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Effect of Packaging and Storage Temperature on the Shelf Life of Crisps from four Kenyan Potato Cultivars

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ABSTRACT
Potato crisps are known to absorb high amounts of processing oil that may undergo oxidation and hydrolysis during storage, depending on packaging and storage temperature. These changes may, however, have profound effects and impact negatively on product acceptability. This study was therefore designed to determine changes in the levels of peroxides, free fatty acids and moisture as influenced by packaging and temperature during storage of crisps processed from four Kenyan potato cultivars. Potato tubers were processed into crisps of 1.5 mm thickness at a frying temperature of 170°C for 3.5 min. The crisps were packaged into aluminium foil pack and polyethylene bags commonly used by Kenyan industries and stored at 25, 30 and 35°C for a period of 24 weeks. The results showed that aluminium foil pack was the most effective in controlling increase in moisture content, peroxide values and free fatty acid levels. Potato cultivar significantly ($p \leq 0.05$) influenced the formation of peroxides. Crisps stored at 35°C had significantly ($p \leq 0.05$) shorter shelf life compared to those stored at 25 and 30°C. The flavor, aroma and acceptability scores of the crisps significantly ($p \leq 0.05$) decreased and varied with cultivar and storage temperature. Cultivar, packaging and storage temperature are important determinants of crisps shelf life and safety.

Key words: Fat oxidation, hydrolytic alterations, peroxides, moisture buildup, potato crisps

INTRODUCTION
Among the world's snack foods, potato crisps are currently consumed by millions of people of diverse cultural backgrounds in many countries (Knol *et al*., 2009; Lachman *et al*., 2009). Notably, worldwide consumption of potato products including crisps has been on the increase indicating the need to pay more interest on consumer behavior and innovations in the sector (Buono *et al*., 2009; Abong *et al*., 2011b). According to Shiroma and Rodriguez-Saona (2009), potato crisps are some of the most important products in the snack industry and are among the top choice for between-meal snacks for many people in the world and especially among the American adults and children. The consumption of crisps in Kenya, especially in major urban centers, has been on the increase in the past five years with the main consumers being children under 15 years of age (Abong *et al*., 2010a).

Deep fried foods such as crisps absorb high levels of oil that is not only important nutritionally but also has a great influence on the flavor, calories supplied and shelf life. Depending on product, therefore, potatoes absorb varied amounts of cooking oil, crisps having oil contents ranging from

25 to 45% (Abong *et al.*, 2011a; Kita *et al.*, 2007; Debnath *et al.*, 2009), while French fries have on the average 12% (Abong *et al.*, 2009b). However, crisps processing exposes frying oil to high temperatures (≥160°C) in the presence of oxygen and water from the food being fried. In such conditions, oils undergo thermal oxidation, polymerization and hydrolysis and the resulting decomposition products adversely affect the quality of frying oils and foods (Gertz *et al.*, 2000).

Packaging plays an important role of protecting food products from outside influences and damage. Packaging does not only ensure that food contains and maintains the amount and form of the required ingredient and nutrients but also improves sensory quality and color stability (Balev *et al.*, 2011). It has been demonstrated that food packaging can retard product deterioration, retain the beneficial effects of processing, extend shelf-life and maintain or increase the quality and safety of food (Marsh and Bugusu, 2007; Singh and Goyal, 2011). Consumer demand for food products with high quality is on the forward trend. In this front, packaging is critical in maintaining product quality while offering protection from microbial and chemical contamination, as well as from oxygen, water vapor and light (Silva *et al.*, 2004; Bibi *et al.*, 2008; Adetunji and Chen, 2011; Rajkumar *et al.*, 2007). The extent of food protection by packaging, however, is dependent on type of materials used which varies between countries. For instance, the major packaging material for potato crisps in Kenya has been polyethylene bags and only recently has aluminium foil packs been introduced (Abong *et al.*, 2010b).

Due to changes that are bound to occur, crisps quality attributes that require attention during storage include fat oxidation, flavor alteration, peroxide, free fatty acids and moisture buildup (Ogunsola and Omojola, 2008). Most of these factors are known to be affected by among other factors the variety of potato because of the differences in chemical composition (Abong *et al.*, 2009a). Different kinds of off-flavor volatile compounds have been shown to develop and their concentrations tend to increase during storage of potato crisps (Pangloli *et al.*, 2002). Storage conditions are of paramount importance since they strongly influence the final quality of the product (Laine *et al.*, 2006). The objective of this study was therefore to investigate the effect of packaging and temperature on moisture content, peroxide value and free fatty acids during storage of crisps made from four Kenyan potato cultivars.

