



Effect of TBHQ Concentration on Sensory Quality of Banana Peel based 'sev' in Package Materials

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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

Present investigation was aimed to evaluate sensory quality of banana peel based 'sev' (snake food) during storage. An experiment was set up with ten treatment combinations consisting of five different TBHQ concentrations and two different packing materials for the preparing of banana peel-based 'sev.' The prepared 'sev' was kept for five months in order to analyze the sensory characteristics every month. The findings showed that banana peel-based 'sev' that was frying in oil containing 150 ppm TBHQ and packaged in laminated aluminum bags showed little loss in color, taste, texture, flavor and overall acceptability. Overall research findings showed that banana peel-

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based 'sev' with improved sensory qualities could be made by frying 'sev' in sunflower oil containing 150 ppm TBHQ, then packing in laminated aluminum bags. The banana peel based 'sev' can be successfully stored for a period of 5 months with minimum changes in sensory quality.

Keywords: *Banana peel; TBHQ; packaging; peroxide.*

1. INTRODUCTION

"Banana (*Musa paradisiaca* L.) is a monocotyledonous herbaceous perennial plant of the Scitamineae family. The plant is sometimes referred to as Kalpatharu, which means herb of endless uses" [1]. "The fourth-most important food crop in the world and one of the most popular fruits, bananas and plantains are a staple food and export good in India as well" [2]. Millions of people in under developed nations benefit from it in terms of their ability to access food.

Despite being a major source of numerous functionally significant bioactive chemicals, banana peel is still underutilized and very little research has been done to determine its potential applications in food and nutraceuticals [3] "Banana peel is rich source of dietary fiber (50% on a dry matter basis), protein (8-11%), crude fat (3.8-11%), lipid (2.2-10.9%), pectin, essentials amino acids (leucine, valine, phenylalanine and threonine), polyunsaturated fatty acids mainly (linoleic acid and α -linolenic acid) and micronutrients like potassium, phosphorous, calcium, magnesium etc. With the exception of lysine, the quantity of all essential amino acids is stated to be higher than FAO standards" [4,5].

Fruit peels have reportedly been shown to contain more gallic catechin than the actual fruit. The greater antioxidant benefits of the banana peel could be attributed to its higher gallic catechin concentration [6]. At all stages of fruit ripening, the peel has higher total polyphenol and flavonoid levels than the fruit pulp. Similar to this, banana peel extracts have been shown to have a higher capacity to scavenge DPPH radicals, which is related to their increased antioxidant activity [7].

Consuming banana peel may aid in maintaining normal blood pressure and fluid balance in the body. Additionally, it aids in managing respiratory, cardiac and kidney issues (Anhwange, 2008). According to Fleming [8], banana peels contain an appropriate amount of iron for delivering oxygen to the cells, generating energy, synthesizing collagen, and maintaining

healthy immunological, cellular growth, and cardiovascular systems.

There is a current need to produce more wholesome and affordable snacks due to the rise in demand and consumption of processed snack foods. Although 'sev' is a well-known snack food in many regions of the country, the product's high cost restricts the amount that can be produced. Chickpea flour's high cost as a raw material affects how much the completed product will ultimately cost. The peel produced during the processing of bananas might result in pollution issues if it is not managed properly, yet bananas are relatively less expensive. However, as was previously said, banana peels have a great deal of potential for use in the creation of snack meals because they are a rich source of numerous nutrients. Thus addition of peel in chick pea flour can overcome the limiting cost of the 'sev'.

2. MATERIALS AND METHODS

Ten treatment combinations of five distinct levels of TBHQ (C₁- control, C₂- 50 ppm, C₃- 100 ppm, C₄- 150 ppm, and C₅- 200 ppm) and two levels of packaging material (P₁- polypropylene bag and P₂- aluminum laminated bag) were used in an experiment for banana peel-based 'sev' (snake food). The peel of the fresh, ripe banana was manually detached, immersed in a solution of 2% salt (NaCl) and 100 ppm ascorbic acid, then blanched in hot water for three minutes at 90°C, followed by cooling in water for two minutes. To make the peel paste, the blanched peel was mashed in a blender. In accordance with the recipe, 70% chick pea flour was combined with additional ingredients to create the 'Sev' formulation used in the experiment. Every item was placed in a stainless steel bowl and hand mixed with water. The amount of water supplied was regulated so that the finished kneaded dough maintained its malleability. Afterward, the dough was manually extruded over heated sunflower oil that contained several concentrations of TBHQ (control, 50 ppm, 100 ppm, 150 ppm, and 200 ppm) for frying at a temperature of 175±5°C. When bubbling from the 'sev' stops, the frying is thought to be finished. After frying, 'sev' samples were removed from

the frying pan and kept in a different pan to let the excess oil to drain. The deep-fat fried 'sev' was cooled to room temperature before being packing in two types of packaging (polypropylene and laminated aluminum bags) and kept there. The main procedures for sev preparation are shown in Fig. 1.

Recipe for making 'sev': The recipe for the preparation of ripe banana peel based 'sev' comprised of 30 g ripe banana peel paste, 70 g chick pea flour (Besan), 2.5 g common salt, 1.5 g chilli powder, 0.75 g white pepper powder, 1.0 g turmeric powder, 2.5 g coriander powder and 5 ml edible oil.

