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Effect of frying media and primary packaging material on shelf life of banana chips

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Abstract

Banana chips are very common snacks like potato chips, all over the world. These are produced by deep frying in edible oil which are then either plain salted or spiced before packaging. The primary packaging of the chips depends on the desired shelf life of the products. If these are sold fast, then normally these are packed in polyethylene bags or poly propylene bags, heat sealed and sold. The oxygen from the trapped air do not generate fatty acid peroxides to the extent, which could be harmful to human health, nor does the moisture in the trapped air alter the texture of the chips inside. However, the free fatty acid content of the cooking oil also plays an important role, in making the products safe at the same time extending the shelf life a bit longer than usual. In this study the 2 edible oils used were refined sunflower oil and palmolein. The chips were crispier for 45 days (total shelf life checked was 60 days) when fried in sunflower oil than in palm oil, when packed in low density polyethylene film. The chips were rancid and with significant loss of texture when packed in polypropylene films.

Introduction

Banana is a very common edible fruit, consumed in both raw and ripened form. It is mostly grown in tropical countries like India, Sri Lanka Philippines Cuba and Australia etc. It belongs to the genus Musa (Nelson *et al*., 2006). The raw banana is usually consumed after processing or cooking. The average fruit weight is 125 gm and which approximately contain 75% water and 25% dry matter. Banana are classified as either as 'Desert banana' i.e. they are yellow and fully ripe when eaten or as 'Green banana'. These are valuable source of Vitamin B6, Vitamin C (Stover and Simmonds, 1987). In many regions it is also called as plantains' (Ploetz *et al*., 2007). The fruits are classified as leathery berry type. The banana fruit has seed inside the pulp. The present hybrid variety is seedless with only small dark specs in the pulp (Simmonds, 1962).

The banana chips are made out of raw banana. Raw banana is often called as plantains (Durance and Scaman, 2002). The chips are either horizontally slices or longitudinally slices of the fruit. Like peeled potato and potato slices (used to make potato chips), the peeled banana and banana slices also turn grayish black if kept open in air. This is because of the action of polyphenol oxidase on catechol present in the pulp of the fruit, which is converted to quinines and benzoquinones (Chen *et al*., 2001). In order to prevent such discoloration these are usually kept immersed in salt water (usually 2% salt solution) after peeling, so that these do not come in contact with air.

The chips are usually fried in refined vegetable oils. One of the most common and economically affordable oil is the refined sunflower oil. The oil is rich in omega 9 and omega 6 fatty acid esters which constitute 89% of the total lipids present. The remaining 11% is saturated fats of which palmitic acid ester is barely 5% (Brevedan *et al*., 2000). The other most affordable edible refined oil is the palmolein or what is known commonly as palm oil. The unrefined palm oil is rich in saturated fats mostly made up of esters of palmitic acid (44%) and mono unsaturated fatty acid (omega 9) ester (37%) (Andreu *et al.*, 2009). However, upon refining, the saturated fatty acid esters are removed to a large extent by fractional crystallization, where first stearic acid esters separate, followed by myristic acid esters and finally palmitic acid esters. It is not possible to remove all palmitic acid esters and hence refined palmolein contains around 20% to 30% of residual saturated fatty acid esters. The other less used oil for frying chips is the raw but filtered coconut oil. It has more than 90% saturated fats. Both, palmolein and

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coconut oil also has some moisture. It is very high in coconut oil since the refined variety is not generally used as it does not give the flavor of coconut.

Normally, crispy fried food items are packed in impermeable primary packages, which are either Low Density Polyethylene (LDPE) films or sometime in Polypropylene films (PP) (Dennis, 2010). The most common one is the LDPE film package. If PP is used, usually these are laminated from inside. This is because, normally PP is not allowed to come in contact with food, as the polymer tends to undergo degradation in presence of heat and light when stored over a long period of more than 30 days, forming free radical of the tertiary carbon atoms which further combines with oxygen from air to form aldehydes and carboxylic acids. All these contribute to development of fine cracks and crevices, which will allow air to enter inside the package along with moisture and oxygen (Maier and Calafut, 1998).

In this investigation, banana chips were fried in refined sunflower oil and in palmolein to see which of the products had a better keeping quality. The peeled bananas were first pretreated by various means to avoid browning when kept in open but under dry condition. The objective of this investigation was to see how storage conditions would affect the sensory qualities of the fried chips over a period of time.

Material and Methods

Materials

Unripe Banana (variety - g9) of 90 days maturation, iodized salt, refined sunflower oil and palm oil, turmeric powder and Water. Analytical grade chemicals were used for the chemical analysis and were supplied by local suppliers. Raw material like unripe banana, refined sunflower oil, palm oil, salt, and turmeric powder were purchased from local market.

