

# Effect of Antioxidant Rich Vegetable Peels in Enhancing Shelf Life of Nendran Banana Chips

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**Abstract**—The role of antioxidant rich vegetable peels in enhancing the quality and shelf life of Nendran banana chips was explored. Of all the peels tried, fresh banana peel was effective in enhancing shelf life. Peels of potato, watermelon and cucumber were not effective in controlling rancidity. A good quality banana chips should have less moisture, oil uptake, shrinkage, free fatty acid value, peroxide value and high integrity and iodine value. Banana chips prepared by addition of 0.02% chopped fresh banana peel to frying oil at smoke point of 165°C recorded the least moisture (6.45%), oil uptake (30.65%), shrinkage (21.00%), peroxide value (4.70 meq. O<sub>2</sub>/ kg), free fatty acid value (3.08 mg KOH/ g) along with highest integrity (84.45%) and iodine value (8.76) indicating superior quality. Highest sensory scores were also obtained for the same treatment indicating its superiority and suggesting a possible method of waste utilization too.

## 1. INTRODUCTION

Banana chips is an integral part of traditional Kerala meal, “Sadya” and also, a most popular crispy snack on various occasions. They are prepared by peeling and slicing fully mature but unripe bananas and deep-fat frying the slices in suitable edible oil. During deep frying, the oil is exposed to atmospheric oxygen, high temperature and moisture released from the food and it enters the food, providing nutrients and flavour. When a fatty substance is exposed to air, its unsaturated components are converted into hydro peroxides, which break down into volatile aldehydes, esters, alcohols, ketones and hydrocarbons which produce disagreeable odours, leading to increased rancidity [8].

Antioxidants are often added to fat containing foods in order to delay the onset or slow the development of rancidity due to oxidation. The main characteristic of an antioxidant is its ability to trap free radicals. The protection of foods from oxygen is the basic principle upon which antioxidant protective technologies are based. Synthetic antioxidants such as butylated hydroxyl anisole (BHA), butylated hydroxy toluene (BHT) and propyl gallate (PG) are widely used as food additives, but their application has been reassessed

because of possible toxic or carcinogenic components formed during their degradation [15].

A recent area of interest in antioxidant research is concerned with finding effective replacements for the conventional synthetic antioxidants from among the various natural plant tissues rich in bio-active compounds such as phenolic compounds, carotenoids, flavonoids, anthocyanins and vitamins. In most cases the waste products have similar or even higher amounts of antioxidant and antimicrobial compounds compared to main products. Wastes from processing industry like potato peel [14], banana peel [16], water melon peel [20], cucumber peel [9] etc. are reported to have potent antioxidant activity. Hence in the present study, it was explored to find out whether addition of these antioxidant rich vegetable peels can enhance shelf life of banana chips, thereby exploiting possibility of waste utilisation.

## 2. MATERIALS AND METHODS

Fully mature unripe banana bunches of cultivar Nendran were harvested between 85 – 95 days after inflorescence emergence from Instructional Farm, College of Agriculture, Vellayani. Good sized fingers were selected, separated, washed to remove adhering dirt and dust; subsequently peels were removed and sliced using an adjustable hand slicer into uniform slices of two mm thickness. Chips were prepared in unrefined coconut oil at 165°C with an oil- slice ratio of 2:1 by adding 0.7% salt and 0.15% turmeric as 20% aqueous solution at the end of frying [1].

Four different vegetable peels, which are rich in antioxidant principles were collected from Processing laboratory of College of Agriculture, Vellayani, cleaned and incorporated into chips.

1- Banana peel, 2- Potato peel, 3- Watermelon peel, 4- Cucumber peel

Form of application-2

F- Fresh form (chopped into small bits)

D- Oven dried powdered form (fresh peels were dried at 50°C for 7 – 10 hours till it attains 6 – 8% moisture and powdered).

Concentration-2 [C1 - 0.01%, C2- 0.02%]

Method of application- 2

PS- pre-soaking slices before frying.

Required quantity of vegetable peel was added to 100 ml distilled water and banana slices were soaked in it for 30 minutes. After 30 minutes, the slices were taken out, surface dried by spreading it on muslin cloth for 30 minutes, before frying.

DA- Direct addition of vegetable peels in oil.

Peels were added directly to oil at smoke point of 165°C, before addition of the banana slices.