MATERIALS AND METHODS

Processing of potato crisps: Potato tubers from four cultivars (Tigoni, Dutch Robjin 391691.96 and 393385.39) previously shown to be the most suitable for processing into crisps (Abong *et al.*, 2010c) were used for this study during the year 2010/11. These were peeled and sliced using an automatic electric slicer (Hitech Systems, Saudi Arabia) to a uniform thickness of 1.5 mm. The slices were washed in running tap water to remove surface starch, dried with cloth towel and fried in an institution size, batch type, deep oil fryer (E 6 ARO S.A., La Neuveville, Switzerland) containing about 7 liters of "Chef" corn oil (Premier Oil Mills Ltd., Nairobi, Kenya) at a temperature of 170°C for 3.5 min. The fried slices were removed and excess oil drained off for 1 min, cooled and packaged.

Storage of potato crisps: Approximately 150 g of crisps from each cultivar were packaged into polyethylene bags (gauge 150 microns) and aluminium foil packs. The packaged crisps were stored at 25, 30 and 35°C. As a measure of shelf life, the crisps were analyzed for moisture, peroxide value and free fatty acids immediately and thereafter at 4 week intervals during storage for 24 weeks. The flavor, aroma and acceptability were determined initially and at 12 week intervals during the same period.

Determination of moisture content: The moisture content of potato crisps was determined by the standard AOAC (1984) with three replications per analysis.

Determination of peroxide value: Peroxide value was determined according to standard AOAC (1984) with 2 replications per analysis.

Determination of free fatty acids: Free fatty acids were determined according to standard AOAC (1984) with 2 replications per analysis.

Sensory evaluation: Coded samples were presented to 20 panelists, all familiar with potato crisps. Panel members scored for flavor, aroma and overall acceptability on a 7-point hedonic rating scale varying from 1 (dislike very much) to 7 (like very much). A score of 4 was the lower limit of acceptability (Larmond, 1977).

Data analysis: All the experiments were arranged in a completely randomized block design with a factorial structure of main treatments of packaging and storage temperature. The sub-treatments were the two types of packaging material (transparent polyethylene and aluminium foil packs), three different storage temperatures (25, 30 and 35°C) and seven lengths of storage (from 0 to 24 weeks). The experiments were replicated twice. Analysis of variance (ANOVA) and Least Significant Difference (LSD) test for the variables was conducted using the Statistical Analysis System (SAS version 9). Differences at $p \leq 0.05$ were considered significant.

RESULTS AND DISCUSSION

Moisture content: The average moisture content of potato crisps stored in polyethylene bags and aluminium foil packs at three different temperatures is shown in Fig. 1 and 2, respectively. The analysis of variance is given in Table 1. Aluminium foil pack was the found to be the most effective in controlling the moisture content of potato crisps compared to polyethylene bag which allowed the highest moisture buildup in the stored crisps. The products stored at 35°C had significantly ($p \leq 0.05$) higher increase in moisture content compared to those stored at 25 and 30°C. The difference in relative humidity was high and would be responsible for the high overall moisture content of crisps. The results were in agreement with those reported on storage changes by Vanhanen and Savage (2006).

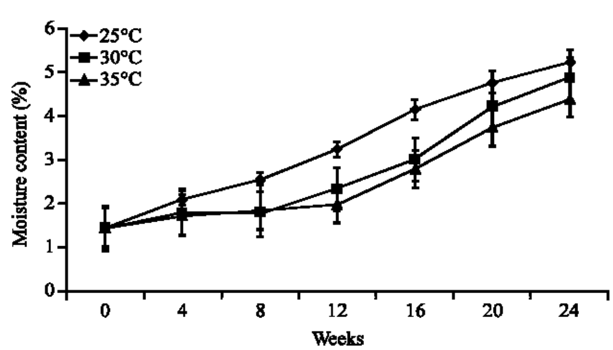

Fig. 1: Moisture content of crisps stored in polyethylene bags at three different temperatures. The bars indicate standard errors

