0 to 90 days of storage period respectively and for aluminium pouches (P_2) whiteness index content (%) was decreases from 24.197 to 18.242 (%) for 0 to 90 days of storage period respectively. From Fig. 10 it is clear that as storage period increases, the whiteness index content (%) of multigrain mixes packed in polythene pouches (P_1) and aluminium pouches (P_2) decreases.

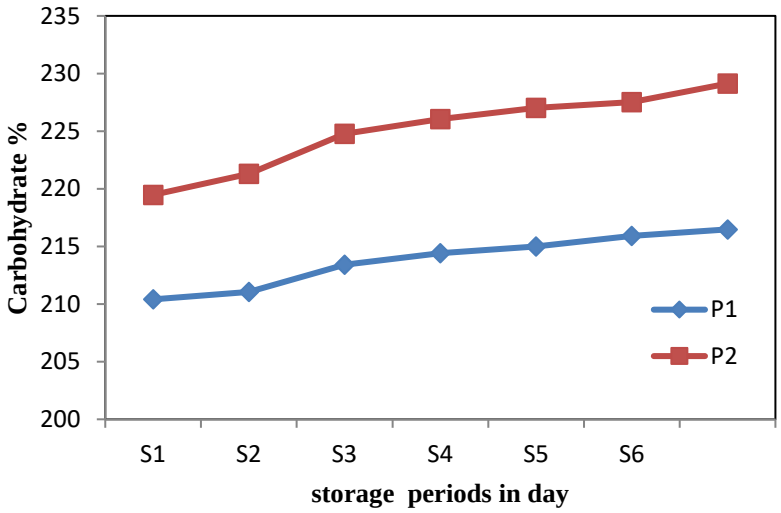

Fig. 8. Effect of packaging material and storage duration on carbohydrate content of multigrain mixes from finger millet malt and moth bean malt

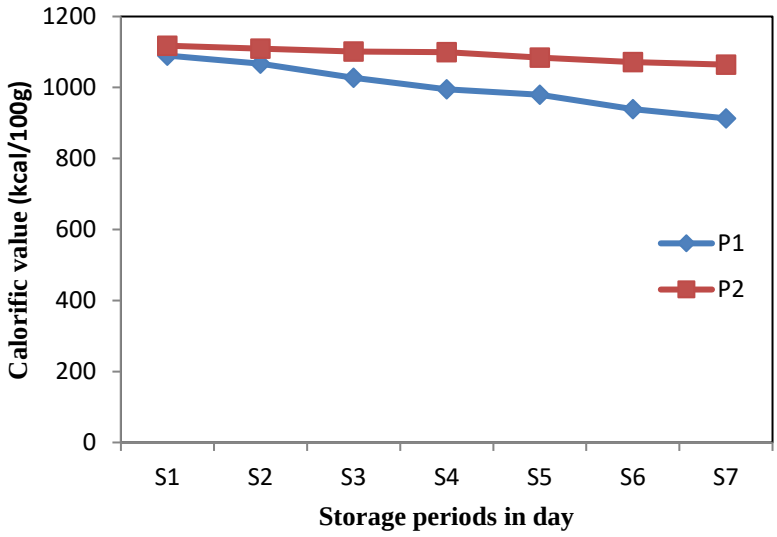

Fig. 9. Effect of packaging material and storage duration on calorific value content of multigrain mixes from finger millet malt and moth bean malt

Table 7. F– test for effect of carbohydrate content on storage life of multigrain mixes packed in different packaging material

Treatment	Storage duration (days)								% retention
	0 day	15 day	30 days	45 days	60days	75 days	90days	Avg.	
P_1	70.136±0.012	71.347±0.017	71.134±0.027	71.000±0.039	71.662±0.033	71.968±0.026	72.159±0.0204	71.343	102.885
P_2	70.136±0.012	73.770±0.024	74.922±0.031	75.354±0.027	75.674±0.027	75.838±0.026	76.376±0.030	75.013	104.400
Mean	70.136	72.558	73.028	73.177	73.668	73.903	74.267	73.178	
		SEm(±)			**CD at 5%**				
Treatment (T)		0.006			0.017				
Storage Duration (S)		0.012			0.034				
Interaction (T×S)		0.017			0.048				

Table 8. F– test for effect of calorific value content on storage life of multigrain mixes packed in different packaging material