Total no. of treatments = 32

Replication = 2

Vegetable peels incorporated were stored in laminated pouches (LDPE/Metalised polyester/LDPE) under ambient storage conditions ( $32 \pm 5$  °C) for analysing physical, chemical and sensory quality parameters.

Physical quality parameters like yield, moisture content, oil uptake, integrity and shrinkage of chips were recorded. Moisture content of chips was estimated using moisture analyser, which dries the sample using a halogen lamp and gives the moisture content based on the principle of thermo gravimetric analysis. Oil content of chips was estimated by solvent extraction method using petroleum ether [3]. Twenty numbers of chips were selected at random from each treatment and the number of chips which remained intact without any breakage after frying was noted as integrity (%). Surface area was calculated before and after frying and difference in diameter was calculated [2] to find out shrinkage.

Chemical quality parameters like free fatty acid (FFA) value, peroxide value and iodine value, which represent the rancidity factors of deep fried products were recorded after three months of storage [17]. Based on physical and chemical parameters, superior banana chips were selected and sensory parameters like appearance, colour, flavour, texture and taste of the selected superior banana chips were organoleptically scored using a nine-point hedonic scale [11] by a 30 member semi-trained panel drawn from the scientific staff of different departments of College of Agriculture, Vellayani.

The treatment combinations were analyzed using one way ANOVA and significance was tested using CD. In organoleptic analysis of the superior treatments, the different preferences as indicated by scores were evaluated by Kruskal – Wallis test to get the mean rank values for all the treatments.

### 3. RESULTS AND DISCUSSION

Banana chips prepared using antioxidant rich vegetable peels showed significant difference in physical, chemical and sensory quality parameters.

#### 3.1 Effect of vegetable peels on physical quality of chips

Banana chips should have low moisture content and oil uptake for good shelf life [7]. At the same time it should have high integrity and low shrinkage for good physical appearance. Yield is an essential factor to be considered along with these quality parameters.

Fresh watermelon peel applied directly to frying oil at 0.02% concentration produced chips with the lowest moisture content (6.35%) (Table 1). Chips prepared by application of fresh banana peel directly to frying oil at 0.02% concentration had lowest oil uptake (30.65%) which was on par with chips prepared by direct addition of dried banana peel powder in oil at both concentration. Direct addition of 0.02% fresh potato peel and dry cucumber peel powder also produced chips with least oil uptake. Banana chips prepared from slices presoaked in 0.02% oven dried banana peel powder recorded the highest yield recovery (77.10%) which was on par with chips prepared using slices pre-soaked in 0.01% dry banana peel powder (72.30), 0.02% fresh potato peel (72.40) and 0.02% potato peel powder (73.80).

Banana chips prepared by directly adding 0.02% chopped fresh banana peel to frying oil recorded the least moisture content (6.45%) and oil uptake (30.65%) but with a low yield (65.6%). At the same time, banana chips prepared using slices presoaked in 0.02% oven dried banana peel powder, which had the highest yield (77.10%) had produced chips with a higher oil uptake (38.05%) and maximum moisture content (9.00%). It could be noted that there is a negative correlation between yield and quality parameters like moisture content and oil uptake. Presoaking banana slices results in an increased moisture content which increases the chance for more oil absorption and hence higher yield. A high oil content in fried banana chips shortens the shelf life of product and also causes a decrease in product acceptability to consumers [19].

When the influence of method of vegetable peel application on moisture content of banana chips was examined, it could be seen that application of vegetable peels directly to frying oil had produced chips with less moisture content and hence better than presoaking slices in water containing peels. A higher moisture content of 9.00% was also observed by chips prepared from slices presoaked in 0.01% oven dried cucumber peel powder. This agrees with the findings of Adrika [1] who had reported that presoaked slices with antioxidants recorded higher moisture content compared to direct antioxidant addition to frying oil. The result was found to be same in all the vegetable peels tried. Presoaking of slices also produced

chips with high moisture content, which is a factor limiting shelf life of chips.

High integrity and low shrinkage are the two essential factors for chips with good appearance and acceptance. Shrinkage starts as a surface occurrence, since drying during frying initiates at the surface and then progresses into the sample with the frying time. Fried foods shrink when the moisture is lost and the food cells collapse as a consequence of heating and evaporation during frying. A decrease in the product dimension occurs when heat – induced evaporation / drying is done [13]. Banana chips prepared by direct addition of 0.02% fresh banana peel into frying oil recorded high integrity (84.45%). When the influence of method of application of vegetable peel on these parameters was examined, it could be seen that applying vegetable peels directly to frying oil had resulted in high integrity and less shrinkage compared to presoaking slices with peels. Highest integrity was recorded by chips prepared by direct addition of 0.01% oven dried banana peel powder (84.60%) whereas chips prepared by direct addition of 0.02% fresh potato peel recorded lowest shrinkage (20.90%).

