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Jharana Panda
Research Scholar, Department of Food and Nutrition, College of Community Science, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar, India

Gitanjali Chaudhary
Assistant Professor Cum Scientist, Department of Food and Nutrition, College of Community Science, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar, India

Sunita Kumari
Subject Matter Specialist, Krishi Vigyan Kendra, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar, India

Corresponding Author
Jharana Panda
Research Scholar, Department of Food and Nutrition, College of Community Science, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar, India

Effect of storage on quality attributes of proso millet based composite flour

Jharana Panda, Gitanjali Chaudhary and Sunita Kumari

Abstract
The study evaluated the effect of storage on the quality attributes of proso millet based composite flour. Quality attributes like moisture and organoleptic characteristics of the composite flour was investigated during storage. Five proportion of proso millet based composite flour was developed from which proso millet based composite flour-2 (proso flour: wheat flour: bengal gram flour in ratio 20:60:20) was selected as most acceptable on the basis of nine-point hedonic rating scale. This flour was further stored in a Low Density Polyethylene (LDPE) pouches for 30 days and compared with control (100% wheat flour) for their moisture content and organoleptic characteristics at an interval of 0 day, 15 days and 30 days of storage period. The result showed a significant (p<0.05) increase in moisture content in both the flours while organoleptic assessment revealed that the composite flour was accepted by the panel members on 30th day of storage.

Keywords: Quality attributes, proso millet, flour

Introduction
Composite flour is a mixture of different flours and other ingredients intended to replace wheat flour partially or totally (Milligan *et al.* 1981) [1]. Shittu *et al.* (2007) also explained composite flour is a blend of two or more flours from various food crops with or without wheat flour. Recently, the development of food products using composite flour has been increasing and is attracting attention from many researchers. In present scenario, composite flour is considered to reduce the importation of wheat flour in developing countries and thus encourages the utilization of locally grown crops (Hugo *et al*. 2000; Harmadi *et al*. 2014) [2, 3]. Therefore, developing countries are now encouraged to initiate programmes to use locally available flours as a substitute for wheat flour (Abdelghafer *et al*. 2011) [4].

Proso millet (*Panicum miliaceum*) is an important short duration minor millet crop that adapts to extreme climatic conditions. It is grown globally for food, feed and fodder purposes. Due to its lowest water and nutrient requirement, it has the potential for agriculture diversification. Nutritionally, proso millet is rich in protein, vitamins, minerals and micronutrients compared to other staple cereals. The protein content in proso millet is around 11% on dry basis (Kalinova and Moudry, 2006) [5]. They reported that the proso millet is richer in essential amino acids such as leucine, isoleucine and methionine when compared to wheat. Kalinova and Moudry also found that the protein quality of proso millet was higher (51%) compared to wheat. Thus, it has the potential to provide both food and nutritional security.

Wheat is the major food produce among all cereal crops. It is a commonly consumed food grain in large segments of global population. Wheat is an important source of calories, dietary fibre, protein and various health-promoting phytochemicals. From the nutritional point of view, wheat contains 64.17% of carbohydrates, 1.28% minerals, 10.57% protein, and 1.53% fat (Longvah *et al*. 2017) [6]. Its bran along with germ has therapeutic properties which help to protect against diseases like- diabetes mellitus, cardiovascular, constipation, obesity, etc. Legumes are considered as 'Poor Man's meat'. They are rich in protein, complex carbohydrates, dietary fibre including essential vitamins and minerals. Legumes has low glycemic index, thus can help to treat type-2 diabetes mellitus and other health related problems.

Addition of cereals and legumes to millet based composite flour could be a good option for improving the nutrient composition and increasing the intake of millets. Thus, in the present study five different proportions of composite flours were developed by combining proso millet flour, wheat flour and commonly used legume i.e. bengal gram flour. The developed flours were organoleptically assessed to get the most acceptable proso based composite flour.

Further, the most acceptable composite flour was stored and its moisture content and organoleptic characteristics were assessed.