Methods

Unripe banana (variety g9) were washed and peeled which were then kept immersed in 2% salt solution for 5 minutes. The bananas were sliced in thin slices (0.5 cm thickness). These were then deep fried in refined sunflower oil and in palm oil separately. The chips were dabbed with tissue paper to remove excess oil. These were packed in low density polyethylene (LDPE) and polypropylene (PP) bags having average thickness of about 5 µm. These bags were stored at room temperature (25^{o}C to 28^{o}C) for further evaluation of chemical and sensory properties.

The raw and peeled banana and banana chips were analyzed for protein, moisture, fat, total ash, carbohydrates (Mogra and Choudhary, 2014) , crude fiber content (Yin and Feng, 2004). The qualities of chips after frying and in storage were analyzed for peroxide value and acid value of the residual oil (Mishra and Sharma, 2014). The unripe bananas were analyzed for enzyme (polyphenol oxidase) activity and browning intensity (Lee and Smith, 1979).The quantization was repeated 3 times.

Banana chips fried in palm oil and refined sunflower oil and packed in low density polyethylene and polypropylene bags and stored for 60 days, were subjected to sensory analysis. This sensory analysis carried out at regular intervals of 15 days, using 9 point hedonic scale.

Results obtained were the mean of three or more determinants. Analysis of variance was carried for all data at $p< 0.05$ using Graph Pad software (Graph Pad InStat version 3.00, Graph Pad Software, San Diego, CA, USA)

Results and Discussion

The most commonly cultivated type of banana is the g9 variety or Chiquita variety of Cavendish banana commonly found and used. Unlike other varieties the fruits are more or less straight. In this study such fruits are used which are matured for 90 days. The physical characteristics such as variety, weight, color, size, length, circumference of raw banana were observed and recorded in Table 1. This is done so to ensure that the experiments were conducted as reported earlier by Nelson *et al*. (2006).

The effect of pretreatment and frying on physico-chemical properties of chips were carried out. The pretreatments were observed on color after frying, texture after frying .The temperature used during frying was 180^{o}C for 1 to 3 min. and oils for frying used were refined sunflower oil and palm oil. It was observed that hot (80-90^{o}C) 2% salt solution treatment gave the maximum crispy texture to the chips. This is as seen from the figure 1, of texture analysis. It can be seen from this figure that these chips required a force of 0.01 Kg for 2 seconds to crumble.

The proximate analysis of freshly unpacked banana chips fried in palm oil and refined sunflower oil was carried out for moisture, protein, fat, ash, carbohydrate. The results are as shown in Table 2. The moisture content was slightly higher than reported (Ammawath and Rahman, 2001). The banana chips were prepared by frying in palm oil and refined sunflower oil, and packed in low density polyethylene and polypropylene bags. The chips samples were subjected to chemical analysis .The

Table 1. Physical and chemical characteristics of peeled raw banana

Sr. No.	Parameter	Description
1.	Color	Pale yellow
2.	Weight of single whole banana	120 g
3.	Weight of peeled banana	80 g
4.	Weight of peel and stalk	40 g
5.	Size of banana	
	a) Length of banana :	
	➢ Convex side	16.2 cm
	➢ Concave side	11.5 cm
	b) Diameter of banana	3.8 cm
	c) Circumference of banana :	
	➢ Top	9 cm
	➢ Middle	9.5 cm
6	Moisture	70.69 %
7.	Fat	0.48 %
8.	Protein	1.03 %
9.	Ash	2.5%
10.	Carbohydrate	22.1%
11.	Fiber	2.4%

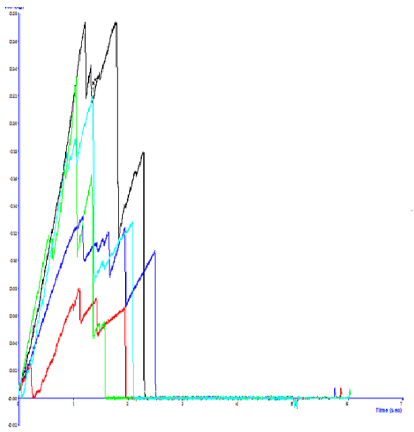

Figure 1. Graphical representation of Texture analysis of banana chips
Banana Pre- treated with (▪)Distilled water+ 2 % salt, (▪) Distilled water +2 % salt + Turmeric powder, (▪)Distilled water (80-90^{0}C) +2 %salt, (▪)Distilled water (80-90^{0}C) +2 %salt +Turmeric powder, (▪)Citric acid 0.3 %+ Distilled water

results obtained were presented in Table 2 and Table 3. The data shows that the peroxide value increases in the storage period for all samples. The chips fried in refined sunflower oil and packed in low density polyethylene bags shows lower values as compared to chips fried in palm oil and packed in low density polyethylene bags and chips fried in refined sunflower oil and packed in polypropylene bags shows lower values as compared to chips fried in palm oil and packed in polypropylene bags.