### 3.2 Effect of vegetable peels on chemical quality

Good quality banana chips should have low free fatty acid value, peroxide value and a high iodine value for enhanced shelf life. In the present study banana chips prepared by direct addition of 0.02% fresh banana peel into frying oil had lowest FFA value (3.08 mg KOH/g), peroxide value (4.70 meq. O<sub>2</sub> / kg) and highest iodine value (8.76) indicating its superiority. Fresh banana peel at 0.01% concentration was also effective as direct addition of it to frying oil also resulted in chips with least free fatty acid value (3.37 mg KOH/g), least peroxide value (4.70 meq. O<sub>2</sub> / kg) and highest iodine value (8.68) too.

The highest FFA value was recorded by banana chips prepared from slices presoaked in 0.01% oven dried cucumber peel powder (12.34 mg KOH/g). Banana chips when soaked in fresh or dry potato and cucumber peels, the resulting chips had highest free fatty acid value. 0.02% fresh water melon peel also had similar effect. Slices soaked in fresh cucumber and watermelon peels as well as dry watermelon powders in both concentration had produced chips with highest peroxide values. Chitturi *et al.* [6] reported that antioxidant concentration was lower in water melon (0.08%).

Chips prepared by presoaking slices in 0.01% of fresh potato peel recorded lowest iodine value (5.78). Presoaking slices in 0.01% fresh cucumber peel, dry cucumber/ watermelon peel powder or direct addition of 0.01/ 0.02% banana peel powder resulted in banana chips with high iodine value. All these values clearly indicate that fresh banana peel is having high antioxidant property compared to other peels tested. When the efficiency of form of antioxidant was compared fresh banana peel was better compared to oven dried powdered form. When

physical and chemical quality parameters are considered together, it was seen that chips prepared with good quality banana peel is better than chips prepared with other peels tried, which is due to the high antioxidant activity of banana peel. Antioxidant principle of Nendran banana is 0.49 +/- 0.06mg catechol equivalents/g fresh tissue [4]. Phenolics are stored in pectin or cellulose networks of peels which is released during thermal processing. Heat during deep frying of chips breaks the supramolecular structure which might make the phenolic compounds react better with the reagents [5].

### 3.3 Effect of vegetable peels on sensory quality of banana chips

Quality of a food involves maintenance or improvement of its key attributes such as colour, flavor, texture etc. [10]. Banana chips prepared by incorporating banana peel, which had superior physical and chemical quality parameters were subjected to a sensory analysis. The chips prepared by adding 0.02% fresh banana peel to frying oil recorded highest mean rank value for colour (223.50), taste (266.90) and texture (248.80) (Figure 1.). The chips with highest physical and chemical quality attributes had high sensory scores too, thus proving acceptability of the banana peel incorporation.

The lowest mean rank value for texture (102.80) was recorded by banana chips prepared from slices presoaked in 0.01% oven dried banana peel powder. As in physical and chemical parameters, the least sensory quality attributes were recorded by banana chips prepared after presoaking slices with peels. Presoaking for 30 minutes resulted in loss of integrity, high moisture absorption and oil uptake which might have affected all the sensory scores negatively.

This work highlights the importance of fresh banana peel as a potent antioxidant in delaying lipid oxidation, which may be attributed to compounds like gallicocatechin [12] and dopamine [18]. The study proves that direct addition of 0.02% fresh banana peel to frying oil at smoke point of 165<sup>o</sup>C along with banana slices can ensure a shelf life of three months to banana chips, without affecting its sensory quality.

