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Processing and Quality Evaluation of Tortilla and Corn Chips

Rupinder Jeet Kaur
Deptt. of Food Science and Technology
Punjab Agricultural University
Ludhiana

Savita Sharma
Assistant Professor
Deptt. of Food Science and Technology
Punjab Agricultural University
Ludhiana

Gurkirat Kaur
Deptt. of Food Science and Technology
Punjab Agricultural University
Ludhiana

Abstract

The recipe and process of production of tortilla and corn chips were standardized using different maize varieties (Sheetal, Parbhat, Partap I and JH-4193). The process of nixtamalization was standardized using 1.5% alkali and 300% water for cooking (both on corn basis), stean cooking for 20 min., steeping for 20 hr at 30-40 ^{o}C, washing and grinding to obtain masa. Dry masa flour was prepared by drying coarse masa at 30-40 ^{o}C for 12-14 hrs to get moisture content of 9-10%. Different variables for production of quality tortilla and corn chips studied were suitability of maize variety, particle size of dry masa (50-100µ and >100 µ), sheeting thickness of chips (0.05, 0.1 and 0.2 cm), baking temperature and time for tortilla chips (200, 240 and 280 ^{o}C for 1, 2, 3 and 4 min.), frying temperature and time (180 ^{0}C for 1,2 and 3 min; 190 ^{o}C for 1, 1.5 and 2 min; 200 and 210 ^{o}C for 0.5, 1 and 1.5 min), different seasonings (salt, cumin, celry and mixed seasonings). Storage study was done in aluminium foil laminated and polyethylene packs (0, 1, 3, 5, 7, 9 and 11 weeks). Best combinations of all variables was chosen on the basis of organoleptic evaluation.

Keywords: Consumption, Extremely, Nixtamalization, Mexican

Introduction

Snack food consumption and demand is rapidly rising worldwide. The demand of the snack foods is increasing because of changing food habits, shortage of time and advent of new convenient foods in the market with numerous varieties. Snack foods are categorized into hot snacks and cold snacks (milk and dairy products; bakery products; bars; savory products and other products). The prospects for the worldwide development of savory snacks – the largest of the snack food sectors – are rated as extremely positive. These snacks include chips, sticks, extruded products, crackers, salt sticks, nuts and nut mixtures (Tettweiler, 1991). According to Snack Food Association, potato chips are still the leading salted snacks in nearly every region of US, but tortilla chips and corn chips are increasing in popularity. The primary products of the corn snack food market include tortilla chips, corn chips, some extruded products, corn flakes and popcorn, etc. Americans consumed 3.48 billion pounds worth of salty snacks including potato chips, tortilla chips, corn chips, extruded and fabricated chips and multigrain chips (Shukla, 1994).

Tortilla and corn chips are Mexican corn products, which involve the ancient Aztec process of nixtamalization (Gomez et al., 1987). Tortillas, tortilla chips and corn chips have gone from being an almost exclusively Spanish food to being a highly accepted food across America with increasing importance worldwide (Rooney and Suhendro, 1999). In Indian food industry, corn has a very wide scope of its utility. The over dependence of Indian farmers on paddy-wheat rotation had made them realize that the potential yield of these two crops cannot be increased beyond their present status. Other factors such as over exploitation of ground water and decline in soil fertility due to this repeated rotation has already rang the alarm bell. Resultantly, in present scenario a need for diversification is seriously felt. The best alternative of the diversion can be the coarse cereals of which maize has the best scope to offer. Being cheaper than rice and wheat, it not only serves as food for the poorer sections of the population, but also as animal feed. Its utility is nearly 100%, out of which nearly 90% is used directly as food. Maize as food is chiefly used in the form of *chapattis*, various forms of porridge, as green and roasted ears and as popcorns. It is milled to get various products such as pure starch, gluten, germ by wet milling and flaking grits, coarse grits, maize meal, flour, oil and hominy by dry milling (Singh and Izuno, 1982).