Materials and Methods

Locale of the study and procurement of raw material

The investigation was carried out at Department of Food and Nutrition, College of Community Science, Dr. RPCAU, Pusa in Samastipur district of Bihar. The raw proso millet grains were procured in a lot at one time to avoid any varietal difference during the investigation. Other food ingredients which were used to develop proso millet based composite flour were purchased from the local market of Pusa, Samastipur.

Processing of proso millet flour

The raw proso millet grains were subjected to processing before development of proso millet based composite flour. The proso grains were cleaned, washed and soaked overnight. Further they were germinated for 24hrs, 48hrs, 72hrs and 96hrs. The germinated grains were roasted for 5 minutes and then grinded and sieved to get fine proso millet flour. Based on nutritional and organoleptic assessment, the flour obtained after 72hrs germination was selected as superior compared to other processed proso millet flours. Thus, this flour was utilized for further development of proso millet based composite flour.

Development of proso millet based composite flour

For the development of Proso Millet (PM) based composite flour; proso millet flour obtained after 72hrs germination, bengal gram flour and wheat flour were used in different proportions (Table 1). Wheat flour was taken as a base and the quantity of Bengal gram flour was kept constant. The quantity of processed proso millet flour was 10%, 20%, 30%, 40% and 50% respectively. The developed PM based composite flours were then analyzed for sensory characteristics on the basis of nine point hedonic rating scale and the most acceptable composite flour was used for examining the effect of storage.

Table 1: Formulation of different proso millet (PM) based composite flours

Treatment	Processed PM flour (%)	Wheat flour (%)	Bengal gram flour (%)
Control (C)	-	100	-
PM based Composite flour-1	10	70	20
PM based Composite flour-2	20	60	20
PM based Composite flour-3	30	50	20
PM based composite flour-4	40	40	20
PM based composite flour-5	50	30	20

Effect of storage on quality attributes of PM based composite flour

The effect of storage on quality attributes of PM based composite was conducted for 30 days. The selected PM based composite flour was evaluated at an interval of 0, 15 and 30 day for their sensory characteristics and moisture content.

Moisture analysis of flour sample

The moisture content of the experimental samples was estimated by hot air oven method as per the procedure given by AOAC (2000). A clean bottle was dried in an oven, cooled in a desiccator and was weighed (W_1). For the analysis, 10g of flour sample was taken in that bottle (W_2) and was dried in hot air oven at 100 ºC to 105 ºC for 2-3hrs, cooled in desiccator and weighed (W_3). This process was repeated till a constant weight was obtained.

$$\text{Moisture } \% = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Organoleptic assessment of flour sample

The most commonly used scale to measure any food product acceptability is hedonic rating scale. This method helps to grade products with respect to their quality attributes. In this study, chapattis were developed using PM based composite flour and their sensory evaluation was done by 30 panel members using nine-point hedonic rating scale (Rangana, 2002). Extremely liked was scored as 9 while extremely disliked was scored as 1.

Statistical analysis

The final results from the study were compiled and analyzed using suitable statistical methods. The data were represented as descriptive statistics such as mean, standard deviation and were analyzed using one-way ANOVA and two-way ANOVA whereas p values<0.05 were considered as significant. One-way ANOVA was used to test the differences in developed proso millet based composite flours while two-way ANOVA was used to test the differences among moisture content and sensory attributes of the PM based composite flour and control flour during storage. The data shown in the tables are an average of six replicate observations.