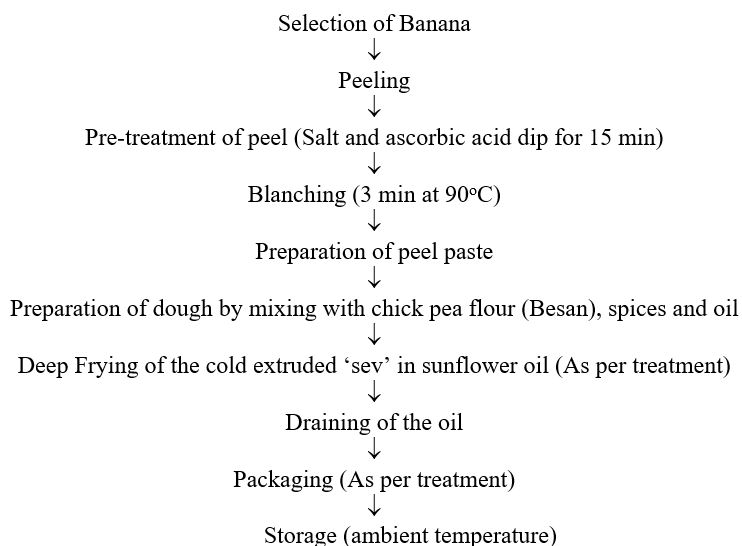


Fig. 1. Principal steps used for preparation of banana peel based 'sev'

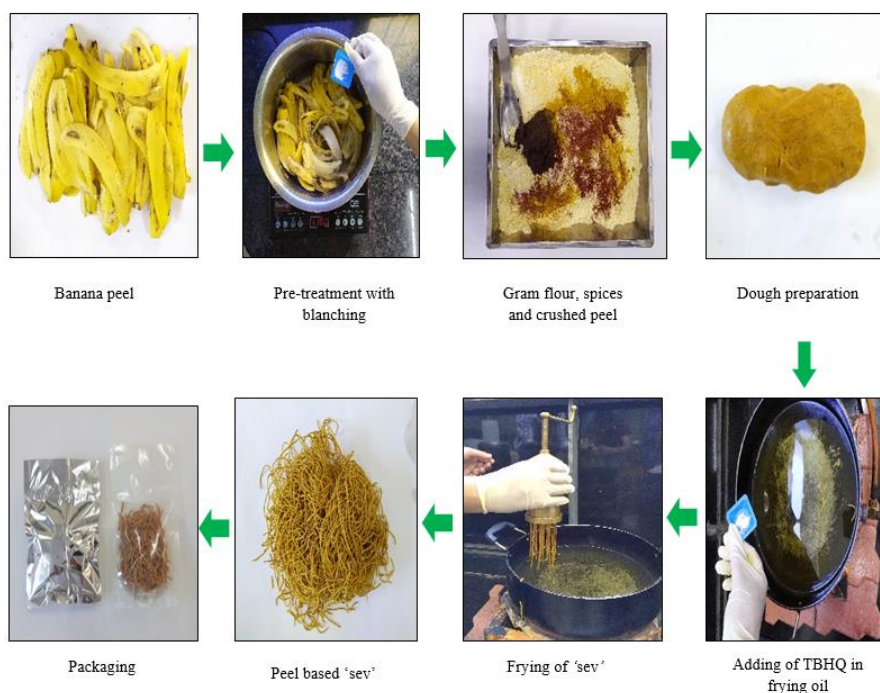


Plate 1. Principal steps used for 'sev' preparation

3. RESULTS AND DISCUSSION

3.1 Colour

Interaction of TBHQ concentration and storage (Table 1) depicted variations in mean color score from 8.50 to 7.50, with decrease in color score from 8.50 to 7.50 in 'sev' fried in oil containing no TBHQ, 50, 100, 150 and 200 ppm TBHQ (C₁S₁ to C₁S₆, C₂S₁ to C₂S₆, C₃S₁ to C₃S₆, C₄S₁ to C₄S₆ and C₅S₁ to C₅S₆). Interaction of packaging treatments and storage depicted variations in mean color during five months storage from initial value of 8.50 to 7.42, with minimum decrease from 8.50 (P₂S₁) to 7.58 (P₂S₆) in 'sev' packed in aluminium laminated bag and maximum decrease from 8.50 (P₁S₁) to 7.42 (P₁S₆) in 'sev' packed in polypropylene bag.

Further, interaction of TBHQ, packaging material and storage depicted variations of mean color score in 'sev' during five month storage from initial value of 8.50 to 8.42, with minimum decrease (8.50 to 7.58) in 'sev' fried in oil using no TBHQ, 50, 100, 150 and 200 ppm TBHQ and packed in aluminium laminated bags (C₁P₂S₁ to

C₁P₂S₆, C₂P₂S₁ to C₂P₂S₆, C₃P₂S₁ to C₃P₂S₆, C₄P₂S₁ to C₄P₂S₆ and C₅P₂S₁ to C₅P₂S₆) and maximum decrease in color score (8.50 to 7.42) was found in 'sev' prepared by oil without TBHQ, 50, 100, 150 and 200 ppm TBHQ with polypropylene bags (C₁P₁S₁ to C₁P₁S₆, C₂P₁S₁ to C₂P₁S₆, C₃P₁S₁ to C₃P₁S₆, C₄P₁S₁ to C₄P₁S₆ and C₅P₁S₁ to C₅P₁S₆). Significant differences were observed for P×S interaction and non-significant differences were observed in color among interactions of C×P, C×S and C×P×S. The decrease in color score during storage might be attributed due to non-enzymetic reaction leads to browning of 'sev'. Decrease in colour during storage was earlier reported by Wanna et al. [9] for banana chips.

3.2 Texture

Interaction of TBHQ concentration and storage (Table 2) depicted variations in mean texture score from 8.78 to 7.80, with minimum decrease in texture score from 8.78 to 7.90 in 'sev' fried in oil containing 150 ppm TBHQ (C₄S₁ to C₄S₆), whereas maximum decrease in texture (8.78 to 7.80) in 'sev' fried in oil containing no TBHQ

Table 1. Effect of different treatments on sensory score for colour of banana peel based 'sev' during storage

