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Studies on nutritional and storage qualities of foxtail millet *Sev*

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Abstract
Foxtail millet can be utilized to prepare crunchy noodle type snack *sev*. Various combinations of foxtail millet flour and Bengal flour *sev* were prepared and best combination was selected based on 9 points hedonic scale method of sensory evaluation. Best combination of foxtail millet *sev* was 50% foxtail millet flour and 50% Bengal gram flour. Moisture, lipid, crude protein, ash, crude fibre, total carbohydrates, calcium, iron and phosphorous content of best treatment was 3.19%, 22.40%, 13.34%, 3.40%, 4.80%, 57.67%, 41.80 mg/100g, 5.82 mg/100g and 310.50 mg/100g respectively. Textural parameters of foxtail millet *sev* for compression and crushing force were 8.35 N and 2.38 N respectively. Foxtail millet sev prepared from best combination and stored at ambient condition was found best up to 28 days.

Keywords: foxtail millet**,** *Sev*, nutritional parameters, textural parameters, sensory evaluation and storage study

Introduction
Foxtail millet is one of the minor millet. It is originated in China in 6000 B. C. Foxtail millet is considered as the oldest cultivated millet (archivegramene.com). It is the sixth most grown grain crop in world. Foxtail millet is the 2nd in the total production of millets. This is mostly be used for bird and cattle feed and forage purposes in central Asia. Foxtail millet is an annual grass grown for human food. It is the second most widely planted millet. It can reach the height of 120-200 cm (3.9-6.6ft). Seed head is dense hairy panicles of 5-30 cm. It is about 2 mm in diameter. It is an important arid and semi-arid crop. It is grow mainly in Southeast Asia, China, Europe and North America. In India Rajasthan, Karnataka, Maharashtra, Andhra Pradesh and Chattisgarh are the main foxtail millet growing states. It is planted in late spring and grains are going to harvest after 75-90 days.

Foxtail millet is known as Navane in Kannada, Kangji in Hindi and Kang or Rala in Marathi. Foxtail millet can be used to reduce obesity and overweight, diabetes and cardiovascular diseases. People suffering from celiac disease can also consume foxtail millet. Hundred gram of foxtail millet will give protein 12.3 g, fat 4.3 g, minerals 3.3 g, fibre 8 g, phosphorous 290 mg, energy 331 Kcal (Gopalan *et. al.*, 2004) [7].

Sev is a popular Indian snack food consisting of small piece of crunchy noodles made from chickpea flour paste, which are seasoned with turmeric, cayenne and ajwan before deep frying. *Sev* is eaten as a standalone snack as well as a topping on dishes like *bhelpuri* and *sevpuri* (en.m.Wikipedia.org/wiki/*sev*). *Sev* is very much popular snack in northern part of India. We can vary thickness of *sev* by changing the dies available with pressing machine.

Bengal gram is an important pulse crop grown all over the world especially in Asia-African countries. It is a good source of protein, calcium, magnesium and phosphorous. Bengal gram has significant amount of all the essential amino acids except sulphur containing amino acids (Jukanti *et al.*, 2012) [8]. Bengal gram also contains riboflavin, niacin, thiamine and folic acid. Bengal gram is 3rd most grown pulse crop produced in world. There are 2 types of Bengal gram i.e. Desi and Kabuli. Bengal gram is also rich in dietary fibre which is useful to reduce weight.

Materials and Methods
Ingredients for preparation of *Sev*
The dehusked foxtail millet grains required for the present study were obtained from the local market of Hassan, Karnataka. Other ingredients such as Bengal gram and masala were obtained from local market of Rahuri.

Methods
Sev was prepared using foxtail millet flour and Bengal gram flour combination as given below (Table 1).

Table 1: Combinations of foxtail millet flour and Bengal gram flour

Treatment	Foxtail millet flour (%)	Bengal gram flour (%)
T_0 (Control)	00	100
T_1	25	75
T_2	50	50
T_3	75	25
T_4	100	00

The preliminary trails were done and best combination was identified by organoleptic properties and that best combination was utilized for the final preparation of *sev*. Best treatment

For the preparation of foxtail millet *sev* is T_2 i.e. 50% Bengal gram flour and 50% foxtail millet flour. Recipe for the preparation of best foxtail millet *sev* is given below (Table 2).