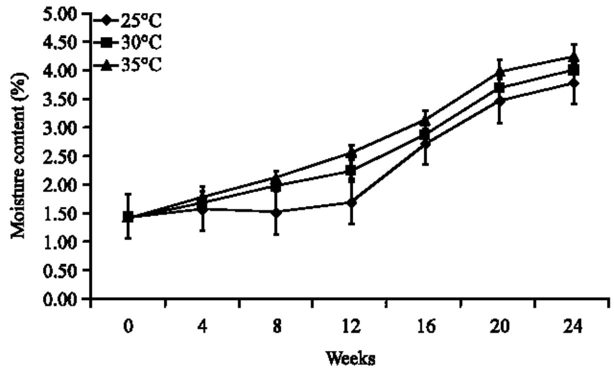

Fig. 2: Moisture content of crisps stored in aluminium foil pack at three different temperatures. The bars indicate standard errors

Table 1: Analysis of variance for moisture content, peroxide value, free fatty acid, flavor, aroma and acceptability in crisps made from four potato cultivars stored in two package materials at three temperatures

Source	Df	Moisture content	Peroxide value	Free fatty acids	Flavor	Aroma	Acceptability
Cultivar (C)	3	***	***	**	***	***	***
Temperature (T)	2	***	***	***	***	***	***
Package (P)	1	***	*	***	***	***	***
Storage time (ST)	6	***	***	***	***	***	***
C×T	6	NS	NS	NS	NS	NS	NS
C×P	3	NS	NS	NS	NS	NS	NS
C×ST	18	NS	**	NS	NS	NS	NS
T×P	2	**	***	**	NS	NS	NS
ST×P	6	**	NS	NS	**	*	***
C×T×P×ST	155	***	***	***	NS	NS	NS

Df: Degrees of freedom. Levels of significance: *$p\leq 0.05$; **$p\leq 0.01$; ***$p\leq 0.001$; NS: Not significant, $p>0.05$

Deep-fat frying of potato crisps is a drying process in which rapid moisture loss occurs and crisps acquire minimal moisture content (Esturk *et al*., 2000). The moisture content of food depends among other factors on packaging and storage conditions. Moisture content is an important shelf-life determinant; the higher the level of moisture the higher the rate of microbial spoilage of food products and the faster the breakdown of oils in stored products. The effectiveness of storage conditions has been assessed in some instances by measuring the moisture content (Alam *et al*., 2001). Crisps, being food products that can be stored for up to 6 months, require that moisture levels be kept as low as possible. According to East African Food Standards, potato crisps must have maximum moisture level of 4.7% (EAS, 2010). In the current study, aluminium foil pack maintained moisture levels below the maximum limit in all the storage conditions even after 24 weeks of storage. Polyethylene bags on the other hand, maintained the required moisture for only up to 16th week of storage at 35°C. At 30°C the moisture limit was maintained up to 20 weeks, while at 25°C the levels were acceptable for the whole storage period. Just like other snacks, potato crisps require protection against moisture which usually ranges between 1-3% when well packaged, but if these levels increase to 4-5%, the product may become unacceptable. In this study, potato crisps stored in opaque aluminium packs minimized the increase in moisture as opposed to transparent polyethylene bags.

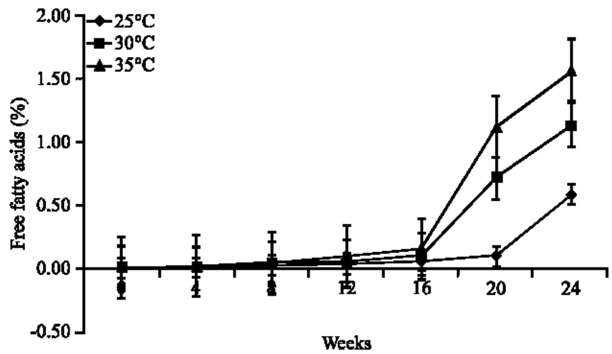

Fig. 3: Variation of free fatty acid levels in crisps stored in polyethylene bags at three different temperatures. The bars indicate standard errors