Storage (S)	Packaging materials (P)	Colour (9 point Hedonic scale)						
		Anti-oxidant concentrations (C)					Mean	Mean (P)
		C ₁	C ₂	C ₃	C ₄	C ₅		
Initial (S ₁)	P ₁	8.50	8.50	8.50	8.50	8.50	8.50	8.10
	P ₂	8.50	8.50	8.50	8.50	8.50	8.50	8.17
	Mean	8.50	8.50	8.50	8.50	8.50	8.50	
1Month (S ₂)	P ₁	8.42	8.42	8.42	8.42	8.42	8.42	
	P ₂	8.42	8.42	8.42	8.42	8.42	8.42	
	Mean	8.42	8.42	8.42	8.42	8.42	8.42	
2Month (S ₃)	P ₁	8.33	8.33	8.33	8.33	8.33	8.33	
	P ₂	8.42	8.42	8.42	8.42	8.42	8.42	
	Mean	8.38	8.38	8.38	8.38	8.37	8.38	
3Month (S ₄)	P ₁	8.08	8.08	8.08	8.08	8.08	8.08	
	P ₂	8.17	8.17	8.17	8.17	8.17	8.17	
	Mean	8.12	8.12	8.13	8.13	8.12	8.12	
4Month (S ₅)	P ₁	7.83	7.83	7.83	7.83	7.83	7.83	
	P ₂	7.92	7.92	7.92	7.92	7.92	7.92	
	Mean	7.88	7.88	7.87	7.87	7.87	7.87	
5Month (S ₆)	P ₁	7.42	7.42	7.42	7.42	7.42	7.42	
	P ₂	7.58	7.58	7.58	7.58	7.58	7.58	
	Mean	7.50	7.50	7.50	7.50	7.50	7.50	
Mean (C)		8.13	8.13	8.13	8.13	8.13		
S.Em.±	C	P	C×P	S	C×S	P×S	C×P×S	
	0.018	0.011	0.025	0.017	0.038	0.024	0.054	
CD at 5%	NS	0.034	NS	0.048	NS	0.068	NS	
CV %	1.35			1.15				

Table 2. Effect of different treatments on sensory score for texture of banana peel based ‘sev’ during storage

Storage (S)	Packaging materials (P)	Texture (9 point Hedonic scale)						
		Anti-oxidant concentrations (C)					Mean	Mean (P)
		C ₁	C ₂	C ₃	C ₄	C ₅		
Initial (S ₁)	P ₁	8.78	8.78	8.78	8.78	8.78	8.78	8.28
	P ₂	8.78	8.78	8.78	8.78	8.78	8.78	8.38
	Mean	8.78	8.78	8.78	8.78	8.78	8.78	
1Month (S ₂)	P ₁	8.60	8.60	8.60	8.60	8.60	8.60	
	P ₂	8.66	8.66	8.66	8.66	8.66	8.66	
	Mean	8.63	8.63	8.63	8.63	8.63	8.63	
2Month (S ₃)	P ₁	8.35	8.35	8.37	8.40	8.40	8.37	
	P ₂	8.50	8.50	8.50	8.50	8.50	8.50	
	Mean	8.42	8.43	8.44	8.45	8.45	8.44	
3Month (S ₄)	P ₁	8.10	8.12	8.15	8.15	8.15	8.13	
	P ₂	8.28	8.20	8.30	8.28	8.30	8.27	
	Mean	8.19	8.16	8.22	8.22	8.22	8.20	
4Month (S ₅)	P ₁	8.00	8.03	8.05	8.08	8.05	8.04	
	P ₂	8.13	8.13	8.13	8.16	8.13	8.14	
	Mean	8.07	8.08	8.09	8.12	8.09	8.09	
5Month (S ₆)	P ₁	7.70	7.75	7.80	7.82	7.82	7.78	
	P ₂	7.90	7.92	7.95	7.97	7.97	7.94	
	Mean	7.80	7.84	7.87	7.90	7.89	7.86	
Mean (C)		8.32	8.32	8.34	8.35	8.34		
S.Em.±	C	P	C×P	S	C×S	P×S	C×P×S	
	0.020	0.012	0.028	0.017	0.038	0.024	0.054	
CD at 5%	NS	0.037	NS	0.047	NS	0.067	NS	
CV %	1.42			1.11				

(C₁S₁ to C₁S₆). Interaction of packaging treatments and storage depicted variations in mean texture during five months storage from initial value of 8.78 to 7.78, with minimum decrease from 8.78 (P₂S₁) to 7.94 (P₂S₆) in ‘sev’ packed in aluminium laminated bag and maximum decrease from 8.78 (P₁S₁) to 7.78 (P₁S₆) in ‘sev’ packed in polypropylene bag.

Further, interaction of TBHQ, packaging material and storage depicted variations of mean texture score in ‘sev’ during five month storage from initial value of 8.78 to 7.70, with minimum decrease (8.78 to 7.97) in ‘sev’ fried in oil using 150 and 200 ppm TBHQ and packed in aluminium laminated bags (C₄P₂S₁ to C₄P₂S₆ and C₅P₂S₁ to C₅P₂S₆) and maximum decrease in texture score (8.78 to 7.70) was found in ‘sev’ prepared by oil using without TBHQ with polypropylene bags (C₁P₁S₁ to C₁P₁S₆). Significant differences were observed for P×S interaction and non-significant differences were observed in texture among interactions of C×P, C×S and C×P×S. The decrease in texture score during storage might be attributed due to an increase in the moisture content in the ‘sev’ [10]. Decrease in texture during storage was earlier reported by Singh et al. [11] for chicken snacks.

3.3 Taste

Interaction of TBHQ concentration and storage (Table 3) depicted variations in mean taste score from 9.00 to 4.12, with minimum decrease in taste score from 8.50 to 6.85 in ‘sev’ fried in oil containing 200 ppm TBHQ (C₅S₁ to C₅S₆), whereas maximum decrease in taste (9.00 to 4.12) in ‘sev’ fried in oil containing no TBHQ (C₁S₁ to C₁S₆). Interaction of packaging treatments and storage depicted variations in mean taste during five months storage from initial value of 8.80 to 5.32, with minimum decrease from 8.80 (P₂S₁) to 5.45 (P₂S₆) in ‘sev’ packed in aluminium laminated bag and maximum decrease from 8.80 (P₁S₁) to 5.32 (P₁S₆) in ‘sev’ packed in polypropylene bag.