A variety of snacks can be prepared from maize e,g. tortillas, tortilla chips, corn chips made from alkali-treated corn dough, corn flakes,

corn muffins etc. these snack foods have become prime target of some consumer advocates and nutritionists who have referred them as sources of ' empty calories'. But reality is that these snacks provide instant energy, as they are rich store house of nutrients. Corn snacks are rarely available in India. Due to urbanization, the life style of Indian people is also changing. The consumers are looking for new recipes and products on grocery shelves. Keeping in view the composition of Indian maize varieties, tortilla chips and corn chips can be prepared from them.

Tortilla chips and corn chips are rich in B-vitamins and proteins. Calcium content of these products is also high because of alkali-treatment known as nixtamalization. This process includes cooking and soaking maize in water containing lime, which softens the pericarp, endosperm and gelatinizes the starch (Rooney and Suhendro, 1999). The alkali treatment also helps to break niacytin complex to release bound niacin to free form (Ranum, 1997). Tortilla and corn chips differ in process of production. Corn is cooked in alkaline water. The cooked, steeped corn called nixtamal is washed to remove loose pericarp and residual lime. The nixtamal is ground to masa, which is kneaded. For corn chips, after extrusion or sheeting and cutting of masa, immediate frying is done. For tortilla chips masa is sheeted and cut. Then baked or dried conditioned for sometime and the fried (Gomez et al., 1987).

Tortilla and corn chips can also be prepared from dry masa flour. This flour is obtained by grinding the masa and flash drying it. Then sieving, regrinding the coarse particles and sieving again. Then particles are reformulated into correct particle size distribution (Rooney and Suhendro, 1999). Increased cost, lack of flavor, poor textures in products prepared from dry masa flour are the major disadvantages (Gomez et al., 1987).

Aim of the Study

Tortilla chips and corn chips have a very bright prospectus in near future in India. This paper covers an attempt to develop tortilla and corn chips from Indian maize. The main objective of this study was to standardize the recipe for preparation of tortilla and corn chips and to assess the quality and acceptability of the product.

Material and Method

Raw Materials

Maize Grains:Four varieties of maize (Sheetal, Parbhat, Partap I, JH-4193) were obtained from the Department of Plant Breeding, PAU, Ludhiana. The grains were properly cleaned and stored in PET jars for subsequent use in the investigation.

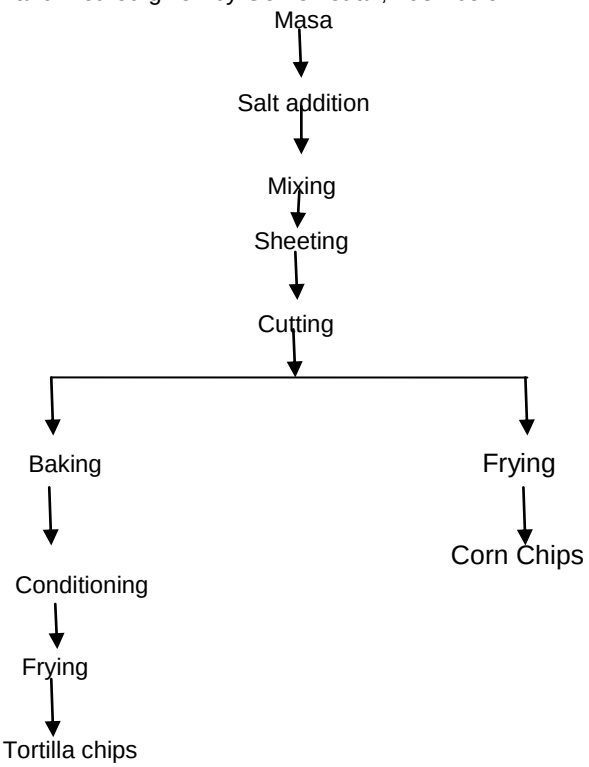
Lime: Calcium hydroxide of high purity was used for the alkali treatment.

Physico-Chemical Analysis: Ground maize samples were analyzed for moisture, crude protein, ash, crude fat, sugars and starch as per standard procedures (AACC, 2000).