Treatment	Storage duration (days)								% retention
	0 day	15 day	30 days	45 days	60days	75 days	90days	Avg.	
P_1	363.338±3.378	355.740±0.345	342.360±1.900	331.792±1.146	326.620±3.167	312.955±1.195	304.335±0.240	333.877	83.760
P_2	363.338±1.491	369.961±0.237	367.220±0.064	366.624±0.226	361.361±0.045	357.225±0.219	354.711±0.139	364.239	95.232
Mean	363.338	362.850	354.790	349.208	343.990	335.05	329.523	349.052	
		SEm(±)			**CD at 5%**				
Treatment (T)		0.300			0.859				
Storage Duration (S)		0.601			1.718				
Interaction (T×S)		0.850			2.431				

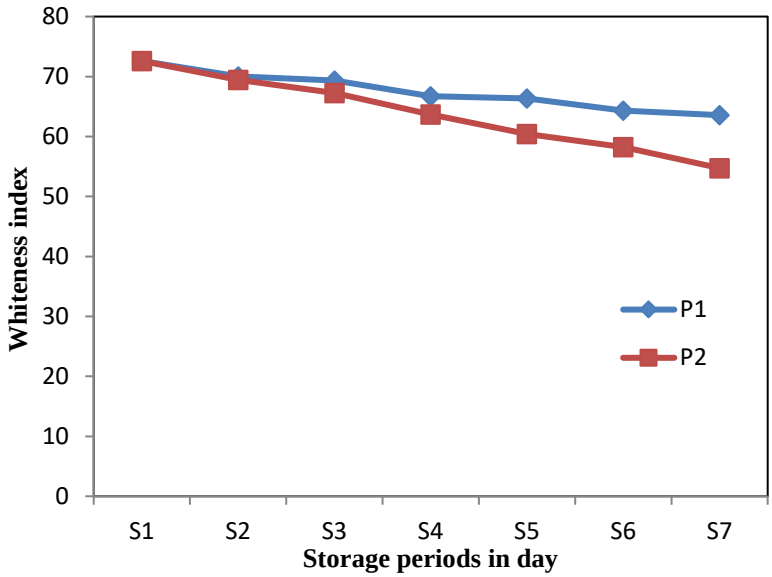

Fig. 10. Effect of packaging material and storage duration on Whiteness index content of multigrain mixes from finger millet malt and moth bean malt

Table 9 shows the effect of packaging material on whiteness index content indicated that the better retention of 95.232 % was observed in P_2 followed by P_1 83.760 %. The Table 9 shows the ANOVA for the effect of packaging material and storage duration on whiteness index content (%) of multigrain mixes w.r.t. packaging material, storage duration and their interaction. From Table 9 it is indicated that packaging material had significant influence on whiteness index content (%) of multigrain mixes at *p≤0.05*. The storage duration had significant influence on whiteness index content (%) of multigrain mixes from finger millet malt and moth bean malt at *p≤0.05*. The interaction effect of packaging material and storage duration also shows the significant influence on whiteness index content of multi grain mixes from finger millet malt and moth bean malt significant at *p≤0.05*.

3.9 Microbial Analysis

3.9.1 Standard plate count

Microbial analysis is the perfect quality assessment protocol performed in food products quality analysis. In the study of microbial quality of multigrain mixes from finger millet malt, moth bean malt and drumstick leaf powder, the study was undertaken examination of the total plate count (TPC) and yeast and mould count or fungal count. The effect of packaging material polythene pouch (P_1) and aluminium pouches (P_2) and storage duration on microbial characteristics of multigrain mixes prepared from finger millet malt, moth bean malt, drumstick leaf powder stored at ambient temperature were recorded and presented in Table 3. Out of total storage duration i.e. 0, 15, 30, 45, 60, 75, 90 days, the microbial analysis was carried out after each day. Bacterial growth was detected for 90^{th} day of analysis for both the packaging material i.e. polythene pouch (P_1) and aluminium pouches (P_2). At 90 days analysis the standard plate count observed for multigrain mixes packed in polythene pouch and aluminium pouches were and 5.3×10^6 CFU/g and 9.0×10^6 CFU/g respectively.