Results and Discussion

Organoleptic assessment of developed proso millet (PM) based composite flour

From Table 2, it was revealed that among all composite flours, chapatti was developed using PM based composite flour-2 recorded highest score in all the sensory parameters except appearance whereas chapatti developed using PM based composite flour-5 had lowest scores in all sensory attributes. The overall acceptability score of chapatti developed using PM based composite flour-1 was 7.55±0.50, PM based composite flour-2 7.64±0.79, PM based composite flour-3 6.67±0.59, PM based composite flour-4 6.65±0.98 and PM based composite flour-5 6.60±1.47, while that of chapatti developed by incorporating control flour was 8.19±0.60. The appearance score of chapatti developed incorporating PM based composite flour-1 was 7.87±0.34, PM based composite flour-2 7.86±0.70, PM based composite flour-3 7.71±0.88, PM based composite flour-4 7.70±0.84 and PM based composite flour-5 7.69±0.92. The highest score for color was obtained by chapatti developed from PM based composite flour-2 (7.96±0.54) where as chapatti developed using PM based composite flour-1 was found to be 7.77±0.80, PM based composite flour-3 (7.52±0.80), PM based composite flour-4 (6.53±0.90), PM based composite flour-5 (6.41±0.99). The highest taste (7.41±1.02), texture (7.71±0.67) and flavor

(7.26±0.62) scores were also found to be highest in chapatti developed using PM based composite flour-2, while chapatti prepared by incorporating PM based composite flour-1 obtained taste (7.32±0.65), texture (7.64±0.66) and flavor (7.19±0.91); PM based composite flour-3 obtained taste (7.00±0.81), texture (6.52±1.02) and flavor (6.38±0.49); PM based composite flour-4 obtained taste (6.21±1.14), texture (6.41±0.62) and flavor (6.30±0.88) and Pm based composite flour-5 obtained lowest scores in taste (6.19±1.47), texture (6.37±1.10) and flavor (6.22±1.33) among all the experimental flour samples.

The organoleptic assessment showed different proportion of PM based composite flours were significantly ($p<0.05$) different to each other in all sensory parameters. From the assessment, PM based composite flour-2 was found to be the most acceptable proso millet based composite flour and was therefore used for the study of storage effect.

Table 2: Organoleptic assessment of formulated PM based composite flours

Flour sample	Appearance	Color	Taste	Texture	Flavor	Overall acceptability
Control flour (C)	8.19±0.47	8.06±0.35	8.32±0.59	7.96±0.60	8.09±0.65	8.19±0.60
PM based composite flour-1	7.87±0.34	7.77±0.80	7.32±0.65	7.64±0.66	7.19±0.91	7.55±0.50
PM based composite flour-2	7.86±0.70	7.96±0.54	7.41±1.02	7.71±0.67	7.26±0.62	7.64±0.79
PM based composite flour-3	7.71±0.88	7.52±0.80	7.00±0.81	6.52±1.02	6.38±0.49	6.67±0.59
PM based composite flour-4	7.70±0.84	6.53±0.90	6.21±1.14	6.41±0.62	6.30±0.88	6.65±0.98
PM based composite flour-5	7.69±0.92	6.41±0.99	6.19±1.47	6.37±1.10	6.22±1.33	6.60±1.47
CD	0.37	0.42	0.53	0.47	0.44	0.44
SE (m)	0.13	0.15	0.19	0.17	0.15	0.15
CV (%)	9.84	11.30	14.86	13.26	12.37	11.95

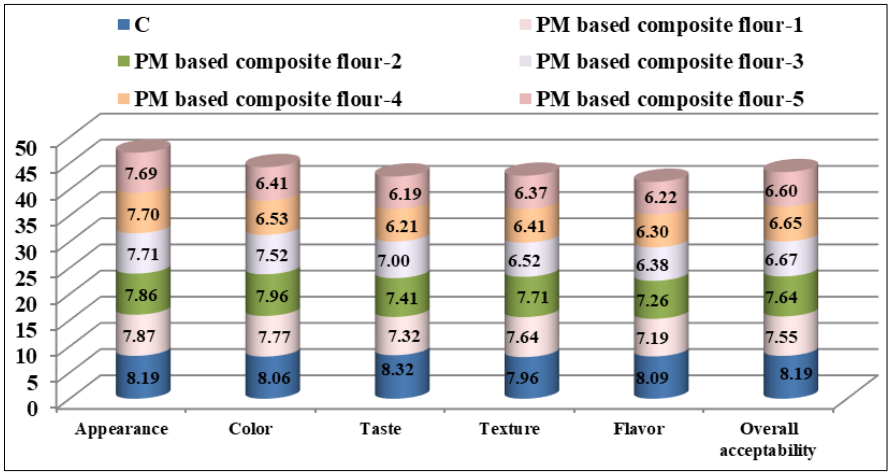

Fig 1: Organoleptic assessment of formulated PM based composite flour

Effect of storage on quality attributes of PM based composite flour

The selected proso millet based composite flour-2 was stored for 30 days and was analysed for moisture content and organoleptic characteristics at an interval of 0 day, 15 days and 30 days during storage period.