Further, interaction of TBHQ, packaging material and storage depicted variations of mean taste score in ‘sev’ during five month storage from initial value of 9.00 to 4.08, with minimum decrease (8.50 to 6.94) in ‘sev’ fried in oil using 200 ppm TBHQ and packed in aluminium laminated bags (C₅P₂S₁ to C₅P₂S₆) and maximum decrease in taste score (9.00 to 4.08) was found in ‘sev’ prepared by oil without TBHQ with

polypropylene bags (C₁P₁S₁ to C₁P₁S₆). Significant differences were observed for P×S, C×S, C×P and C×P×S interactions. The decrease in taste score during storage might be attributed due to increase of peroxide value during storage [12]. Decrease in taste during storage was earlier reported by Butt et al. [13] for breakfast cereals.

3.4 Flavour

Interaction of TBHQ concentration and storage (Table 4) depicted variations in mean flavour score from 8.75 to 3.86, with minimum decrease in flavour score from 8.75 to 6.25 in 'sev' fried in oil containing 150 and 200 ppm TBHQ (C₄S₁ to C₄S₆ and C₅S₁ to C₅S₆), whereas maximum decrease in flavour (8.75 to 3.86) in 'sev' fried in oil containing no TBHQ and 50 ppm TBHQ (C₁S₁ to C₁S₆ and C₂S₁ to C₂S₆). Interaction of packaging treatments and storage depicted variations in mean flavour during five months storage from initial value of 8.75 to 5.06, with minimum decrease from 8.75 (P₂S₁) to 5.11 (P₂S₆) in 'sev' packed in aluminium laminated bag and maximum decrease from 8.75 (P₁S₁) to 5.06 (P₁S₆) in 'sev' packed in polypropylene bag.

Further, interaction of TBHQ, packaging material and storage depicted variations of mean flavour score in 'sev' during five month storage from initial value of 8.75 to 3.82, with minimum decrease (8.75 to 6.28) in 'sev' fried in oil using 150 and 200 ppm TBHQ and packed in aluminium laminated bags (C₄P₂S₁ to C₄P₂S₆ and C₅P₂S₁ to C₅P₂S₆) and maximum decrease in flavour score (8.75 to 3.82) was found in 'sev' prepared by oil contains 50ppm TBHQ with polypropylene bags (C₂P₁S₁ to C₂P₁S₆). Significant differences were observed for P×S, C×S and C×P×S interaction and non-significant differences were observed in flavour among interaction of C×P. The decrease in flavor score during storage might be due to development of lipid oxidation during storage [14]. Decrease in flavore during storage was earlier reported by Pernille [15] for potato flakes.

3.5 Overall Acceptability

Interaction of TBHQ concentration and storage (Table 5) depicted variations in mean overall

acceptability score from 8.76 to 5.82, with minimum decrease in overall acceptability score from 8.63 to 7.12 in 'sev' fried in oil containing 200 ppm TBHQ (C₅S₁ to C₅S₆), whereas maximum decrease in overall acceptability (8.76 to 5.82) in 'sev' fried in oil containing no TBHQ (C₁S₁ to C₁S₆). Interaction of packaging treatments and storage depicted variations in mean overall acceptability during five months storage from initial value of 8.71 to 6.39, with minimum decrease from 8.71 (P₂S₁) to 6.52 (P₂S₆) in 'sev' packed in aluminium laminated bag and maximum decrease from 8.71 (P₁S₁) to 6.39 (P₁S₆) in 'sev' packed in polypropylene bag.

Further, interaction of TBHQ, packaging material and storage depicted variations of mean overall acceptability score in 'sev' during five month storage from initial value of 8.76 to 5.76, with minimum decrease (8.63 to 7.19) in 'sev' fried in oil using 200 ppm TBHQ and packed in aluminium laminated bags (C₅P₂S₁ to C₅P₂S₆) and maximum decrease in overall acceptability score (8.76 to 5.76) was found in 'sev' prepared by oil without TBHQ with polypropylene bags (C₁P₁S₁ to C₁P₁S₆). Significant differences were observed for P×S and C×S interaction and non-significant differences were observed in overall acceptability among interactions of C×P and C×P×S. Similar observations were reported by Allam et al. [16] for rice based snacks, Butt et al. [13] for breakfast cereals, Pawase et al. [17] for mix fruit bar and Raj and Lal [18] for potato chips.

3.6 'L' Colour Value

Interaction of TBHQ concentration and storage (Table 6) depicted variations in mean 'L' value from 59.38 to 56.16, with minimum decrease in 'L' value from 59.38 to 56.18 in 'sev' fried in oil containing 150 ppm TBHQ (C₄S₁ to C₄S₆), whereas maximum decrease in 'L' value (56.38 to 56.16) in 'sev' fried in oil containing 50 ppm TBHQ (C₂S₁ to C₂S₆). Interaction of packaging treatments and storage depicted variations in mean 'L' value during five months storage from initial value of 59.37 to 55.54, with minimum decrease from 59.37 (P₂S₁) to 56.80 (P₂S₆) in 'sev' packed in aluminium laminated bag and maximum decrease from 59.37 (P₁S₁) to 55.54 (P₁S₆) in 'sev' packed in polypropylene bag.

Table 3. Effect of different treatments on sensory score for taste of banana peel based ‘sev’ during storage