It was seen from Table 10 shows the ANOVA for the effect of packaging treatments and storage duration on standard plate count of multigrain mixes from finger millet malt and moth bean malt had significant influence on standard plate count of multigrain mixes at *p≤0.05*. Packaging material and storage duration had significant influence on standard plate count of multigrain mixes at *p≤0.05*. The interaction also shows significant influence on standard plate count of multigrain mixes prepared from finger millet malt and moth bean malt at *p≤0.05*.

Deshpande *et al.*, [22] reported that barley based sattu Increase in the total bacterial and yeasts and moulds count was observed from 4.8×10^3 and 1.0×10^3 cfu/g to 5.6×10^3 and 1.0×10^3 cfu/ g, respectively at the end of the study but were well within the acceptable limits of total bacterial counts of 5.0×04 cfu/ g.

Table 9. F– test for effect of Whiteness index content on storage life of multigrain mixes packed in different packaging material

Treatment	Storage duration (days)								% retention
	0 day	15 day	30 days	45 days	60days	75 days	90days	Avg.	
P_1	24.197±0.231	23.341±0.016	23.116±0.011	22.235±0.005	21.444±0.028	21.444±0.028	21.187±0.058	22.423	87.561
P_2	24.197±0.231	23.141±0.016	22.412±0.076	21.230±0.018	20.144±0.020	19.409±0.076	18.242±0.011	21.253	75.396
Mean	24.197	23.241	22.764	21.732	20.426	20.426	19.714	21.785	
		SEm(±)			**CD at 5%**				
Treatment (T)		0.019			0.055				
Storage Duration (S)		0.038			0.110				
Interaction (T×S)		0.054			0.155				

Table 10. Effect of packaging material and storage duration of multigrain mixes on yeast and mould count

Duration	Polythene pouches		aluminium pouches	
0 Days	Not Detected		Not detected	
15 Days	Not Detected		Not detected	
30 Days	Not Detected		Not detected	
45 Days	Not Detected		Not Detected	
60 Days	Not Detected		Not Detected	
75 Days	Not Detected		Not Detected	
90 Days	53×10^2 CFU/g		90×10^2 [1]CFU/g	
SEm(±)	**Packaging material (P)**	**Storage Duration (S)**		**Interaction (P×S)**
	0.575	1.151		1.628
CD at 5%	1.645	3.290		4.653
Result	SIG 5%	SIG 5%		SIG 5%

[1] *CFU – Colony Forming Unit*

3.9.2 Yeast and mould count

The effect of packaging material polythene pouch (P_1) and aluminium pouches (P_2) and storage duration on microbial characteristics of multigrain mixes prepared from finger millet malt, moth bean malt and drumstick leaf powder stored at ambient temperature were recorded and presented in Table 11. Out of total storage duration i.e. 0, 15, 30, 45, 60, 75, 90 days, the microbial analysis was carried out each day. No yeast and mould growth was detected up to analysis of 75 days for both the packaging material i.e. polythene bag (P_1) and plastic tray (P_2) at 90 days analysis the yeast and mould count observed for multigrain mixes from finger millet malt, moth bean malt and drumstick leaf powder observed were 20×10^2 CFU/g and 44×10^2 CFU/g for polythene pouch (P_1) and 36×10^2 CFU/g and 75×10^2 CFU/g for aluminium pouches (P_2) respectively, It was seen from Table 11 shows the ANOVA for the effect of packaging material and storage duration on yeast and mould count of multigrain mixes prepared from finger millet malt, moth bean malt and drumstick leaf powder. It indicated that packaging materials and storage duration had significant influence on yeast and mould count of multigrain mixes prepared from finger millet malt, moth bean malt and drumstick leaf powder at p≤0.05. The interaction also had significant influence on Yeast and mould count of multigrain mixes prepared from finger millet malt, moth bean malt and drumstick leaf powder at p≤0.05.

Khan *et al*., [23] reported that the total plate counts Instant wheat porridge mix ranged between 100 and 150 cfu/g and Yeast and mold counts in stored samples were below 100 cfu/g.

3.10 Sensory Analysis

Table 12 (a) shows the sensory colour of *thalipeeth* prepared from multigrain mixes stored during for 0, 30, 60, 90 days duration in polythene bag (P_1) and aluminum pouches (P_2). The colour score of P_1 and P_2 decreases from 8.133 to 7.033 The highest colour score was 8.133 observed for (P_1). The effect of packaging treatment had significant effect on colour of the *thalipeeth* at $p \leq 0.05$. The effect of storage duration also had significant effect on the colour of thalipeeth at *p≤0.05*. The interaction of packaging material and storage duration had also a significant effect and the colour of *thalipeeth* prepared from multigrain mixes at p≤0.05 [24].