Preparation of Masa: The method for the preparation of masa was standardized after conducting a number of trials. Variation of amount of alkali to be used (1, 1.5 and 2 per cent on grain basis), amount of water to be used for cooking (200, 250 and 300 per cent on grain basis), type of cooking (open pan boiling, closed pan boiling or cooking, pressure cooking), time of cooking (1.5, 2 and 2.5 hour for open pan boiling and 10,20 and 30 min for pressure cooking), soaking time (16,20 and 24 hour) variations were done. From these trials pressure cooked sample was chosen in terms of easy processing (pericarp removal), softness of grains and less gruel solid loss. The nixatamalized grains were then washed to remove pericarp and ground on stones to obtain masa.

Dry Masa Flour: The nixtamalised grains were coarsely ground and dried in the cabinet dryer at the temperature between 35-40^{o}C for 12-14 hours to obtain a moisture content of 9-10%. The material was then ground in Cemotac lab mill to get fine and coarse flour at setting number 1 and 2 respectively.

Tortilla and Corn Chips: Method of Preparation: To the masa prepared earlier, 2 per cent salt was added by weight and mixed thoroughly. The tortilla and corn chips were prepared as per the flowsheet and method given by Gomez et al., 1987 below



Standardization of Products Using Different Variables:

Suitability of Varieties: Four varieties were taken viz, Sheetal, Parbhat, Partap I and JH-4193. Product was prepared using standard method and best variety chosen on the basis of sensory score and used for subsequent study.

Sheeting Thickness: Masa was sheeted into three thicknesses – 0.05, 0.1 and 0.2 cm to study its effect on quality of tortilla and corn chips.

Baking Temperature and Time: Tortilla chips were baked at 200, 240 and 280 ^{0}C for 1, 2, 3 and 4 min. Best combination of these was worked out.

Frying Temperature and Time: Best frying temperature and time combination were concluded on the basis of sensory quality of product. The different combinations used were as follows:

Temperature (^{o}C)	Time (min.)
180	1, 2, 3
190	1, 1.5, 2
200	0.5, 1, 1.5
210	0.5, 1, 1.5

Different Seasonings: Salt @ 2%, cumin @1%, celery @1%, mixed seasonings (black pepper powder, coriander powder @ 0.5 % and salt @ 1% levels were added and acceptability was worked out.)

Storage Studies: Tortillas and corn chips were packed in aluminum foil laminated packs and polyethylene packs (HDPE,100 gauge) and storage study was done for 1, 3, 5, 7, 9 and 11 weeks.

Statistical Analysis: Data collected from the aforesaid experiments was subjected to statistical analysis with the help of factorial design (Gomez and Gomez, 2010).

Results and Discussion

Proximate Composition of Maize Grains

The proximate composition of maize grains of different varieties is given in Table 1. Variety JH-4193 had highest values of crude protein (12.80%) and starch (61.73%) followed by Sheetal and Parbhat. Partap-I variety had higher crude fat (3.69%), total sugars (5.17%) and reducing sugars (2.73%). Over all the protein content ranged from 11.74 -12.80% with lowest in Partap-I. Crude fat and ash varied from 2.33-3.69% and 0.44-0.84% respectively with lowest in Sheetal for both. Starch and total sugars were in the range of 54.10-61.73% and 4.07-5.17% respectively. According to Gopalan et al. (1992), the proximate composition (protein, fat, ash, starch and total carbohydrates) of Indian maize was 11.1, 3.6, 1.5 and 66.2 per cent respectively. The values obtained after the analysis of four varieties fall approximately in this range. The values for protein, fat and starch in Parbhat variety were 8.55, 3.88 and 56.65 per cent respectively.

Standardization of Nixtamalization Process

After conducting the various trials using different variables (as described in materials and methods), the method of nixtamalization was standardized as given in the flowsheet (Fig. 1)