Storage (S)	Packaging materials (P)	Taste (9 point Hedonic scale)						
		Anti-oxidant concentrations (C)					Mean	Mean (P)
		C ₁	C ₂	C ₃	C ₄	C ₅		
Initial (S ₁)	P ₁	9.00	8.91	8.83	8.75	8.50	8.80	7.38
	P ₂	9.00	8.91	8.83	8.75	8.50	8.80	7.46
	Mean	9.00	8.91	8.83	8.75	8.50	8.80	
1Month (S ₂)	P ₁	8.75	8.83	8.78	8.75	8.48	8.72	
	P ₂	8.75	8.83	8.78	8.75	8.48	8.72	
	Mean	8.75	8.83	8.78	8.75	8.48	8.72	
2Month (S ₃)	P ₁	7.67	7.72	7.80	8.70	8.43	8.06	
	P ₂	7.67	7.75	8.86	8.72	8.45	8.29	
	Mean	7.67	7.73	8.33	8.71	8.44	8.18	
3Month (S ₄)	P ₁	6.44	6.50	6.68	8.61	8.35	7.32	
	P ₂	6.47	6.56	6.73	8.67	8.40	7.37	
	Mean	6.46	6.53	6.70	8.64	8.38	7.34	
4Month (S ₅)	P ₁	4.36	4.45	5.86	7.80	7.72	6.04	
	P ₂	4.45	4.55	5.91	7.89	7.80	6.12	
	Mean	4.41	4.50	5.79	7.85	7.76	6.08	
5Month (S ₆)	P ₁	4.08	4.22	4.72	6.84	6.76	5.32	
	P ₂	4.16	4.30	4.83	7.03	6.94	5.45	
	Mean	4.12	4.26	4.78	6.93	6.85	5.39	
Mean (C)		6.73	6.79	7.22	8.27	8.07		
S.Em.±	C	P	C×P	S	C×S	P×S	C×P×S	
	0.020	0.013	0.029	0.019	0.043	0.027	0.061	
CD at 5%	0.060	0.038	0.085	0.053	0.119	0.076	0.170	
CV %	1.65			1.42				

Further, interaction of TBHQ, packaging material and storage depicted variations of mean ‘L’ value in ‘sev’ during five month storage from initial value of 59.38 to 55.50, with minimum decrease (59.37 to 56.82) in ‘sev’ fried in oil using no TBHQ and packed in aluminium laminated bags (C₁P₂S₁ and C₁P₂S₆) and maximum decrease in ‘L’ value (59.37 to 55.50) was found in ‘sev’ prepared by oil without TBHQ with polypropylene bags (C₁P₁S₁ and C₁P₁S₆). Significant differences were observed for P×S interaction and non-significant differences were observed in ‘L’ value among interactions of C×P, C×S and C×P×S. The decrease in ‘L’ value content during storage might be due to change in water-vapor transmittivity of packaging materials with the increase in relative humidity of air by which the color pigments were subjected to losses in their brightness [19]. Similar observations were reported by Kruger et al. [20] and Tiboobun et al. [21] for noodle, Saifullah et al. [22] for banana peel based noodle and Allam et al. [16] for rice based snacks.

3.7 Colour ‘a’ Value

Interaction of TBHQ concentration and storage (Table 7) depicted variations in mean ‘a’ value

from 12.16 to 13.46, with minimum increase in ‘a’ value from 12.18 to 12.36 in ‘sev’ fried in oil containing 200 ppm TBHQ (C₅S₁ to C₅S₆), whereas maximum increase in ‘a’ value (1.17 to 13.46) in ‘sev’ fried in oil containing no TBHQ (C₁S₁ to C₁S₆). Interaction of packaging treatments and storage depicted variations in mean ‘a’ value during five months storage from initial value of 12.17 to 13.70, with minimum increase from 12.17 (P₂S₁) to 13.15 (P₂S₆) in ‘sev’ packed in aluminium laminated bag and maximum increase from 12.17 (P₁S₁) to 13.70 (P₁S₆) in ‘sev’ packed in polypropylene bag.

Further, interaction of TBHQ, packaging material and storage depicted variations of mean ‘a’ value in ‘sev’ during five month storage from initial value of 12.16 to 13.75, with minimum increase (12.17 to 13.14 and 12.18 to 13.15) in ‘sev’ fried in oil using 150 and 200 ppm TBHQ and packed in aluminium laminated bags (C₄P₂S₁ to C₄P₂S₆ and C₅P₂S₁ to C₅P₂S₆) and maximum increase in ‘a’ value (12.17 to 13.75) was found in ‘sev’ prepared by oil without TBHQ with polypropylene bags (C₁P₁S₁ to C₁P₁S₆). Significant differences were observed for P×S interaction and non-significant differences were observed in ‘a’ value

Table 4. Effect of different treatments on sensory score for flavour of banana peel based 'sev' during storage

Storage (S)	Packaging materials (P)	Flavour (9 point Hedonic scale)						
		Anti-oxidant concentrations (C)					Mean	Mean (P)
		C ₁	C ₂	C ₃	C ₄	C ₅		
Initial (S ₁)	P ₁	8.75	8.75	8.75	8.75	8.75	8.75	7.42
	P ₂	8.75	8.75	8.75	8.75	8.75	8.75	7.48
	Mean	8.75	8.75	8.75	8.75	8.75	8.75	
1Month (S ₂)	P ₁	8.56	8.62	8.73	8.74	8.75	8.68	
	P ₂	8.69	8.70	8.67	8.70	8.69	8.69	
	Mean	8.63	8.66	8.70	8.72	8.72	8.69	
2Month (S ₃)	P ₁	7.47	7.58	8.65	8.71	8.72	8.23	
	P ₂	7.61	7.67	8.67	8.73	8.73	8.28	
	Mean	7.54	7.63	8.66	8.72	8.73	8.26	
3Month (S ₄)	P ₁	7.04	7.08	7.79	8.02	8.02	7.59	
	P ₂	7.02	7.07	7.97	8.23	8.22	7.70	
	Mean	7.03	7.08	7.88	8.12	8.12	7.65	
4Month (S ₅)	P ₁	5.06	5.07	6.29	7.32	7.32	6.21	
	P ₂	5.00	5.04	6.53	7.55	7.55	6.33	
	Mean	5.03	5.06	6.41	7.43	7.44	6.27	
5Month (S ₆)	P ₁	3.83	3.82	5.19	6.22	6.22	5.06	
	P ₂	3.88	3.89	5.24	6.28	6.28	5.11	
	Mean	3.86	3.86	5.22	6.25	6.25	5.09	
Mean (C)		6.80	6.84	7.60	8.00	8.00		
S.Em.±	C	P	CxP	S	CxS	PxS	CxPxS	
	0.013	0.008	0.018	0.016	0.035	0.022	0.050	
CD at 5%	0.038	0.023	NS	0.044	0.099	0.062	0.140	
CV %	1.04			1.16				

among interactions of CxP, CxS and CxPxS. The increase in 'a' value content during storage in the present investigation are in line with the observation reported by Irwandi et al. [23] for durian fruit leather, Sonia et al. (2015) for banana chips and George et al. (2011) for potato crisps. The increase in 'a' value content during storage might be due to change in water-vapor transmittivity of packaging materials with the increase in relative humidity of air by which the color pigments were subjected to losses in their yellowness [19]. Increase in 'a' value during storage was earlier reported by Swain et al. [19] for dried capsicum slices. Almost similar observations were also documented by Irwandi et al. [23] for durian fruit leather.