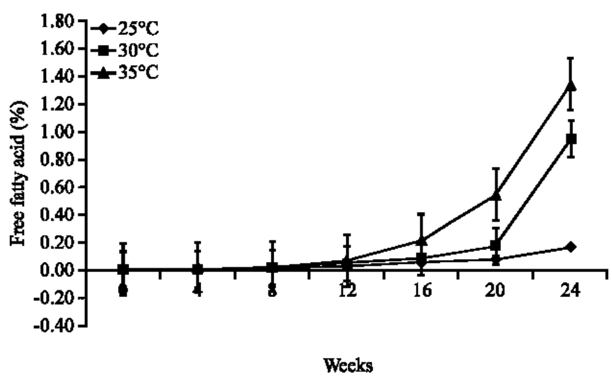

Fig. 4: Variation of free fatty acid levels in crisps stored in polyethylene bags at three different temperatures. The bars indicate standard errors

Free fatty acids: Packaging and storage temperature significantly ($p \leq 0.05$) affected the levels of free fatty acids in potato crisps, depending on duration of storage (Fig. 3, 4). The highest increase was observed in crisps packaged in polyethylene bags. There was, however, no significant ($p > 0.05$) varietal difference in the levels of free fatty acid. After 24 weeks of storage free fatty acids had accumulated to 1.56% in polyethylene bags compared to 1.34% in aluminium foil pack when the products were stored at 35°C.

The crisps stored at 35°C had significantly ($p \leq 0.05$) higher increase in free fatty acids compared to those stored at 25 and 30°C. Notably, in both packages, there was no significant ($p \leq 0.05$) increase in free fatty acid levels until 16 weeks of storage. These results are in agreement with Njobeh *et al.* (2006), who worked on storage of diets with different compositions.

Free fatty acids are known to result from fat or oil breakdown due to either enzyme activity and oxidation or use of high frying temperatures. The accumulation of free fatty acids is normally accelerated by storage at high temperatures and in the presence of light or water. Therefore, total fatty acid change has been found to be a useful tool for determining optimum frying and storage studies (Ullah *et al.*, 2003). In the present study, there was higher accumulation of fatty acids in the transparent polyethylene bags which not only allow more light in the product but also moisture buildup when compared to opaque aluminium foil packs.

Peroxide value: Table 2 shows variation of peroxide value with packaging and storage temperature in four potato cultivars. There was a significant ($p \leq 0.05$) increase in the levels of peroxides in crisps from all the cultivars irrespective of storage temperature. The levels ranged between 0.0 and 0.38 mEq kg^{-1} in crisps with the lowest accumulation, while the highest levels ranged between 0.0 and 7.4 mEq kg^{-1}. Notably, potato cultivar significantly ($p \leq 0.05$) influenced the formation of peroxides. Crisps from cv. 391691.96 had the lowest peroxide values compared to the three other cultivars. Generally, aluminium foil pack was the most effective in controlling the formation of peroxides in potato crisps compared to polyethylene bags. The products stored at 35°C had significantly ($p \leq 0.05$) higher increase in peroxides compared to those stored at 25 and 30°C after 24 weeks of storage. There was no significant ($p > 0.05$) increase in peroxide values until 12 weeks of storage. The peroxides then accumulated steadily reaching the highest level of 7.4% in crisps stored at 35°C.

Deep-oil frying is one of the most popular methods of preparation of food due to the fact that it is easy to use, fast and relatively cheap and results in palatable foods preferred by many consumers. The oil does not only function as a medium for heat transfer from the heating source to the food, but also serves as enhancer of flavor, responsible for the typical smell and taste of the fried products (Matthaus, 2007). However, due to high temperatures used in frying (170°C) undesirable off-flavors occur if deteriorated oil is used or if the oil is used over a long period of

Table 2: Variation of peroxide value (mEq kg^{-1} dwb) with packaging and storage temperature in four potato cultivars