Moisture content of PM based composite flour during storage

The initial moisture content in control flour was 10.95±0.04, 11.01±0.01 on 15th day and 11.10±0.02 on 30th day of storage whereas PM based composite flour-2 recorded 9.87±0.01 (0 day), 9.91±0.14 (15th day) and 9.99±0.12 (30th day) (Table 3).

The moisture content significantly ($p<0.05$) increased from initial day to 30th day of storage. A significant difference was also found between both the flours statistically at 5 percent level. The gradual increase in moisture content of the flour samples may be attributed to relative moisture permeability of the packaging material used (Adebowale, A. A. *et al*. 2017) [9]. During storage, the recommended safe level of moisture content of flours is 12% to 14% (Standard Organization of Nigeria, 2004 and Sanni *et al*. 2005) [10, 11]. In present study, the moisture content of PM based composite flour during storage increased from 9.87% to 9.99%, which still falls within permissible range (Daramola *et al*. 2010) [12].

Table 3: Moisture content of PM based composite flour during storage

Flour sample	Storage period			LSD ($p<0.05$)
	0 day	15 days	30 days	
Control Flour (C)	10.95±0.04	11.01±0.01	11.10±0.02	0.05
PM based composite Flour-2	9.87±0.01	9.91±0.14	9.99±0.12	0.04
LSD ($p<0.05$)	0.26	0.24	0.21	

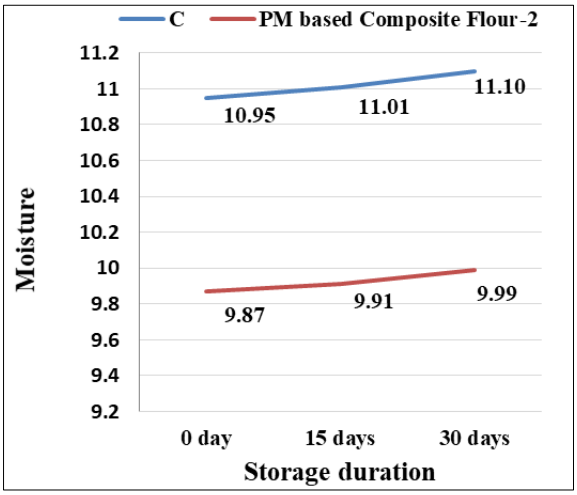

Fig 2: Moisture content of PM based composite flour during storage

Organoleptic characteristics of chapatti developed using PM based composite flour during storage

Chapatti was made from PM based composite flour-2 for evaluation of their organoleptic characteristics during storage. Appearance of chapatti developed by using PM based composite flour-2 was to be found 7.86±0.70 (0 day), 7.79±0.19 (15th day) and 7.68±0.03 (30th day) during storage while control recorded 8.19±0.47, 8.00±0.01 and 7.98±1.26 on 0 day, 15th day and 30th day, respectively. A significant (p<0.05) difference was observed between the chapatti developed using control and PM based composite flour with respect to their appearance.

The color score of chapatti developed by using control flour recorded 8.06±0.35 (0 day), 7.98±0.07 (15th day) and 7.89±0.02 (30th day) while chapatti prepared from PM based composite flour-2 had 7.96±0.54 on 0 day, 7.90±0.01 on 15th day and 7.86±0.12 on 30th day of storage period. The color scores of both products when compared to initial and last day of storage were found to be decreased significantly (p<0.05). The statistical analysis also revealed that the color scores of both the products on 30th day were similar at 5 percent level.