3.8 'b' Colour Value

Interaction of TBHQ concentration and storage (Table 8) depicted variations in mean 'b' value from 54.61 to 51.65, with minimum decrease in 'b' value from 54.60 to 51.67 in 'sev' fried in oil containing 150 ppm TBHQ (C₄S₁ to C₄S₆), whereas maximum decrease in 'b' value (54.61 to 51.65 and 54.61 to 51.66) in 'sev' fried in oil containing 50 ppm TBHQ (C₂S₁ to C₂S₆).

Interaction of packaging treatments and storage depicted variations in mean 'b' value during five months storage from initial value of 54.60 to 51.08, with minimum decrease from 54.60 (P₂S₁) to 52.23 (P₂S₆) in 'sev' packed in aluminium laminated bag and maximum decrease from 54.60 (P₁S₁) to 52.23 (P₁S₆) in 'sev' packed in polypropylene bag.

Further, interaction of TBHQ, packaging material and storage depicted variations of mean 'b' value in 'sev' during five month storage from initial value of 54.61 to 50.13, with minimum decrease (54.60 to 53.16) in 'sev' fried in oil using no TBHQ and packed in aluminium laminated bags (C₁P₂S₁ to C₁P₂S₆) and maximum decrease in 'b' value (54.60 to 50.13) was found in 'sev' prepared by oil without TBHQ with polypropylene bags (C₁P₁S₁ to C₁P₁S₆). Significant differences were observed for PxS and PxCxS interaction and non-significant differences were observed in 'b' value among interactions of CxP and CxS. Significant differences were observed in 'b' value among interactions of CxP and CxS. The decrease in 'b' value during storage might be due to change in water-vapor transmittivity of packaging materials with the increase in relative

Table 5. Effect of different treatments on sensory score for overall acceptability of banana peel based ‘sev’ during storage

Storage (S)	Packaging materials (P)	Overall acceptability (9 point Hedonic scale)						Mean	Mean (P)
		Anti-oxidant concentrations (C)							
		C ₁	C ₂	C ₃	C ₄	C ₅			
Initial (S ₁)	P ₁	8.76	8.73	8.71	8.70	8.63	8.71	7.79	
	P ₂	8.76	8.73	8.72	8.70	8.63	8.71		
	Mean	8.76	8.73	8.72	8.70	8.63	8.71		
1Month (S ₂)	P ₁	8.59	8.63	8.63	8.62	8.55	8.60	8.61	
	P ₂	8.62	8.65	8.64	8.64	8.57	8.62		
	Mean	8.61	8.64	8.63	8.63	8.56	8.61		
2Month (S ₃)	P ₁	7.96	8.00	8.28	8.53	8.47	8.25	8.31	
	P ₂	8.04	8.08	8.62	8.60	8.53	8.37		
	Mean	8.00	8.04	8.45	8.56	8.50	8.31		
3Month (S ₄)	P ₁	7.40	7.44	7.68	8.22	8.16	7.78	7.83	
	P ₂	7.49	7.51	7.79	8.33	8.27	7.88		
	Mean	7.45	7.47	7.73	8.28	8.21	7.83		
4Month (S ₅)	P ₁	6.30	6.33	7.02	7.77	7.74	7.03	7.08	
	P ₂	6.39	6.42	7.12	7.87	7.84	7.13		
	Mean	6.35	6.38	7.07	7.82	7.79	7.08		
5Month (S ₆)	P ₁	5.76	5.81	6.28	7.07	7.05	6.39	6.46	
	P ₂	5.88	5.92	6.40	7.21	7.19	6.52		
	Mean	5.82	5.86	6.34	7.14	7.12	6.46		
Mean (C)		7.50	7.52	7.82	8.19	8.14			
S.Em.±	C	P	C×P	S	C×S	P×S	C×P×S		
	0.008	0.005	0.012	0.009	0.020	0.012	0.028		
CD at 5%	0.025	0.016	NS	0.025	0.056	0.035	NS		
CV %	0.70			0.61					

Table 6. Effect of different treatments on 'L' value of banana peel based 'sev' during storage

Storage (S)	Packaging materials (P)	'L' Value						Mean	Mean (P)
		Anti-oxidant concentrations (C)							
		C ₁	C ₂	C ₃	C ₄	C ₅			
Initial (S ₁)	P ₁	59.37	59.38	59.37	59.37	59.38	59.37	57.72	
	P ₂	59.37	59.37	59.38	59.37	59.37	59.37		
	Mean	59.37	59.38	59.38	59.37	59.38	59.37		
1 Month (S ₂)	P ₁	59.19	59.18	59.20	59.19	59.20	59.19	59.21	
	P ₂	59.22	59.21	59.24	59.24	59.23	59.23		
	Mean	59.21	59.20	59.22	59.22	59.22	59.21		
2 Month (S ₃)	P ₁	58.32	58.35	58.34	58.36	58.33	58.34	58.63	
	P ₂	58.91	58.92	58.91	58.93	58.92	58.92		
	Mean	58.62	58.64	58.63	58.65	58.62	58.63		
3 Month (S ₄)	P ₁	57.30	57.29	57.31	57.30	57.32	57.30	57.87	
	P ₂	58.44	58.45	58.43	58.45	58.44	58.44		
	Mean	57.87	57.87	57.87	57.88	57.88	57.87		
4 Month (S ₅)	P ₁	56.52	56.56	56.55	56.58	56.56	56.56	57.16	
	P ₂	57.78	57.76	57.78	57.77	57.77	57.77		
	Mean	57.15	57.16	57.16	57.18	57.17	57.16		
5 Month (S ₆)	P ₁	55.50	55.54	55.55	55.57	55.54	55.54	56.17	
	P ₂	56.82	56.78	56.80	56.79	56.79	56.80		
	Mean	56.16	56.16	56.18	56.18	56.17	56.17		
Mean (C)		58.06	58.07	58.07	58.08	58.07			
S.Em.±	C	P	C×P	S	C×S	P×S	C×P×S		
	0.144	0.091	0.204	0.178	0.398	0.251	0.562		
CD at 5%	NS	0.269	NS	0.498	NS	0.704	NS		
CV %	1.48			1.68					