			Storage period (weeks)						
Cultivar	PKG[1]	ST[2]	0	4	8	12	16	20	24
391691.96	AF[3]	25	0.00±0.00	0.00±0.00	0.00±0.00	0.12±0.01	0.14±0.01	0.19±0.00	0.38±0.03
		30	0.00±0.00	0.00±0.00	0.01±0.00	0.17±0.03	0.59±0.08	0.75±0.11	1.11±0.05
		35	0.00±0.00	0.00±0.00	0.01±0.00	0.28±0.01	0.80±0.05	1.01±0.07	1.47±0.17
	PE[4]	25	0.00±0.00	0.00±0.00	0.02±0.02	0.17±0.05	0.26±0.13	0.39±0.17	0.78±0.24
		30	0.00±0.00	0.00±0.00	0.03±0.01	0.22±0.01	0.66±0.01	1.09±0.01	1.86±0.02
		35	0.00±0.00	0.00±0.00	0.02±0.01	0.42±0.00	0.98±0.03	1.49±0.05	2.27±0.03
393385.39	AF[3]	25	0.00±0.00	0.00±0.00	0.05±0.01	0.92±0.06	1.61±0.04	1.64±0.06	1.93±0.10
		30	0.00±0.00	0.00±0.00	0.07±0.00	1.16±0.03	1.55±0.09	2.04±0.13	2.41±0.05
		35	0.00±0.00	0.00± 0.00	0.08±0.00	1.53±0.07	2.01±0.07	2.51±0.11	3.03±0.19
	PE[4]	25	0.00±0.00	0.00±0.00	0.05±0.01	1.25±0.08	2.17±0.29	4.53±0.38	5.26±0.58
		30	0.00±0.00	0.00±0.00	0.09±0.00	1.34±0.03	2.54±0.07	3.72±0.09	5.59±0.14
		35	0.00±0.00	0.00±0.00	0.10±0.00	1.44±0.00	2.84±0.04	4.09±0.07	6.45±0.06
Dutch Robjin	AF[3]	25	0.00±0.00	0.00±0.00	0.07±0.00	0.83±0.02	1.63±0.06	2.57±0.08	2.98±0.12
		30	0.00±0.00	0.00±0.00	0.06±0.00	1.57±0.20	2.55±0.05	2.87±0.06	3.45±0.17
		35	0.00±0.00	0.00±0.00	0.09±0.00	1.83±0.00	2.93±0.03	3.52±0.05	4.97±0.09
	PE[4]	25	0.00±0.00	0.00±0.00	0.08±0.00	1.54±0.02	3.03±0.05	3.89±0.06	5.59±0.10
		30	0.00±0.00	0.00±0.00	0.09±0.01	1.49±0.02	2.90±0.07	3.70±0.08	5.50±0.15
		35	0.00±0.00	0.00± 0.00	0.10±0.00	1.55±0.02	3.36±0.03	4.76±0.06	6.57±0.01
Tigoni	AF[3]	25	0.00±0.00	0.00±0.00	0.07±0.00	0.43±0.00	1.76±0.00	2.33±0.00	2.65±0.00
		30	0.00±0.00	0.00±0.00	0.12±0.48	1.92±0.00	2.02±0.42	2.42±0.39	2.99±0.16
		35	0.00±0.00	0.00±0.00	0.08±0.00	1.63±0.00	2.44±0.05	2.74±0.06	3.62±0.36
	PE[4]	25	0.00±0.00	0.00±0.00	0.6±0.59	1.91±0.66	2.74±0.81	4.15±0.88	5.97±1.03
		30	0.00±0.00	0.00±0.00	0.10±0.00	1.53±0.02	2.40±0.08	4.34±0.11	6.72±0.16
		35	0.00±0.00	0.00±0.00	0.11±0.00	1.64±0.01	2.71±0.07	4.95±0.10	7.44±0.08

Values are Mean±SD. PKG[1]: Packaging type, ST[2]: Storage temperature (°C), AF[3]: Aluminium foil pack, PE[4]: Polyethylene bag time. Among the reactions that occur during frying and storage are oxidation and hydrolysis (Jia *et al.*, 2010). The stability of the product will depend on its nature, type of oil used and storage duration (Aminlari *et al.*, 2005; Chiou *et al.*, 2009). In the present study, a relatively stable corn oil was used in preparation of crisps from each of the four cultivars in equal proportion and conditions.

Potato cultivars differ in both physical and chemical constituents. Extracts from some potato cultivars have been shown to contain anti-oxidant properties (Singh and Rajini, 2004). Mohdaly *et al.* (2010) demonstrated potato peels were potent sources of natural antioxidants that might be explored to prevent oxidation of vegetable oils. In the present study, cultivar 391691.96 had the least increase in peroxide value indicating that it could have constituents with antioxidant properties which require further research. Crisps from this cultivar would store for much longer period.