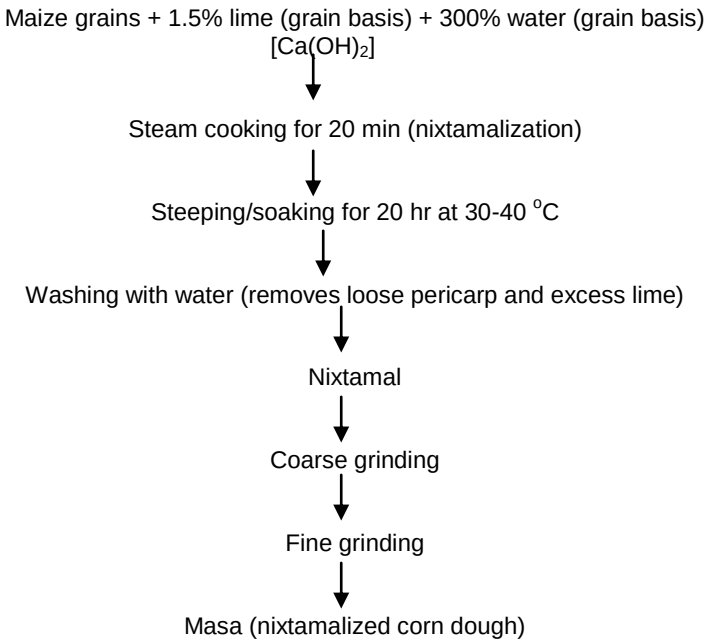


Fig 1: Preparation of Masa

Effect of Different Varieties of Maize on the Sensory Attributes

Data relating to the sensory parameters of tortilla and corn chips revealed that varieties did not affect the quality of tortilla chips (Table 2). But tortilla chips prepared from Sheetal variety had higher score for all sensory attributes followed by Parbhat. Similar pattern was observed for corn chips. From the appearance point of view, Sheetal and Parbhat had the highest scores (7.80) followed by JH-4193 (7.40). the color of products prepared from Sheetal was most acceptable (8.20) may be due to lighter color of this variety as compared to dark yellow of other three varieties. Basically, Indian maize is yellow to orange in color and is hard. So the products prepared from it had bright to dark yellow color and a relatively hard texture. Tortilla and corn chips made from 100% yellow corn often had unacceptable, burnt flavor profiles. To overcome this problem corn hybrids with hard endosperm and white cob, easily removable pericarp and low dry matter losses were preferred (Gomez et al., 1987). Sheetal had a lighter color as compared to other varieties and its pericarp removal was easy and it had no hard core after fine grinding

on stone. Because pericarp removal was an important aspect foe quality chips as it affected product color and texture (Serna-Saldivar et al., 1991), therefore, Sheetal variety, from which tortilla and corn chips were prepared and preferred followed by Parbhat.

Effect of Particle Size of Dry Masa Flour (DMF)

Data depicting the effect of particle size (fine and coarse) of DMF on tortilla and corn chips quality is given in table 2. Tortilla chips prepared from Parbhat had the highest scores for appearance of product (7.60) followed by Sheetal (7.40). But the overall acceptability was best for Sheetal (7.50). The fine particle size (50-100µ) of the DMF had better scores for all the sensory attributes as compared to the coarse DMF (>100 µ). Although fried corn snacks required a moderately coarse masa, as it provides interruptions in the masa texture, permitting air and water vapor to escape during frying and thus preventing formation of bubbles, breakage of chips and high oil uptake (Gomez et al., 1987). Highly coarse size should not be preferred because the particles do not disintegrate or bind properly and are dominantly visible in the final product. This was the reason for the low acceptability of the tortilla chips from coarse DMF. Similar was the case with corn chips prepared from fine and coarse particle size. Corn chips prepared from dry masa flour were best in appearance, color and taste from Prabhat followed by Sheetal. Inspite of this, it was very evident that the overall acceptability of Sheetal was highest (7.50) with equal rating of Prabhat and JH - 4193. Partap I was the most unsuitable variety to prepare DMF as it had lowest scores for almost all the sensory attributes for tortilla and corn chips.

Effect of Sheeting Thickness

Table 2 depicts the different thickness of sheet for tortilla and corn chips. Not much variation was observed with respect to the sensory score of chips. However, overall chips prepared from sheeting thickness 0.05 cm had better score for overall acceptability than 0.2 cm thick as inferred from values i.e. 8.20 and 6.20 respectively. From the sensory score of tortilla chips and corn chips of sheeting thickness 0.05, 0.1 and 0.2 cm; the thin sheeting 0.05 cm was considered best for tortilla and corn chips on the basis of overall acceptability. The thickness of chips should vary between 1-5 mm or 0.04-0.20 inch (Waniska, 1999) or it may be 0.10 inch for standard restaurant “table” tortilla chips and 0.03 inch for snack chips (Deis, 2000). So taking into account the overall acceptability, 0.05 cm thick sheeting is recommended as thicker chips become soggy after frying and absorbed more oil.