Table 2: Best recipe for preparation of foxtail millet *Sev*

Ingredients	Quantity
Foxtail millet flour (g)	100
Bengal gram flour (g)	100
Salt (g)	4
Chilli powder (g)	6
Cumin powder (g)	10
Water (ml)	200
Oil (for frying) (ml)	200

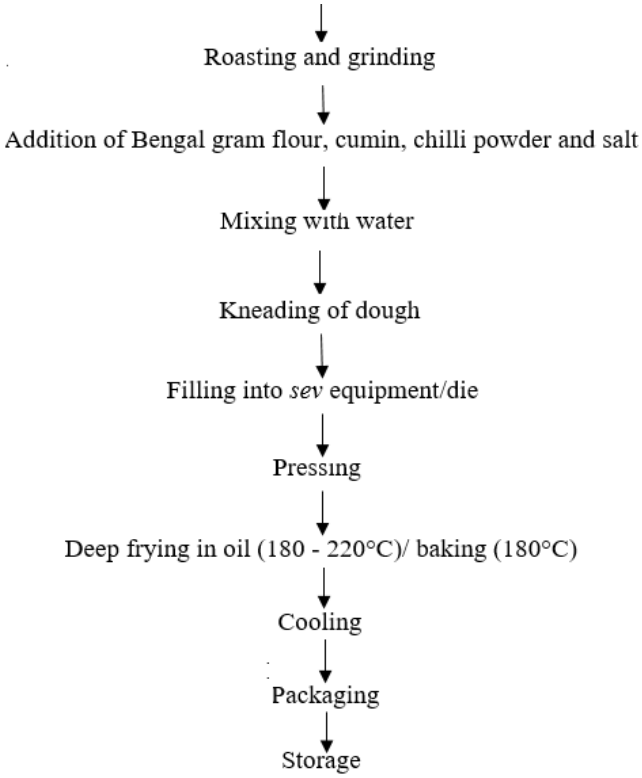

Fig 1. Method for the preparation of foxtail millet *Sev*

Physico-chemical analysis of raw material and *Sev*

Sensory evaluation was done by the method given by Amerine *et al.,* (1965) [1]. The method described in AOAC. (1990) [3] was used to determine crude protein, crude fibre, ash and crude fat. AACC (2000) method was used to determine the moisture content. Calcium and iron were analyzed using atomic absorption spectrometry (AAS) method and phosphorous content was also determined by AOAC. (2000) [4]. Carbohydrates content was determined by the method given by Raguramulu *et al.,* (1983) [10]. Texture analysis was done using INSTRON texture analyzer by the method given by Gaines, (1991) [6]. Peroxide value was determined using method given by AOAC. (1980) [2]. All chemical constituents and organoleptic parameter were analysed by using more than 4 replications. The results obtained in the present investigation were statistically analysed by using Factorial Completely Randomized Design given by Rangaswamy, (2010) [11]. Products were stored in LDPE and aluminium foil packaging material at ambient temperature for the period of 35 days and evaluation was done for nutritional and sensory parameters at the interval of 7 days. The nutritional quality parameters were analyzed up to 28 days.

Results and discussion

Sensory evaluation of foxtail millet *sev*

Sensory scores of the treatments of *sev* are given in below Table 3. Sensory evaluation was done using 9 points hedonic scale. The colour and appearance scores of the *sev* was lowest in T_4 i.e. 6.75 and highest in T_2 i.e. 8.00. The flavour scores of *sev* was lowest in T_4 i.e. 6.67 and highest in T_2 i.e. 7.87. The texture scores of *sev* was lowest in T_4 i.e. 6.77 and highest in T_2 i.e. 8.00. The taste scores of *sev* was lowest in T_4 i.e. 6.88 and highest in T_2 i.e. 8.00. The overall acceptability scores of *sev* was lowest in T_4 i.e. 7.33 and highest in T_2 i.e. 8.00. The best score for colour and appearance, texture, flavour, taste and overall acceptability was observed for the treatment T_2. So T_2 along with T_0 were selected for storage study. Products were stored in LDPE and aluminium foil packaging material at ambient temperature for the period of 35 days for storage study.