## 4. CONCLUSION

Four different vegetable peels, rich in antioxidant principles, were incorporated to banana chips in two concentration, two forms and by two methods to study their effect in enhancing the shelf life of banana chips. Fresh form of peels were more effective compared to oven dried powdered forms and fresh banana peel was effective compared to all other vegetable peels. Direct addition of vegetable peel pieces in oil was the effective method compared to pre-soaking of slices in peels before frying. Superior physical quality parameters like low moisture content, oil uptake, shrinkage and high integrity and chemical quality parameters like low FFA value, peroxide value and high iodine value were recorded for banana chips

prepared after adding 0.02% fresh banana peel pieces to frying oil. Negative correlation existed between yield and good physical quality parameters. The same treatment recorded highest sensory quality parameters too. Direct addition of 0.02% fresh banana peel pieces to frying oil at smoke point of 165°C along with banana slices was selected as the best method for producing quality chips with enhanced shelf life. Addition of banana peel pieces for quality chips production can be suggested as a possible way of waste utilisation in chips industry.

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**Table 1: Physical quality parameters of chips prepared with the incorporation of vegetable peels**

Treatments				Physical quality parameters				
Peels	Form of application	Method of application	Concentration	Yield (%)	Moisture (%)	Oil uptake (%)	Integrity (%)	Shrinkage (%)
Banana	Fresh	PS	0.01%	70.70	7.95	35.80	82.95	22.85
			0.02%	71.70	7.40	37.00	82.75	22.75
		DA	0.01%	66.10	7.05	33.10	84.00	21.45
			0.02%	65.60	6.45	30.65	84.45	21.00
	Dry powder	PS	0.01%	72.30	8.70	37.10	82.90	23.00
			0.02%	77.10	9.00	38.05	81.80	22.50
		DA	0.01%	66.80	6.90	32.10	84.60	21.05
			0.02%	64.60	6.70	30.70	84.15	20.80
Potato	Fresh	PS	0.01%	71.80	7.35	37.10	80.90	22.85
			0.02%	72.40	8.40	37.70	81.20	23.10
		DA	0.01%	67.70	6.65	34.40	83.05	21.50
			0.02%	65.80	6.90	31.55	83.15	20.95

	Dry powder	PS	0.01%	70.30	8.50	37.90	83.20	22.95
			0.02%	73.80	8.75	39.77	81.75	22.10
		DA	0.01%	66.10	7.25	34.30	84.05	21.75
			0.02%	66.90	6.90	33.85	82.25	21.40
Watermelon	Fresh	PS	0.01%	71.80	7.50	36.05	81.90	23.05
			0.02%	70.20	8.15	36.70	79.70	23.15
		DA	0.01%	64.60	7.00	33.10	81.85	22.00
			0.02%	63.00	6.35	32.85	80.60	21.55
	Dry powder	PS	0.01%	70.30	8.95	39.30	80.90	22.90
			0.02%	71.20	8.00	38.20	81.90	22.45
		DA	0.01%	67.00	7.20	32.85	82.55	21.60
			0.02%	65.80	7.30	34.00	82.00	21.40
Cucumber	Fresh	PS	0.01%	70.20	8.25	41.75	80.75	23.10
			0.02%	71.00	7.45	38.20	82.45	23.25
		DA	0.01%	67.40	7.70	32.80	82.00	21.75
			0.02%	69.70	7.30	33.60	80.90	22.40
	Dry powder	PS	0.01%	70.10	9.00	36.95	80.35	22.90
			0.02%	71.80	8.40	38.25	80.65	22.65
		DA	0.01%	66.70	7.55	33.20	81.00	21.75
			0.02%	62.10	7.40	31.85	82.05	21.25
CD (P=0.05)				5.27	0.84	1.98	1.57	0.85

PS- Pre-soaking slices in peels before frying

DA- Direct addition of peels in oil at smoke point.

**Table 2: Chemical quality parameters of chips prepared with the incorporation of vegetable peels**

Treatments				Chemical quality parameters		
Peels	Form of application	Method of application	Concentration	Free fatty acid value (mg KOH/g)	Peroxide value (meq. O <sub>2</sub> /kg)	Iodine value
Banana	Fresh	PS	0.01%	5.05	6.20	7.54
			0.02%	5.33	6.10	7.75
		DA	0.01%	3.37	4.70	8.68
			0.02%	3.08	4.70	8.76
	Dry powder	PS	0.01%	9.26	7.00	6.69
			0.02%	8.71	6.80	6.79
		DA	0.01%	6.17	5.00	5.96
			0.02%	6.70	5.10	6.22
Potato	Fresh	PS	0.01%	10.38	7.40	5.78
			0.02%	11.22	7.50	6.67
		DA	0.01%	9.54	6.40	6.73
			0.02%	9.54	6.50	7.05
	Dry powder	PS	0.01%	11.78	7.40	6.47
			0.02%	12.06	7.30	6.60
		DA	0.01%	9.26	6.40	7.24
			0.02%	9.53	6.10	7.42
Watermelon	Fresh	PS	0.01%	10.43	9.00	6.41
			0.02%	10.37	9.10	6.67
		DA	0.01%	8.14	6.50	7.49
			0.02%	8.97	6.10	7.61