Snacks such as crisps with oil content higher than 30% not only require protection against moisture but also light and oxygen to prevent oil oxidation during storage (Lennersten and Lingnert, 1998). Air is considered to be a pro-oxidant agent and proper packaging is necessary for longer shelf life of the products. In this study, potato crisps stored in opaque aluminum packs minimized the influence of moisture, light and air in comparison to transparent polyethylene bags. Alternative and innovative packaging method with oxygen absorbents which decreases the residual oxygen concentration and modified atmosphere packaging, have been used in some circumstances even though these pose many challenges including high costs (Del-Nobile, 2001). Use of aluminium foil pack provides an easy way of packaging while ensuring safety of products in storage.

Sensory characteristics: Crisps flavor scores significantly ($p \leq 0.05$) reduced from the highest initial value of 6.0 to the lowest value of 3.3 after 24 weeks of storage. Aroma and overall acceptability scores followed the same trend decreasing from 6.0 to 3.2 and 6.5 to 3.7, respectively. All the sensory scores significantly ($p \leq 0.05$) varied with cultivar and storage temperature during the storage period (Table 3). Scores in all the attributes for crisps made from Cv. 391691.96 were, however, acceptable even after 24 weeks of storage at all the trial storage temperatures. Flavor and aroma perception significantly ($p \leq 0.05$) reduced with storage period reaching unacceptable levels (<4.0) after 24 weeks of storage, especially for crisps in polyethylene bags under higher temperatures. Higher reductions on scores were noted in crisps stored at 35°C compared to 25°C. Significant ($p \leq 0.05$) negative correlations were noted between sensory attributes and the peroxide and free fatty acid levels (Table 4). Highest correlations were observed between peroxide values and flavor ($r = -0.76$) and aroma ($r = -0.66$), while moderate values were observed when free fatty acid values were correlated to flavor ($r = -0.53$) and aroma ($r = -0.53$).

Storage of crisps at higher temperatures increased the levels of peroxides, indicating the significant role of heat in oil hydrolysis and oxidation. It therefore follows that similar products in hot areas will develop rancidity faster compared to those in cold areas. The development of rancidity in deep-fried foods during storage is known to be a critical factor that limits the shelf-life of the stored products (Asap and Augustin, 1986). The onset of rancidity is usually a consequence of oxidative reactions of the lipids present in the food and can be minimized by proper choice of packaging and storage conditions. The decrease in scores of sensory attributes indicates that consumers are able to detect changes that occur in stored crisps. Proper packaging and storage of

Table 3: Variation in sensory attributes with packaging and storage temperature in four potato cultivars