Table 3: Sensory evaluation of *sev* for treatment finalization*

Treatments	Colour and appearance	Flavour	Texture	Taste	Overall acceptability
T_0 (control)	7.33	7.77	7.55	7.55	7.57
T_1	7.33	7.44	7.40	7.66	7.48
T_2	8.00	7.87	8.00	8.00	8.00
T_3	7.88	7.66	7.88	7.55	7.8
T_4	6.75	6.67	6.77	6.88	7.33
Mean	7.46	7.48	7.44	7.53	7.64

*These are the average value of 10 replications. Highest value is 9 points

T_0 = 100% Bengal gram flour (control)
T_1 = 75% Bengal gram flour + 25% Foxtail millet flour
T_2 = 50% Bengal gram flour + 50% Foxtail millet flour
T_3 = 25% Bengal gram flour + 75% Foxtail millet flour
T_4 = 100% Foxtail millet flour

Nutritional value of fried foxtail millet *sev*

The nutritional value of fried *sev* is presented in Table 4. The moisture content was more in control when compared to treatment. The lipid content of control (24.00%) was more when compared to treatment (22.40%). It means that absorption of oil is more in control when compared to treatment. Crude protein content of the control was more when compared to treatment because in control we used Bengal gram flour which was rich in protein when compared to foxtail millet. Ash content of treatment was more when compared to control because polishing is higher in rice and pulses than foxtail millet. Crude fibre content was higher in treatment (4.80%) than control (3.20%) because foxtail millet is rich in complex carbohydrates which add to crude fibre content. Total carbohydrates content was more in treatment when compared to control because protein, lipids and moisture contents are less when compared to control. Calcium, phosphorous and iron contents were also more in control when compared to treatment.

Table 4: Nutritional value of fried foxtail millet *sev*

Nutritional parameter	*Sev* control	Foxtail millet *sev*	Mean
Moisture (%)	4.21	3.19	3.70
Lipid (%)	24.00	22.40	23.2
Crude protein (%)	15.31	13.34	14.33
Ash (%)	3.00	3.40	3.20
Crude fibre (%)	3.20	4.80	4.00
Total carbohydrates (%)	53.49	57.67	53.18
Calcium (mg/100g)	51.00	41.80	46.40
Phosphorous (mg/100g)	328.80	310.50	319.65
Iron (mg/100g)	8.20	5.82	7.01

*Results are mean value of 4 replications

Textural parameters of foxtail millet *Sev*

Textural parameters of *sev* are presented in below Table 5. Hardness value was more in foxtail millet *sev* when compared to control. For crushing force control was more when compare to treatment. It means that to compress small piece of sample treatment takes more force and to break large quantity of same sample control required more force.

These results indicated that foxtail *sev* were more crunchy and crispy. This type of characteristic is very good for consumer point of view. Therefore fifty per cent foxtail millet flour *sev* was more acceptable than the traditional (control) *sev*.

Table 5: Textural parameters of foxtail millet *sev*

Treatments	Hardness (N)	Crushing (N)
Control (fried) *sev*	5.68	4.89
Foxtail millet *sev* (fried)	8.35	2.38
Mean	7.02	3.64

***** All observations are mean value of 5 replications

Organoleptic evaluation of foxtail millet *sev* stored at ambient condition

Organoleptic evaluation of foxtail millet *sev* stored at ambient condition is presented in Table 6. Fried products were stored in LDPE and aluminium foil packaging material at ambient temperature for the period of 35 days. Colour and appearance scores of products stored in LDPE packaging materials were decreased gradually from 7.86 to 3.00 in T_1P_1 and from 8.22 to 3.00 in T_2P_1 during the storage period of 35 days. The scores of products stored in aluminium foil packaging material were reduced from 7.86 to 3.00 in T_1P_2 and 8.22 to 3.00 in T_2P_2 during the storage period of 35 days. Flavour value of products stored in LDPE packaging materials were decreased gradually from 7.85 to 3.00 in T_1P_1 and from 8.60 to 3.00 in T_2P_1 during the storage period of 35 days. The scores of products stored in aluminium foil packaging material were reduced from 7.85 to 3.00 in T_1P_2 and 8.60 to 3.00 in T_2P_2 during the storage period of 35 days. Texture value of products stored in LDPE packaging materials were decreased gradually from 8.20 to 7.00 in T_1P_1 and from 8.50 to 6.00 in T_2P_1 during the storage period of 35 days. The scores of products stored in aluminium foil packaging material were reduced from 8.20 to 6.00 in T_1P_2 and 8.52 to 7.00 in T_2P_2 during the storage period of 35 days. Taste scores of products stored in LDPE packaging materials were decreased gradually from 8.14 to 3.00 in T_1P_1 and from 8.67 to 5.00 in T_2P_1 during the storage period of 35 days. The scores of products stored in aluminium foil packaging material were reduced from 8.14 to 4.00 in T_1P_2 and 8.67 to 5.00 in T_2P_2 during the storage period of 35 days. Overall acceptability scores of products stored in LDPE packaging materials were decreased gradually from 7.97 to 4.00 in T_1P_1 and from 8.53 to 3.75 in T_2P_1 during the storage period of 35 days. The scores of products stored in aluminium foil packaging material were reduced from 7.97 to 4.25 in T_1P_2 and 8.53 to 5.00 in T_2P_2 during the storage period of 35 days. Results are indicating that there is major difference in colour, flavour, texture, taste and overall acceptability value of *sev* during storage period in decreasing manner. Aluminium foil got good scores when compared to LDPE and more suitable packaging material for foxtail millet *sev* storage. Statistically values are at par with each other. Foxtail millet *sev* showed higher level of overall acceptability than control during storage period. The