Cucumber	Dry powder	PS	0.01%	10.43	9.30	6.22
			0.02%	11.78	9.40	6.67
		DA	0.01%	9.26	6.70	7.36
			0.02%	9.26	7.10	7.43
	Fresh	PS	0.01%	11.22	9.30	6.28
			0.02%	11.78	9.30	6.79
		DA	0.01%	8.42	8.50	7.61
			0.02%	9.26	8.80	7.68
	Dry powder	PS	0.01%	12.34	8.40	6.16
			0.02%	11.78	8.80	6.35
DA		0.01%	9.26	7.40	7.42	
		0.02%	9.26	7.60	7.74	
CD (P=0.05)			1.30	0.50	0.52	

PS- Pre-soaking slices in antioxidants before frying  
 DA- Direct addition of antioxidants in oil at smoke point.

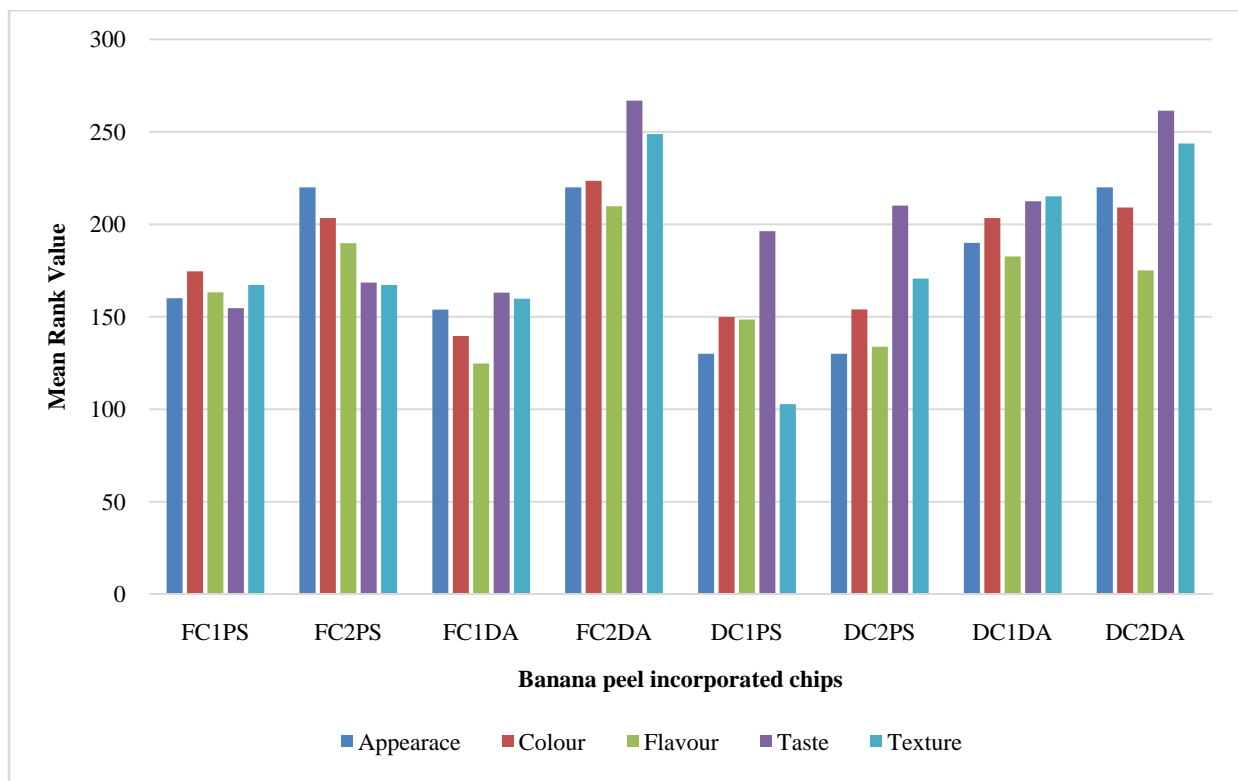


Fig. 1: Sensory quality parameters of banana peel incorporated chips