Table 12 (b) shows the sensory Texture of *thalipeeth* prepared from multigrain mixes for 0, 30, 60, 90 days duration in polythene bag (P_1) and aluminum pouches (P_2). The score Texture of $P_1$and P_2decreases from 8.300 to. 7.567. The highest Texture score was observed 8.300 for (P_1). The effect of storage duration had significant effect on Texture of the *thalipeeth* at $p \leq 0.05$. The effect of packaging materials also had significant effect on the Texture of *thalipeeth* at *p≤0.05*. The interaction of packaging material and storage duration had also a significant effect and the Texture of *thalipeeth* prepared from multigrain mixes at p≤0.05.

Table 11. Effect of packaging material and storage duration of multigrain mixes on yeast and mould count

Duration	Polythene pouches		aluminium pouches
0 Days	Not Detected		Not detected
15 Days	Not Detected		Not detected
30 Days	Not Detected		Not detected
45 Days	Not Detected		Not Detected
60 Days	Not Detected		Not Detected
75 Days	Not Detected		Not Detected
90 Days	53×10^2 CFU/g		90×10^2 [2]CFU/g
SEm(±)	**Packaging material (P)**	**Storage Duration (S)**	**Interaction (P×S)**
	0.523	1.046	1.480
CD at 5%	1.495	2.991	4.230
Result	SIG 5%	SIG 5%	SIG 5%

[2]*CFU – Colony Forming Unit*

Table 12. Effect of packaging material and storage duration of *thalipeeth* prepared from multigrain mixes on sensory attribute and its ANOVA

Source of Variance	**Storage duration (days)**				
	0	30	60	90	Mean
(a) Colour					
P_1	8.133±0.142	8.100±0.01	8.00±0.02	7.867±0.004	8.025
P_2	7.467±0.058	7.327±0.058	7.367±0.058	7.033±0.058	7.335
Mean	7.8	7.713	7.683	7.45	7.68
	Packaging material (P)		**Storage duration (S)**		**Interaction (P×S)**
SEm(±)	0.014		0.02		0.029
CD $_{at\ 5\%}$	0.044		0.062		0.087
Source of Variance	**Storage duration (days)**				
	0	30	60	90	Mean
(b) Texture					
P_1	8.300±0.115	8.227±0.126	8.167±0.263	8.0±0.023	8.173
P_2	8.033±0.058	7.967±0.123	7.833±0.005	7.567±0.01	7.850
Mean	8.166	8.097	8.000	7.783	8.011
	Packaging material (P)		**Storage duration (S)**		**Interaction (P×S)**
SEm(±)	0.022		0.031		0.044
CD $_{at\ 5\%}$	0.067		0.094		0.133
Source of Variance	**Storage duration (days)**				
	0	1	2	3	Mean
(c) Taste					
P_1	8.400±0.115	8.356±0.263	8.233±0.154	7.967±0.023	8.225
P_2	7.867±0.115	7.835±0.058	7.533±0.058	7.267±0.208	7.625
Mean	8.133	8.097	7.883	7.617	7.925
	Packaging material (P)		**Storage duration (S)**		**Interaction (P×S)**
SEm(±)	0.032		0.046		0.065
CD $_{at\ 5\%}$	0.098		0.138		0.195

Table 13. Effect of packaging material and storage duration of *sev* prepared from multigrain mixes on sensory attribute and its ANOVA