product and packaging material interaction effect also showed higher overall acceptability score for foxtail millet *sev* than control during storage up to 28 days. These results indicated that foxtail millet *sev* and control can remain in acceptable condition up to 28 days. Similar results were found in kodo millet *sev* prepared by Patel, (2016) [9].

Table 6: organoleptic evaluation of foxtail millet *sev* stored at ambient condition

Parameter	Colour and appearance		Flavour		Texture		Taste		Overall acceptability	
Days	**0**	**35**	**0**	**35**	**0**	**35**	**0**	**35**	**0**	**35**
Treatments										
T_1	7.86	3.00	7.85	3.00	8.20	6.50	8.14	3.50	7.97	4.13
T_2	8.22	3.00	8.60	3.00	8.51	6.50	8.67	5.00	8.53	4.38
SE	0.008	0.013	0.022	0.010	0.010	0.010	0.009	0.012	0.083	0.013
CD@5%	0.026	NS	0.067	NS	0.031	NS	0.027	0.036	0.023	0.038
Packaging material										
P_1	8.04	3.00	8.23	3.00	8.35	6.50	8.41	4.00	8.25	3.88
P_2	8.04	3.00	8.23	3.00	8.36	6.50	8.41	4.50	8.25	4.63
SE	0.008	0.013	0.022	0.010	0.010	0.010	0.009	0.012	0.008	0.013
CD@5%	NS	NS	NS	NS	NS	NS	NS	0.036	NS	0.038
Interaction										
T_1P_1	7.86	3.00	7.57	3.00	8.20	7.00	8.14	3.00	7.97	4.00
T_1P_2	7.86	3.00	7.57	3.00	8.20	6.00	8.14	4.00	7.97	4.25
T_2P_1	8.22	3.00	8.60	3.00	8.50	6.00	8.67	5.00	8.53	3.75
T_2P_2	8.22	3.00	8.60	3.00	8.52	7.00	8.67	5.00	8.53	5.00
Mean	8.04	3.00	8.23	3.00	8.35	6.50	8.41	4.25	8.25	4.25
SEm	0.012	0.018	0.031	0.014	0.014	0.014	0.013	0.017	0.010	0.018
CD@5%	NS	NS	NS	NS	NS	0.043	NS	0.051	NS	0.054

NS = Non-Significant Maximum score out of 9. Results are mean value of 10 replications.
T_1 = 100% Bengal gram flour, T_2= 50% Bengal gram flour + 50% foxtail millet flour,
P_1= LDPE, P_2= aluminium foil.