Table 7. Effect of different treatments on 'a' value of banana peel based 'sev' during storage

Storage (S)	Packaging materials (P)	'a' Value					Mean	Mean (P)
		Anti-oxidant concentrations (C)						
		C ₁	C ₂	C ₃	C ₄	C ₅		
Initial (S ₁)	P ₁	12.17	12.16	12.16	12.17	12.18	12.17	12.94
	P ₂	12.17	12.16	12.16	12.17	12.18	12.17	
	Mean	12.17	12.16	12.16	12.17	12.18	12.17	
1 Month (S ₂)	P ₁	12.67	12.65	12.66	12.67	12.66	12.66	12.75
	P ₂	12.56	12.56	12.57	12.57	12.56	12.56	
	Mean	12.62	12.60	12.62	12.62	12.61	12.61	
2 Month (S ₃)	P ₁	12.95	12.90	12.89	12.89	12.91	12.91	12.86
	P ₂	12.74	12.73	12.72	12.70	12.70	12.72	
	Mean	12.84	12.81	12.80	12.80	12.81	12.81	
3 Month (S ₄)	P ₁	13.09	13.08	12.05	13.04	13.04	12.86	12.86
	P ₂	12.90	12.86	12.87	12.85	12.85	12.87	
	Mean	12.10	12.97	12.46	12.94	12.94	12.86	
4 Month (S ₅)	P ₁	13.38	13.35	13.34	13.34	13.33	13.35	13.20
	P ₂	13.07	13.06	13.05	13.04	13.06	13.06	
	Mean	13.23	13.21	13.20	13.19	13.20	13.20	
5 Month (S ₆)	P ₁	13.75	13.73	13.69	13.68	13.67	13.70	13.43
	P ₂	13.18	13.15	13.14	13.14	13.15	13.15	
	Mean	13.46	13.44	13.42	13.41	13.41	13.43	
Mean (C)		12.89	12.87	12.78	12.86	12.86		
S.Em.±	C	P	C×P	S	C×S	P×S	C×P×S	
	0.039	0.025	0.055	0.048	0.107	0.068	0.152	
CD at 5%	NS	0.073	NS	0.134	NS	0.189	NS	
CV %	1.83			2.04				

Table 8. Effect of different treatments on 'b' value of banana peel based 'sev' during storage

Storage (S)	Packaging materials (P)	'b' Value						
		Anti-oxidant concentrations (C)					Mean	Mean (P)
		C ₁	C ₂	C ₃	C ₄	C ₅		
Initial (S ₁)	P ₁	54.60	54.61	54.60	54.60	54.61	54.60	53.08
	P ₂	54.60	54.60	54.61	54.60	54.60	54.60	
	Mean	54.60	54.61	54.61	54.60	54.61	54.60	
1 Month (S ₂)	P ₁	54.92	54.59	54.30	53.89	54.47	54.43	53.73
	P ₂	53.97	54.29	54.62	55.02	54.44	54.47	
	Mean	54.45	54.44	54.46	54.46	54.46	54.45	
2 Month (S ₃)	P ₁	53.76	53.69	53.82	53.67	53.21	53.65	53.92
	P ₂	54.05	54.16	54.01	54.20	54.52	54.19	
	Mean	53.90	53.93	53.92	53.94	53.92	53.92	
3 Month (S ₄)	P ₁	53.09	52.15	52.99	52.36	52.93	52.70	53.22
	P ₂	53.35	54.29	53.46	54.09	53.52	53.74	
	Mean	53.22	53.22	53.23	53.23	53.22	53.22	
4 Month (S ₅)	P ₁	51.52	52.29	51.82	52.35	52.07	52.01	52.57
	P ₂	53.59	52.86	53.33	52.81	53.07	53.13	
	Mean	52.56	52.57	52.58	52.58	52.57	52.57	
5 Month (S ₆)	P ₁	50.13	51.20	51.21	51.80	51.06	51.08	51.66
	P ₂	53.16	52.10	52.12	51.54	52.25	52.23	
	Mean	51.65	51.65	51.67	51.67	51.66	51.66	
Mean (C)		53.40	53.40	53.41	53.41	53.41		
S.Em.±	C	P	C×P	S	C×S	P×S	C×P×S	
	0.145	0.092	0.205	0.130	0.290	0.183	0.409	
CD at 5%	NS	0.270	NS	0.362	NS	0.513	1.145	
CV %	1.63			1.33				

humidity of air by which the color pigments were subjected to losses in their yellowness [23]. Similar observations were reported by Saifullah et al. [22] for banana peel based noodle, Petitot et al. [24] for pasta, Kihong et al. [25] for noodle and Wanna et al. [9] for banana chips [26-30].