Effect of baking temperature and time

Table 3 represents the effect of baking temperature and time (200, 240, 280 ^{o} C for 1, 2, 3, 4 min.) for tortilla chips. Within the temperature of 200^{o}C, there was no significant difference between the various time parameters for all the quality aspects. Using temperature of 240^{o}C, the appearance of the chips baked for 1 and 2 minutes was best (8.20 both), but the color of 2 min. baked chips was better (8.60) followed by 1 min. baked chips. Similar was the case of scoring for overall acceptability, which depicted that 2 min. baked chips were best (8.05). Baking time of 4 min. at 240^{o}C tend to make the chips dry, thus deteriorating the texture on frying. In 280^{o}C range baking time of 3 and 4 min. were highly unacceptable in terms of all the quality aspects because chips got burnt at such a high temperature and had dark brown color. Taste was also unacceptable. So the overall acceptability decreased with increasing temperature and time of baking. At high temperature complete baking occurred. But, the tortilla chips should not to be baked completely and allowed to equilibrate for sometime (Gomez et al., 1987). Also tortillas baked for longer time yielded browned and large puffed areas (Waniska, 1999). Among the three temperatures and time ranges, the combination that gave best score in terms of appearance, color, texture, taste and overall acceptability was 240^{o}C for 2 min.

Effect of Frying Temperature and Time

The data illustrating the frying temperature and time for chips showed that there were no significant differences between the time ranges in a particular temperature as shown in table 4a. Tortilla chips fried for 1 and 2 min. at 180^{o}C were a bit soggy and had low scores for overall acceptability (7.60 each) and overall acceptability (7.55). Tortilla chips exposed to higher temperature (190^{o}C) in a non aqueous medium during frying resulted in a low moisture content of tortilla chips after frying (Gomez et al 1992). So in temperature range of 190^{o}C, the appearance and color of 1 min. fried chips was best (7.60). but the texture, taste (7.60 both) and overall acceptability (7.50) of 1,5 minute fried chips were rated highest (7.60 for all). At temperatures of 200^{o}C and above, the sensory score for all the parameters decreased significantly because due to baking of tortilla chips, the moisture content was already low and after frying chips got burnt and overall acceptability decreased . in case of corn chips, higher temperatures were required for frying to volatilize the extra water in the masa (Gomez et al., 1987). As evident from table 4b, the overall acceptability and other parameters for temperature 180^{o}C did not vary significantly. Using of temperature of 190 ^{o}C, frying time of 1 min. had good scores for color and texture (8.00). but frying time of 1.5 min had best scores for all the sensory attributes and its overall acceptability was the best (7.95). at higher temperatures, the same results were obtained as in case of tortilla chips i.e. the product gave burnt flavor and color.

Storage Quality

Data depicting the effect of packaging material and storage time on the quality of tortilla and corn chips is given in fig 2. The chips were packed in aluminum foil laminated and polyethylene packs. After 1 week the overall acceptability of chips packed in both the packaging materials was good. Upto 3 weeks of storage at average temperature of 28 – 35^{o}C, the overall acceptability of chips packed in both types of packaging material was similar (7.80 and 7.75). there was not variation in the sensory attributes of the tortilla chips even up to 5 weeks of storage with

average temperature of 28-35^{o}C. After 7 weeks of storage, the overall acceptability score of tortilla chips packed in both types of packaging material got affected. After 11 weeks of storage, the overall acceptability of chips packed in aluminum foil laminated pack (5.40) deteriorated. This may be attributed to the change in taste and texture of chips. But there was no significant change in chips packed in polyethylene bags (6.65).