Nutritional parameter of foxtail millet *sev* stored at ambient condition

Nutritional parameters of foxtail millet *sev* are presented in Table 7. In sensory evaluation it was found that product can stay in good condition up to 28 days and on 35th day it was spoiled because of rancidity. Moisture content of products stored in LDPE packaging materials were decreased gradually from 4.23% to 4.39% in T_1P_1 and from 3.22% to 3.35% in T_2P_1 during the storage period of 28 days. The scores of products stored in aluminium foil packaging material were reduced from 4.23% to 4.39 % in T_1P_2 and 3.22% to 3.34% in T_2P_2 during the storage period of 28 days. Ash content of products stored in LDPE packaging materials were decreased gradually from 3.00% to 2.97% in T_1P_1 and from 3.40% to 3.38% in T_2P_1 during the storage period of 28 days. The scores of products stored in aluminium foil packaging material were reduced from 3.00% to 2.97% in T_1P_2 and 3.40% to 3.38% in T_2P_2 during the storage period of 28 days. The lipid content of products stored in LDPE packaging materials were decreased gradually from 24.10% to 24.03% in T_1P_1 and from 22.40% to 22.36% in T_2P_1 during the storage period of 28 days. The lipid content of products stored in aluminium foil packaging material were reduced from 24.10% to 24.07% in T_1P_2 and 22.40% to 22.37% in T_2P_2 during the storage period of 28 days. The crude protein content of products stored in LDPE packaging materials were decreased gradually from 15.31% to 15.20% in T_1P_1 and from 13.34% to 13.25% in T_2P_1 during the storage period of 28 days. The crude protein content of products stored in aluminium foil packaging material were reduced from 15.31% to 15.22% in T_1P_2 and 13.34% to 13.26% in T_2P_2 during the storage period of 28 days. The crude fibre content of products stored in LDPE packaging materials were decreased gradually from 3.18% to 3.12% in T_1P_1 and from 4.80% to 4.75% in T_2P_1 during the storage period of 28 days. The crude fibre content of products stored in aluminium foil packaging material were reduced from 3.18% to 3.14% in T_1P_2 and 4.80% to 4.76% in T_2P_2 during the storage period of 28 days. Present results are indicating that there is no difference in moisture, ash, crude protein, lipid and crude fibre content of the sample during storage period. Statistical values are showing that there is no effect of packaging material on products. Statistically values are at par with each other and there is no significant difference. Similar results were reported for little millet *chakli* by Singson *et al*., (2014) [12].

Some other nutritional parameters of foxtail millet *sev* are presented in Table 8. Total carbohydrates content of products stored in LDPE packaging materials were changed from 53.38% to 53.41% in T_1P_1 and from 57.67% to 57.67% in T_2P_1 during the storage period of 28 days. The total carbohydrates content of products stored in aluminium foil packaging material were reduced from 53.38% to 53.35% in T_1P_2 and 57.67% to 57.65% in T_2P_2 during the storage period of 28 days. The calcium content of products stored in LDPE packaging materials were decreased gradually from 51.00 to 50.90 mg/100g in T_1P_1 and from 41.80 to 41.71 mg/100g in T_2P_1 during the storage period of 28 days. The calcium content of products stored in aluminium foil packaging material was reduced from 51.00 to 50.92 mg/100g in T_1P_2 and 41.80 to 41.72 mg/100g in T_2P_2 during the storage period of 28 days. The iron content of products stored in LDPE packaging materials were decreased gradually from 8.20 mg/100g to 8.10 mg/100g in T_1P_1 and from 5.82 mg/100g to 5.73 mg/100g in T_2P_1 during the storage period of 28 days. The iron content of products stored in aluminium foil packaging material were reduced from 8.20 mg/100g to 8.10 mg/100g in T_1P_2 and 5.82 mg/100g to 5.73 mg/100g in T_2P_2 during the storage period of 28 days. The phosphorous content of products stored in LDPE packaging materials were decreased gradually from 328.80 mg/100g to 328.40 mg/100g in T_1P_1 and from 310.50

mg/100g to 310.10 mg/100g in T_2P_1 during the storage period of 28 days. The phosphorous content of products stored in aluminium foil packaging material were reduced from 328.80 mg/100g to 328.40 mg/100g in T_1P_2 and 310.50 mg/100g to 310.10 mg/100g in T_2P_2 during the storage period of 28 days. The peroxide value of products stored in LDPE packaging materials were increased from 3.72 to 25.41 (meq peroxide/kg oil) in T_1P_1 and from 3.35 to 15.58 (meq peroxide/kg oil) in T_2P_1. The peroxide value of products stored in aluminium foil packaging material were increased from 3.72 to 23.46 (meq peroxide/kg oil) in T_1P_2 and 3.35 to 13.33 (meq peroxide/kg oil) in T_2P_2. Present results are indicating that there is no change in total carbohydrates, calcium, iron and phosphorous content of the sample during storage period. Statistical values are showing that there is no effect of packaging material on product. Statistically values are at par with each other. Similar results were reported for little millet *chakli* by Singson *et al*., (2014) [12]. Peroxide value of *sev* during storage period is showing large change. This drastic increase in peroxide value indicates that oxidation of fatty acids occurred during storage period. This means product is spoiled at the end of the 35 days. In both the packaging material there is increase in the peroxide value but less in aluminium foil when compared with the LDPE. Similar results were reported for little millet *chakli* by Singson *et al*., (2014) [12].