The free fatty acid content of banana chips were estimated at 15 days interval for 60 days and results obtained were presented in Table 4. The data shows

Table 2. Effect of frying medium and packaging material on peroxide value of chips

Number of days	Peroxide value (Milliequivalent oxygen /g of sample)			
	Sample A	Sample B	Sample C	Sample D
0	0.0012	0.0034	0.0008	00.001
15	0.0016	0.0038	0.0014	0.0016
30	0.0022	0.0048	0.0016	0.0028
45	0.0088	0.0108	0.0058	0.0066
60	0.0012	0.0015	0.0064	0.0088

Sample A Chips fried in Palm oil and packed in low density polyethylene,
Sample B Chips fried in palm oil and packed in polypropylene,
Sample C Chips fried in refined sunflower oil and packed in low density polyethylene,
Sample D Chips fried in refined sunflower oil and packed in polypropylene.

Table 3. Free fatty acid contents of banana chips stored in LDPE and PP bags.

Number of days	Free fatty acid content (%)			
	Sample A	Sample B	Sample C	Sample D
0	0.012	0.016	0.008	0.008
15	0.032	0.032	0.016	0.040
30	0.040	0.048	0.032	0.048
45	0.056	0.064	0.048	0.056
60	0.072	0.080	0.064	0.072

Sample A Chips fried in palm oil and packed in low density polyethylene (LDPE)
Sample B Chips fried in Palm oil and packed in polypropylene (PP)
Sample C Chips fried in refined sunflower oil and packed in low density polyethylene
Sample D Chips fried in refined sunflower oil and packed in Polypropylene

that contents increased with increase in storage period .The sample C i.e. chips fried in refined sunflower oil and packed in low density polyethylene bag shows lower values than other samples. These chips were fried in refined sunflower oil and packed in low density polyethylene bags as compared to those fried in palm oil (Sample A). Likewise chips fried in refined sunflower oil and packed in polypropylene bags (sample B) shows lower values as compared to chips fried in palm oil and packed in polypropylene bags (Sample D). It can be seen from this that Sample C is the better of the lots of other samples. These results are as per the observation of Mogra and Choudhary (2014).

The Banana chips fried in Palm oil and Refined sunflower oil and packed in low density polyethylene and polypropylene and stored for 60 days were subjected to sensory analysis. The results obtained were presented in Table 4. The following data shows that, samples packed in LDPE and PP bags did not affect on crispiness. Chips fried in refined sunflower

Table 4. Sensory evaluation of banana chips after storage for 60 days

Sample code	Storage days	Colour	Flavor	Texture	Mouth feel	Overall acceptability
A	0	7.1	7.3	7.3	7.0	7.3
	15	8.5	8.5	8.5	8.2	8.3
	30	7.6	7.5	7.3	7.1	7.5
B	0	6.9	6.5	6.4	6.6	6.7
	15	8.6	7.6	7.9	8.1	8.0
	30	7.3	7.5	7.2	7.3	7.6
C	0	7.5	6.7	7.6	7.3	7.4
	15	8.2	7.5	8.4	8.3	8.2
	30	7.7	7.9	8.5	8.5	8.6
D	0	7.9	7.5	7.7	7.7	8.3
	15	8.4	8.2	8.4	8.4	8.2
	30	6.8	7.1	7.5	7.5	7.4

Sample A Chips fried in Palm oil and packed in Low density Polyethylene,
Sample B Chips fried in Palm oil and packed in Polypropylene,
Sample C Chips fried in refined sunflower oil and packed in Low Density polyethylene,
Sample D Chips fried in refined sunflower oil and packed in Polypropylene

oil and packed in low density polyethylene shows higher scores for color, flavor, texture, taste etc.

Conclusion

The Banana chips are popular snack products consumed by all age groups. These are classified as fast moving consumer goods and hence shelf life is usually not a major concern. The average shelf life can be considered as 15 days maximum. However, due to non availability of good quality bananas sometime, the manufacturers prefer to buy the bananas in large quantities and the store the chips for a longer period of time like 45-60 days. Hence the effect of frying oils such as palm oil and refined sunflower oil shows minimum changes and packaging materials such as low density polyethylene and polypropylene on shelf life of banana chips was studied. During shelf life study physico-chemical (acid value and peroxide value) and sensorial parameters were carried out. The banana chips fried in palm oil have more flavor deterioration as compared to chips fried in refined sunflower oil. The banana chips packed in low density polyethylene have good texture as compared to chips packed in polypropylene.

The banana chips fried in palm oil and refined sunflower oil and packed in Low density polyethylene and polypropylene shows increase in acid value and peroxide value during 60 days of storage. Sensory analysis of banana chips fried in palm oil and packed in LDPE and PP bags respectively shows the development of rancid flavor and loss in crispiness after 30 days of storage but sensory analysis of banana chips fried in refined sunflower oil and packed in Low density polyethylene bags were liked very much till 45 days of storage period with retention of crispiness. Definitely the chips could not be stored for 60 days when prepared by the methods mentioned above.

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