The chapatti developed by using PM based composite flour-2 obtained taste score 7.41±1.02 on initial day of storage while 7.30±0.02 on 30th day of storage. The results also showed that taste score of control significantly (p<0.05) decreased from 8.32±0.59 (0 day) to 8.19±0.61 (30th day).

Texture score of chapatti prepared from control and PM based composite flour was to be found significantly (p<0.05) unchanged during shelf life evaluation. The texture score of chapatti developed using control and composite flour recorded 7.96±0.60 and 7.71±0.67, respectively on initial day, 7.89±0.34 and 7.68±0.04, respectively on 30th day of storage period. A significant (p<0.05) difference was found in texture scores between the products during shelf life study. The chapatti developed using control flour obtained flavor score 8.09±0.65 (0 day), 7.99±0.64 (15th day) and 7.90±0.12 (30th day) while composite flour chapatti showed 7.26±0.62 (0 day), 7.19±0.04 (15th day) and 7.10±0.03 (30th day).

Overall acceptability score of chapatti developed by incorporating control flour significantly (p<0.05) decreased from 8.19±0.60 (0 day) to 7.92±0.36 (30th day) during storage while chapatti developed using PM based composite flour-2 recorded 7.64±0.79 (0th day), 7.59±1.06 (15th day) and 7.50±0.32 (30th day). It was apparent from the results that, a significant difference was present between control and PM based composite flour-2. It was also inferred that, all the sensory parameters had non-significant (p>0.05) difference till 15th day of storage but the scores gradually decreased on 30th day of storage. Though the sensory scores decreased but the chapatti prepared from PM based composite flour-2 were liked moderately by the panel members.

Table 4: Organoleptic characteristics of proso millet based composite flour-2 during storage

Sensory attributes	Product	0	15	30	LSD (p<0.05)
Appearance	Control flour (C)	8.19±0.47	8.00±0.01	7.98±1.26	0.02
	PM based composite flour-2	7.86±0.70	7.79±0.19	7.68±0.03	0.02
	LSD (p<0.05)	0.06	0.08	0.01	
Color	Control flour (C)	8.06±0.35	7.98±0.07	7.89±0.02	0.04
	PM based composite flour-2	7.96±0.54	7.90±0.01	7.86±0.21	0.06
	LSD (p<0.05)	0.05	0.05	0.02	
Taste	Control flour (C)	8.32±0.59	8.29±1.23	8.19±0.61	0.08
	PM based composite flour-2	7.41±1.02	7.39±0.24	7.30±0.02	0.10
	LSD (p<0.05)	0.15	0.17	0.15	
Texture	Control flour (C)	7.96±0.60	7.89±0.34	7.80±0.06	0.10
	PM based composite flour-2	7.71±0.67	7.68±0.04	7.60±0.15	0.15
	LSD (p<0.05)	0.03	0.05	0.03	
Flavor	Control flour (C)	8.09±0.65	7.99±0.64	7.90±0.12	0.02
	PM based composite flour-2	7.26±0.62	7.19±0.04	7.10±0.03	0.02
	LSD (p<0.05)	0.12	0.17	0.15	
Overall acceptability	Control flour (C)	8.19±0.60	8.00±0.51	7.92±0.36	0.05
	PM based composite flour-2	7.64±0.79	7.59±1.06	7.50±0.32	0.03
	LSD (p<0.05)	0.21	0.20	0.15	