			Storage period (weeks)								
			0			12			24		
Cultivar	PG[1]	ST[2]	Flavor	Aroma	Accep	Flavor	Aroma	Accep	Flavor	Aroma	Accep
391691.96	AF[3]	25	6.0±0.0	6.0±0.0	6.5±0.7	5.5±0.0	5.5±0.7	5.8±0.5	5.2±0.5	4.7±0.3	4.8±0.5
		30	6.0±0.0	6.0±0.1	6.5±0.5	5.8±0.21	5.2±0.4	5.5±0.6	4.7±0.5	4.7±0.1	4.7±0.3
		35	6.0±0.0	6.0±0.0	6.5±0.3	5.5±0.6	4.7±0.3	5.0±0.2	4.7±0.4	4.5±0.1	4.5±0.5
	PE[4]	25	6.0±0.0	6.0±0.0	6.5±0.2	5.2±0.7	5.8±0.4	5.3±0.4	4.6±0.1	5.0±0.1	4.5±0.4
		30	6.0±0.0	6.0±0.0	6.5±0.7	5.8±0.2	5.3±0.2	5.2±1.1	4.5±0.6	4.4±0.4	4.0±0.0
		35	6.0±0.2	6.0±0.0	6.5±0.8	5.3±0.5	4.9±0.1	5.2±0.9	4.5±0.5	4.3±0.4	4.1±0.1
393385.39	AF[3]	25	6.0±0.0	5.5±0.5	6.0±0.0	5.0±0.0	4.9±0.1	5.0±0.0	5.0±0.0	4.8±0.4	4.8±0.3
		30	6.0±0.0	5.5±0.3	6.0±0.0	5.7±0.3	4.8±0.6	5.4±0.8	4.5±0.9	4.2±0.2	4.2±0.4
		35	6.0±0.0	5.5±0.3	6.0±0.0	4.5±0.0	4.4±0.2	5.3±0.3	4.2±0.3	4.3±0.2	4.0±0.0
	PE[4]	25	6.0±0.0	5.5±0.4	6.0±0.0	4.5±0.7	4.4±0.5	5.0±0.0	3.7±0.3	4.0±0.1	4.2±0.2
		30	6.0±0.0	5.5±0.6	6.0±0.0	4.7±1.6	4.3±0.2	4.9±0.1	3.7±0.4	3.3±0.2	3.9±0.1
		35	6.0±0.0	5.5±0.3	6.0±0.0	4.2±0.3	4.1±0.2	5.0±0.0	3.6±0.1	3.2±0.2	3.7±0.3
Dutch Robjin	AF[3]	25	5.5±0.6	5.5±0.3	6.0±0.0	5.0±0.0	5.2±0.5	5.7±0.3	4.5±0.4	4.2±0.3	5.1±0.6
		30	5.5±0.8	5.5±0.7	6.0±0.0	5.3±0.4	4.6±0.1	5.5±0.1	4.5±0.4	4.0±0.0	4.3±0.0
		35	5.5±0.3	5.5±0.6	6.0±0.0	4.7±0.4	4.4±0.1	5.0±0.0	3.9±0.2	4.1±0.1	4.1±0.2
	PE[4]	25	5.5±0.2	5.5±0.6	6.0±0.1	4.8±0.2	5.0±0.0	5.3±0.3	3.8±0.2	4.0±0.1	4.3±0.4
		30	5.5±0.7	5.5±0.7	6.0±0.0	5.1±0.6	4.4±0.4	5.0±0.0	3.8±0.3	3.4±0.6	3.9±0.1
		35	5.5±0.6	5.5±0.5	6.0±0.2	4.5±0.2	4.2±0.2	4.8±0.3	3.3±0.3	3.5±0.2	3.8±0.5
Tigoni	AF[3]	25	6.0±0.0	6.0±0.0	6.3±0.2	5.9±0.2	5.4±0.5	5.7±0.3	4.2±0.3	4.2±0.3	4.9±0.1
		30	6.0±0.3	6.0±0.0	6.2±0.3	5.5±0.7	4.8±0.2	5.2±0.4	4.5±0.6	3.8±0.2	3.8±0.2
		35	6.0±0.2	6.0±0.0	6.2±0.3	4.7±0.4	4.5±0.3	5.2±0.2	4.1±0.1	4.2±0.5	4.0±0.0
	PE[4]	25	6.0±0.0	6.0±0.0	6.2±0.3	5.3±0.5	5.3±0.5	5.2±0.3	5.3±0.4	5.3±0.5	5.3±0.4
		30	6.0±0.7	6.0±0.2	6.3±0.2	4.5±0.8	4.3±0.4	5.3±0.4	3.5±0.8	3.8±0.4	4.0±0.0
		35	6.0±0.0	6.0±0.0	6.3±0.5	4.5±0.7	4.2±0.2	5.0±0.6	3.5±0.7	3.5±0.4	3.9±0.1

Values are Mean±SD. PKG[1]: Packaging type, ST [2]: Storage temperature (°C), AF :[3] Aluminium foil pack, PE :[4]Polyethylene bag, Accep: acceptability

Table 4: Pearson correlation coefficient (r) between peroxide value, free fatty acids and sensory attributes for crisps made from four potato cultivars

	Sensory attributes		
Parameters	Flavor	Aroma	Acceptability
Peroxide value	-0.76***	-0.66**	-0.43*
Free fatty acids	-0.53**	-0.52*	-0.78***

Levels of significance: *p≤0.05, **p≤0.01, ***p≤0.001, NS: Not significant, p>0.05, NA: Not applicable

crisps in appropriate conditions is therefore an important necessity if acceptability of products in the market is to be maintained. Aluminium foil packs in comparison to polyethylene bags were shown to maintain crisps acceptability for longer storage duration.

CONCLUSION

Depending on the cultivar, shelf life of potato crisps is influenced by packaging and storage temperature. Compared to the popular polyethylene bags, aluminium foil packs extended shelf life of crisps. Storage of crisps at lower temperatures is desirable to maintain product acceptability. It is therefore advisable, that for longer storage duration (> 5 months) processors should consider the use of aluminium foil packs and prevailing weather conditions in the product destination.

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