Corn chips stored in polyethylene packs were better than those packed in aluminum foil laminated packs in terms of overall acceptability (8.40). Although the chips packed in aluminum foil laminated packs also had good acceptability (8.05) after 1 week, but the acceptability of polyethylene packed chips was better. This may be due to the reason that polyethylene has high gas transmission rate. So rancid flavor escapes from the pack. After 3 weeks with average temperature of 28-35 ^{o}C, the overall acceptability of chips packed in both types of packaging material did not change significantly. Same case was observed after 5 weeks (average temperature 28-35 ^{o}C) with little decrease in taste of both types of chips. Overall the product remained acceptable as inferred from overall acceptability score of the chips packed in aluminum foil laminated packs (6.85) and polyethylene packs (6.85). According to Almeida-Dominguez et al (1992), if the frying oil was added with antioxidant and chips were packed in high-density polyethylene (HDPE) bags, it resulted in higher shelf life. After 11 weeks of storage, the corn chips had lower acceptability scores (6.25 and 6.40) but they were in acceptable range. With increase in storage time and temperature, the acceptability of product was not affected.

Conclusion

The process of production of tortilla and corn chips was standardized using the best combination of all the variables. Sheetal was the best among all varieties. Products prepared with fine particle size (50-100µ) of dry masa flour were better in quality. The chips sheeted to 0.05 cm thickness, cut to small rectangular shapes, baked at 240^{o}C for 2 min (for tortilla chips), fried at 190^{o}C for 1.5 min and sprinkled with mixed seasonings scored highest for all sensory attributes and produced good quality chips. Tortilla chips and corn chips remained acceptable upto 11 weeks of storage in both of the packaging materials at room temperature (28-37^{o}C).

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Table 1

Proximate composition of maize varieties.

Characteristic	**Variety**			
	Sheetal	**Parbhat**	**Partap I**	**JH-4193**
Crude Protein (% N x 6.25)	12.65	12.55	11.74	12.80
Crude fat (%)	2.33	3.67	3.69	3.13
Ash (%)	0.44	0.67	0.84	0.78
Starch (%)	58.64	54.61	54.10	61.73
Total Sugars (% Glucose)	4.07	5.16	5.17	4.18
Reducing Sugars (% Glucose)	2.09	2.35	2.73	2.66
Non Reducing Sugars (% Glucose)	1.88	2.66	2.31	1.44
*Other Constituents (% approx.)	7.87	9.34	10.46	3.38

* Crude fiber, cellulose and hemicelluloses etc..

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Table 2
Effect of different varieties, particle size and sheeting thickness on the overall acceptability score of Tortilla and corn chips

	Products	
	Tortilla chips	**Corn chips**
Varieties		
Sheetal	7.80 [a]	7.80 [a]
Prabhat	7.45 [a]	6.90 [a]
Partap I	7.20 [a]	6.90 [a]
JH-4193	6.98 [a]	6.90 [a]
Prticle size (Best variety : Sheetal)		
Fine 50-100µ	7.50 [a]	7.50 [a]
Coarse (> 100 µ)	7.05 [a]	7.55 [a]
Sheeting thickness (cm)		
Thin (0.05)	7.95 [a]	8.00 [a]
Medium (0.1)	7.85 [a]	7.35 [a]
Thick (0.2)	7.00 [a]	6.50 [a]

The means having the same superscript do not differ significantly from each other (p>0.05)

Table 3
Effect of baking temperature and time on the sensory attributes of Tortilla chips.