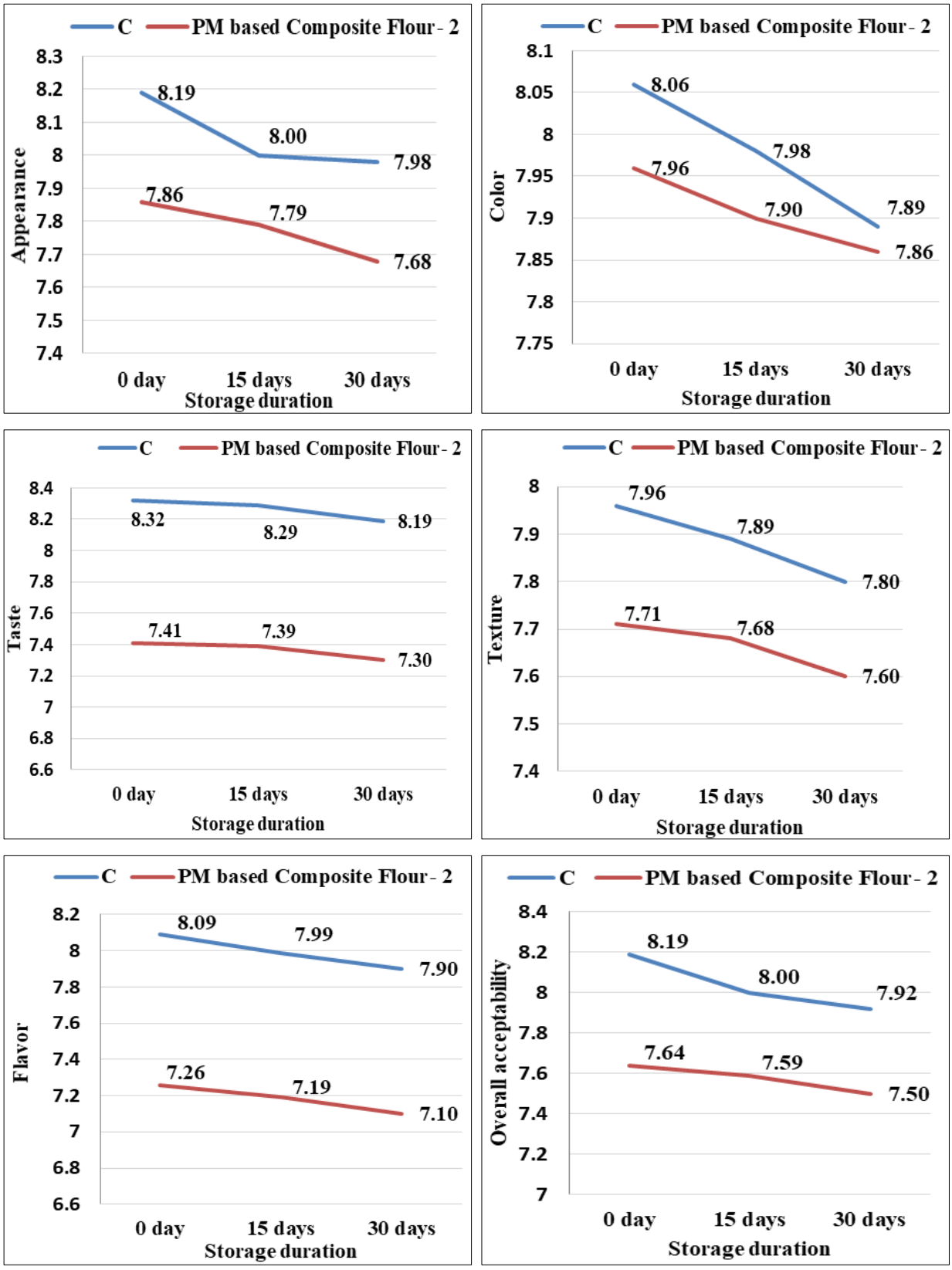

Fig 3: Organoleptic characteristics of PM based composite flour-2 during storage

Conclusion

The organoleptic assessment of different proportion of proso millet based composite flour showed a significant (p<0.05) difference between control and developed composite flours. Among the flour samples, proso millet based composite flour-2 was found to be most acceptable with an overall acceptability score 7.64±0.79. While moisture analysis of proso millet based composite flour-2 during storage showed a significant increase from 9.87±0.01 to 9.99±0.12. The organoleptic assessment of the composite flour showed a non-significant (p>0.05) change from initial to 15 day of storage while a significant difference was observed between initial and 30th day scores. From the results, it was inferred that proso millet based composite flour-2 could be stored up to 30 days without much variation in the quality attributes.

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