Source of	**Storage duration (days)**				
Variance	0	30	60	90	Mean
(a) Colour					
P_1	8.62±0.145	8.59±0.22	8.08±0.221	8.05±0.237	7.7
P_2	8.52±0.245	8.30±0.385	7.99±0.385	7.75±0.287	7.5
Mean	8.57	8.44	8.03	7.9	7.6
	Packaging material (P)			**Storage duration (S)**	**Interaction (P×S)**
SEm(±)	0.032			0.053	0.071
CD $_{at\ 5\%}$	0.091			0.145	0.216
Source of	**Storage duration (days)**				
Variance	0	30	60	90	Mean
(b) Texture					
P_1	9.0±0.001	8.23±0.208	7.66±0.208	7.46±0.057	8.091
P_2	8.80±0.058	8.46±0.057	7.466±0.057	7.16±0.015	7.975
Mean	8.901	8.350	7.566	7.316	8.033
	Packaging material (P)			**Storage duration (S)**	**Interaction (P×S)**
SEm(±)	0.037			0.053	0.075
CD $_{at\ 5\%}$	0.108			0.152	0.216
Source of	**Storage duration (days)**				
Variance	0	30	60	90	Mean
(c) Taste					
P_1	8.45±0.308	8.39±0.406	8.04±0.198	8.04±0.198	7.79
P_2	8.41±0.265	8.30±0.240	7.97±0.421	7.72±0.299	7.56
Mean	8.43	8.35	8.00	7.86	7.67
	Packaging material (P)			**Storage duration (S)**	**Interaction (P×S)**
SEm(±)	0.032			0.050	0.071
CD $_{at\ 5\%}$	0.091			0.145	0.200

Table 12 (d) shows the sensory taste score of *thalipeeth* prepared from multigrain mixes stored during for 0, 30, 60, 90 days duration in polythene bag (P_1) and aluminum pouches (P_2). The Taste score of $P_1$and P_2decreases from 8.40 to 7.26. The highest taste score was observed 8.40 for (P_1). The effect of packaging treatment had significant effect on colour of the *thalipeeth* at $p \leq 0.05$. The effect of storage duration also had significant effect on the colour of *thalipeeth* at *p≤0.05*. The interaction of packaging material and storage duration had also a significant effect and the tast of *thalipeeth* prepared from multigrain mixes at *p≤0.05*.

Table 13 (a) shows the sensory colour of *sev* prepared from multigrain mixes stored during for 0, 30, 60, 90 days duration in polythene bag (P_1) and aluminium pouches (P_2). The colour score of P_1 and P_2 decreases from 7.7 to 7.5 The highest colour score was 7.7 observed for (P_1). The effect of packaging treatment had significant effect on colour of the *sev* at $p \leq 0.05$. The effect of storage duration also had significant effect on the colour of sev at *p≤0.05*. The interaction of packaging material and storage duration had also a significant effect and the colour of *sev* prepared from multigrain mixes at *p≤0.05*.

Table 13 (b) shows the sensory Texture of *sev* prepared from multigrain mixes for 0, 30, 60, 90 days duration in polythene bag (P_1) and aluminium pouches (P_2). The score Texture of $P_1$and P_2 decreases from 8.0 to 7.9. The highest Texture score was observed 8.0 for (P_1). The effect of storage duration had significant effect on Texture of the *se*v at $p \leq 0.05$. The effect of packaging materials also had significant effect on the Texture of *sev* at p≤0.05. The interaction of packaging material and storage duration had also a significant effect and the Texture of *sev* prepared from multigrain mixes at p≤0.05.

Table 13 (d) shows the sensory taste score of *sev* prepared from multigrain mixes stored during for 0, 30, 60, 90 days duration in polythene bag (P_1) and aluminium pouches (P_2). The Taste score of $P_1$and P_2 decreases from 7.7 to 7.5. The highest taste score was observed 7.7 for (P_1). The effect of packaging treatment had significant effect on colour of the *sev* at $p \leq 0.05$. The effect of storage duration also had significant effect on the colour of *sev* at *p≤0.05*. The interaction of packaging material and storage duration had also a significant effect and the taste of *sev* prepared from multigrain mixes at *p≤0.05*.

4. CONCLUSIONS

The stored multigrain mixes was observed during each day from 0, 15, 30, 45, 60, 75, 90 days. Nutritional analysis indicated that both multigrain mixes packed packaging material and during storage period moisture content increases from 7.0 to 8.745%, protein content decreases from 14.97 to 12.85%, fat decreases 2.15 to 1.23%, fiber content decreases from 0.95 to 0.31%, ash content decreases from 2.24 to 1.67% carbohydrate increases from 70.13 to 72.159 %, whiteness index decreases from 24.19 to 21.187 and microbiological study depicted that standard plate count was observed after 90 days, the yeast and mould count was observed after 90 days of storage of multigrain mixes, that it is best to store it in plastic & aluminum pouch - less than 90 days, based on the growth of yeast and mold.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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