Table 7: Nutritional parameters of foxtail millet *sev* stored at ambient condition

Parameter	Moisture		Ash		Crude protein		Lipid		Crude fibre	
Days	**0**	**28**	**0**	**28**	**0**	**28**	**0**	**28**	**0**	**28**
Treatments										
T_1	4.24	4.39	3.00	2.97	15.31	15.15	24.10	24.05	3.18	3.13
T_2	3.22	3.35	3.40	3.38	13.34	13.26	22.40	22.36	4.80	4.76
SE	0.006	0.005	0.003	0.003	0.010	0.010	0.010	0.009	0.005	0.005
CD@5%	0.017	0.014	0.009	0.009	0.032	0.031	0.032	0.029	0.015	0.014
Packaging material										
P_1	3.74	3.87	3.20	3.18	14.33	14.23	23.25	23.19	3.99	3.94
P_2	3.73	3.87	3.20	3.18	14.33	14.24	23.24	23.22	3.99	3.95
SE	0.006	0.007	0.003	0.003	0.010	0.010	0.010	0.009	0.055	0.005
CD@5%	NS	NS	NS	NS	NS	NS	NS	0.029	NS	0.014
Interaction										
T_1P_1	4.25	4.39	3.00	2.97	15.31	15.20	24.10	24.03	3.18	3.12
T_1P_2	4.23	4.39	3.00	2.97	15.31	15.22	24.10	24.07	3.18	3.14
T_2P_1	3.22	3.35	3.40	3.38	13.34	13.25	22.40	22.36	4.80	4.75
T_2P_2	3.22	3.34	3.40	3.38	13.34	13.26	22.39	22.37	4.80	4.76
Mean	3.73	3.87	3.20	3.18	14.33	14.23	23.23	23.56	3.99	3.94
SEm	0.008	0.006	0.004	0.004	0.015	0.015	0.012	0.013	0.007	0.006
CD@5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS = Non-Significant Results are mean value of 4 replications.
T_1 = 100% Bengal gram flour, T_2= 50% Bengal gram flour + 50% foxtail millet flour,
P_1= LDPE, P_2= aluminium foil.

Table 8: Nutritional parameter of foxtail millet *sev* stored at ambient condition

Parameter	Total carbohydrates		Calcium		Iron		Phosphorous		Peroxide value	
Days	**0**	**28**	**0**	**28**	**0**	**28**	**0**	**28**	**0**	**28**
Treatments										
T_1	53.38	53.38	51.00	50.91	8.20	8.10	328.70	328.40	3.72	24.44
T_2	57.67	57.66	41.80	41.72	5.82	5.73	310.38	310.10	3.35	14.46
SE	0.008	0.008	0.012	0.009	0.007	0.007	0.008	0.008	0.015	0.013
CD@5%	0.023	0.003	0.035	0.026	0.020	0021	0.024	0.023	0.047	0.038
Packaging material										
P_1	55.53	55.54	46.40	46.31	7.01	6.92	319.53	319.25	3.53	20.50
P_2	55.53	55.50	46.40	46.32	7.01	6.92	319.55	319.25	3.53	18.40
SE	0.008	0.008	0.012	0.008	0.007	0.007	0.008	0.008	0.015	0.013
CD@5%	NS	NS	NS	NS	NS	NS	0.024	NS	NS	0.038
Interaction										
T_1P_1	53.38	53.41	51.00	50.90	8.20	8.10	328.80	328.40	3.72	25.41
T_1P_2	53.38	53.35	51.00	50.92	8.20	8.10	328.80	328.40	3.72	23.46
T_2P_1	57.67	57.67	41.80	41.71	5.82	5.73	310.50	310.10	3.35	15.58
T_2P_2	57.67	57.65	41.80	41.72	5.82	5.73	310.50	310.10	3.35	13.33
Mean	55.53	55.52	46.40	46.31	7.01	6.92	319.65	319.25	3.53	19.45
SEm	0.011	0.011	0.016	0.012	0.007	0.009	0.011	0.011	0.022	0.018
CD@5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.054

NS = Non-Significant Results are mean value of 4 replications.
T_1 = 100% Bengal gram flour, T_2= 50% Bengal gram flour + 50% foxtail millet flour,
P_1= LDPE, P_2= aluminium foil.

Conclusion

These results indicated that foxtail millet *sev* prepared from 50% foxtail millet flour and 50% Bengal gram flour was having better organoleptic and nutritional properties when compared to the other treatments.

Foxtail millet *sev* was crunchy and crispy in nature. It was having good nutritional properties and storage stability up to 28 days at ambient condition. So minor millet foxtail millet can be utilized in the preparation of niche products such as *sev*.

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