4. CONCLUSION

It can be concluded that ripe banana peel based 'sev' can be prepared by frying in sunflower oil containing 150 ppm TBHQ and packed in 400 gauge aluminium laminated bags to have better storage stability upto 5 month. The 'sev' prepared from the above treatment combination, possess higher sensory quality attributes, 'L' value, 'b' value and lower 'a' value during storage. Thus, the developed technology can commercially be adopted by food processing industry for the production of 'sev' by utilizing banana peel.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Cumo C. Foods that changed history: How foods shaped civilization from the ancient world to the present. Bloomsbury Publishing USA; 2015.
2. Ganapathi TR, Kulkarni VM, Suprasanna P, Bapat VA, Rao PS. Studies on *in vitro* multiplication and encapsulation in an elite variety of banana – Lal Kela (AAA). Proc. Natl. Acad. Sci. 1999;68:45-51.
3. Zou F, Tan C, Zhang B, Wu W, Shang N. The valorization of banana by-products: Nutritional composition, bioactivities, applications, and future development. Foods. 2022;11(20):3170.
4. Emaga TH, Robert C, Ronkart SN, Wathelet B, Paquot M. Dietary fiber components and pectin chemical features of peels during ripening in banana and plantain varieties. Bioresour. Technol. 2007;99(10):4346-4354.
5. Gohil Mehul M, Raj D, Mayani JM, Pandey AK. Effect of anti-oxidant and packaging material on the quality of banana [*Musa paradisiaca* L.] peel based 'Sev'. The Pharma Innovation Journal. 2022;11(6): 1227-1234
6. Mokbel MS, Hashinaga F. Antibacterial and antioxidant activities of banana (*Musa*, AAA cv. Cavendish) fruits peel. Am. J. Biochem. Biotechnol. 2005;1(3):125-131.
7. Fatemeh SR, Saifullah R, Abbas FMA, Azhar ME. Total phenolics, flavonoids and antioxidants activity of banana pulp and peel flours: Influence of variety and stage of ripeness. Int. Food Res. J. 2012;19(3): 1041-1046.
8. Feming DJ. Dietary determination of iron stones in a free-living elderly population: The framingham heart study. Am. J. Clin. Nutr. 1998;67:722-733.
9. Wanna A, Yaakob C, Salmah Y, Russly AR. Effects of type of packaging material on physico-chemical and sensory characteristics of deep-fat-fried banana chips. J. Sci. Food Agric. 2002;82:1621–1627.
10. Tiwari A, Jha SK. Effect of nitrogen gas enriched packing on quality and storage life of pearl millet based fried snack. J. Biosystems. Eng. 2017;42(1):62-68.
11. Singh VP, Sanyal MK, Dubey PC, Sachan N, Kumar V. Chicken snacks as affected by storage conditions under aerobic and vacuum packaging. African J. Food Sci. 2011;5(11):620-625.
12. Jaswir I, Yaakob B, Che M, David DK. Use of natural antioxidants in refined palm olein during repeated deep-fat frying. Food Res. Int. 2000;33:501-508.
13. Butt MS, Ali A, Pasha I, Hashmi A, Sarwar D. Effect of different antioxidant and packaging materials on the storage stability of breakfast cereals. Int. J. Food Saf. 2003;2:1-5.
14. Rababah TM, Feng H, Yang W, Sevil Y. Fortification of potato chips with natural plant extracts to enhance their sensory properties and storage stability. J. Am. Oil Chem. Soc. 2011;89:1419-1425.
15. Pernille B. Effect of selected antioxidants on the stability of dehydrated mashed potatoes. Food Addit. Contam. 1989;6(2): 201-207.
16. Allam MS, Shivani P, Kumar S, Anjali S. Studies on storage on storage stability of carrot pomace- chickpea incorporated rice based snacks. Agric. Res. J. 2015;52(4): 73-79.
17. Pawase PA, Veer SJ, Chavan UD. Studies on effect of different packaging materials on shelf life of mix fruit bar. J. Food Sci. Nutr. Int. 2019;4(5):156-162.

18. Raj D, Lal BB. Effect of cultivars, cold storage and frying media on yield and processing qualities of potatoes. J. Food Sci. Technol. 2008;45(1):20-27.
19. Swain S, Samuel DVK, Abhijit K. Effect of packaging materials on quality characteristics of osmotically pretreated microwave assisted bried sweet pepper (*Capsicum annum* L.). J. Food Process. Technol. 2013;4(9):2-7.
20. Kruger JE, Hatcher DW, Anderson MJ. The effect of incorporation of rye four on the quality of oriental noodles. Food Res. Int. 1998;31:27-35.
21. Tiboonbun W, Sungstri M, Moongngarm A. Effect of replacement of unripe banana flour for rice flour on physical properties and resistant starch content of rice noodle. World Acad. Sci. Eng. Technol. 2011; 57:608- 611.
22. Saifullah R, Abbas FMA, Shin YY, Azhar ME. Utilization of banana peel as a functional ingredient in yellow noodle. As. J. Food AgInd. 2009;2(03):302-310.
23. Irwandi J, Che YB, Yusof S, Jinap S, Sugisawa H. Effects of type of packaging materials on physico-chemical, microbiological and sensory characteristics of durian fruit leather during storage. J. Sci. Food Agric. 1998;76:427-434.
24. Petitot M, Boyer L, Minier C, Micard V. Fortification of pasta with split pea and faba bean flours: Pasta processing and quality evaluation. Food Res. Int. 2009;43: 634-641.
25. Kihong J, Youngboong K, Youngho K, Yoonseon H, Jinyoung C. Effects of pork round powder addition on the quality characteristics of noodle product. 60th International Congress of Meat Science and Technology; 2014.
26. Anonymous. Development of technology for utilization of banana peel for preparation of seviran. 12th AGRESCO Report, NAU, Navsari. 2014;79-85.
27. Gohil Mehul M, Dev Raj J, Mayani M, Pandey AK. Effect of anti-oxidant and packaging material on the quality of banana [*Musa paradisiaca* L.] peel based 'Sev'. Pharma Innovation J. 2022;11(6): 1227-1234.
28. Gojiya D, Gohil V. Design and development of low cost sesame dehuller and its process standardization. Journal of Food Science and Technology. 2022;59 (11):4446-4456.
29. Gojiya D, Davara P, Gohil V, Dabhi M. Process standardization for formulating protein-augmented corn-based extrudates using defatted sesame flour (DSF): Sesame oil industry waste valorization. Journal of Food Processing and Preservation. 2022;e17203.
30. Pernille B. Effect of selected antioxidants on the stability of dehydrated mashed potatoes. Food Addit. Contam. 1989;6(2): 201-207.

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