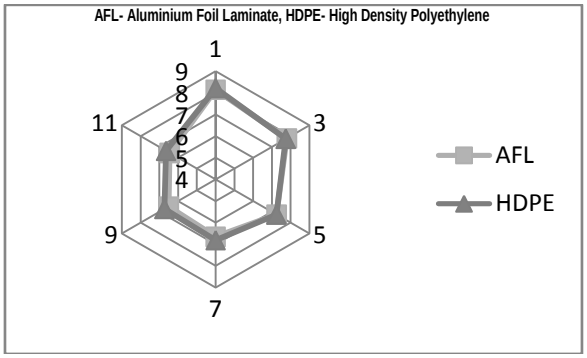
Temperature (^oC)	Time (min.)	Sensory Score (Out of 9)				
		Appearance	Color	Texture	Taste	Overall Acceptability
200	1	7.40 [a]	7.80 [a]	7.40 [a]	8.00 [a]	7.65 [a]
	2	4.60 [a]	7.80 [a]	7.80 [a]	7.80 [a]	7.75 [a]
	3	7.60 [a]	7.80 [a]	7.60 [a]	7.80 [a]	7.70 [a]
	4	7.40 [a]	7.60 [a]	7.40 [a]	7.80 [a]	7.55 [a]
240	1	8.20 [c]	8.40 [a]	7.80 [a]	7.80 [a]	8.05 [a]
	2	8.20 [c]	8.60 [a]	7.80 [a]	7.60 [a]	8.05 [a]
	3	7.80 [b]	8.20 [a]	7.20 [a]	7.60 [a]	7.70 [a]
	4	7.00 [a]	7.60 [b]	7.20 [a]	7.80 [a]	7.40 [a]
280	1	7.80 [c]	8.20 [d]	7.40 [a]	7.00 [a]	7.60 [c]
	2	8.00 [d]	8.00 [c]	7.40 [a]	7.20 [a]	7.65 [d]
	3	5.80 [b]	5.60 [b]	7.40 [a]	6.40 [a]	6.30 [b]
	4	5.40 [a]	5.20 [a]	7.20 [a]	5.60 [a]	5.85 [a]

The means having the same superscript do not differ significantly from each other (p>0.05)

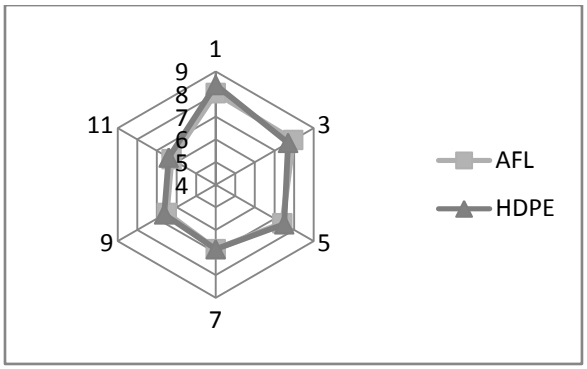
Table 4a
Effect of frying temperature and time on the sensory attributes of Tortilla chips.

Temperature (oC)	Time (min.)	Sensory Score (Out of 9)				
		Appearance	Color	Texture	Taste	Overall Acceptability
180	1	7.60 [a]	7.60 [a]	6.80 [a]	6.60 [a]	7.15 [a]
	2	7.60 [a]	7.60 [a]	7.40 [a]	7.00 [a]	7.40 [a]
	3	7.60 [a]	7.60 [a]	7.60 [a]	7.40 [a]	7.55 [a]
190	1	7.60 [a]	7.60 [a]	7.40 [a]	7.20 [a]	7.45 [a]
	1.5	7.40 [a]	7.40 [a]	7.60 [a]	7.60 [a]	7.50 [a]
	2	7.40 [a]	7.40 [a]	7.40 [a]	7.60 [a]	7.45 [a]
200	0.5	7.40 [b]	7.20 [a]	7.20 [a]	6.40 [a]	7.05 [c]
	1	6.20 [a]	6.20 [a]	7.20 [a]	5.40 [a]	6.25 [b]
	1.5	6.20 [a]	6.20 [a]	6.80 [a]	5.20 [a]	6.10 [a]
210	0.5	7.40 [c]	7.20 [c]	7.40 [a]	6.40 [a]	7.10 [c]
	1	5.40 [b]	5.40 [b]	6.40 [a]	5.20 [a]	5.60 [b]
	1.5	4.60 [a]	4.60 [a]	6.20 [a]	4.60 [a]	5.00 [a]

The means having the same superscript do not differ significantly from each other (p>0.05)



AFL- Aluminium Foil Laminate, HDPE- High Density Polyethylene
a) Tortilla Chips



AFL- Aluminium Foil Laminate, HDPE- High Density Polyethylene
b) Corn Chips

Fig 2: Effect of storage time on the sensory attributes of Tortilla and Corn chips