Minufiya J. Agric. Res. Vol.37 No. 2: 325-336 (2012) "http://www.mujar.net"

EFFECT OF STORAGE ON THE OIL CHARACTERISTICS OF SOME SNACK FOODS

A. E. El-Beltagy[1], A. Bakr[2], Ragaa A. Gawish[3] and Doaa Z. El-Basuony[1]

[1] Food Science and Technology Department, Faculty of Agriculture, Minufiya University, Shibin El-Kom, Egypt.

[2] Dean of Cairo Higher Institute for Tourism and Hotels, El-Mokattum, Cairo .

[3] Horticulture Department, Faculty of Agriculture, Minufiya University, Shibin El-Kom, Egypt.

(Received: Jan. 1, 2012)

ABSTRACT: *This study was conducted to evaluate the safety and quality of different types of marketable snack products, potato chips with different flavors (chicken, kebab, chili, and cheese) as well as extruded corn snacks with different flavors (ketchup, cheese, and chili), produced by three different companies. Chemical characteristics of oil (the values of acid, peroxide and thiobarbituric acid) were carried out at the beginning of experiments and during storage at ambient temperature 25 ± 2°C for different periods (6 months for potato chips and 3 months for corn snacks). Corn snacks with ketchup flavor from company 3 had the highest (p≤0.05) acid, peroxide and TBA values (0.42 mg KOH/100 gm oil, 0.45 meq O_2 /kg oil and 0.55 mg malonaldehyde / kg sample, respectively), while the highest (p≤0.05) values of peroxide and TBA were noticed in potato chips with cheese flavor (0.79 meq O_2/kg oil and 0.41 mg malonaldehyde / kg sample). Acid, peroxide and TBA values were increased significantly (p≤0.05) by increasing storage periods in all snack samples, the highest value were observed by the end of storage (3 and 6 months). Acid value of the stored potato chips ranged from 0.86 to 5.21 mg KOH/100 gm oil, while peroxide value was ranged from 4.47 to 27.75 meq O_2/kg oil, whereas TBA value was ranged from 0.47 to 1.39 mg malonaldehyde / kg sample. Highest (p≤0.05) acid and TBA values were noticed in corn snacks with ketchup flavor (3.16 mg KOH/100 gm oil and 1.27 mg malonaldehyde / kg sample),while highest value of peroxide value were noticed in corn snacks with chili flavor (18.94 meq O_2/kg oil). Although the importance of oil characteristics of snack foods on human health, there is no allowed limits found in the Egyptian standard specifications (ESS) of corn snacks (1525/2005) or ESS of potato chips (1629/2005).*

Meanwhile, the results of this work indicated that acid and peroxide values in all samples were up to the limits recommended in the Egyptian standard specifications of oil (ESS 2142/2005) by the end of storage period. Meanwhile, TBA value not mentioned in neither ESS of snacks nor ESS of oils so that we can not decide about it.

Key words: *potatoes chips, corn snacks, acid value, peroxide value, storage period,* TBA.

INTRODUCTION

Extruded foods such as snacks have become part of the dietary habits of a great part of population. They can be prepared with ingredients or components that give them specific functional properties (Huang, R. C. 2006). Consumer acceptance of extruded foods is mainly due to the convenience, value, attractive appearance and texture found to be particular for these foods, especially when it concerns snack products (Harper, 1981; Anton & Luciano, 2007). Snack foods are widely consumed by children and adolescents. (Hamilton *et al.*, 1993). The snack food industry is facing increasing scrutiny from the media and consumer groups for their perceived contribution to the health deterioration. (Peters, 2001). Substantial efforts have been made to reduce the snaking habit of the population. However, snack foods consumption continues to increase (Stauffer, 1993).

It is well to know that ready to eat food is count one of the food could be subjected to deterioration due to hydrolysis, oxidation

and carmelization of its content from lipid, protein and sugars by enzymatic reactions. Shelf life of potato chips is dependent not only on the fat or oil used in the raw stock, frying equipment, fat turnover in the kettle, packaging, exclusion of light, adequacy of filtering the oil and other aspects of handling the fat or the chips (Smith, 1987).

The extent of deterioration of potato chips was correlated with the oxidation indexes of frying oil. Peroxide value and conjugated dienes increased linearly with storage time. The rates of increase were higher for higher temperature and longer process time, and correlated linearly with the oxidation indexes of the frying oil at the moment that chips were removed (Houhoula and Oreopoulou 2004).

Capriles *et al.*, (2009) mentioned that the partially hydrogenated vegetable oil has been used in snack flavoring for its ability to entrap hydrophobic aroma compounds. However, increasing concerns about the risks of saturated and *trans* fatty acids (TFA) consumption led to development of alternative agents for this use.

The Egyptian standard specifications (ESS) include no allowed limits or guidelines for some of these foods especially that concern the chemical characteristics of snack foods oil, which are considered very critical attributes for the human health. Therefore, most Egyptian companies probably use their own standards in manufacturing of these products.

This study aimed to evaluate the chemical characteristics (acid, peroxide and TBA values) of oil extracted from freshly prepared as well as stored snack foods (corn snacks and potato chips) produced by different companies.

MATERIALS AND METHODS

1. Materials:

1.1. Source of snack foods:

Different types of potato chips were selected from the product store of Chipsy Company with four flavors (chicken, kebab, chill & lemon and cheese), Cairo Egypt.

Different types of extruded corn snack foods were obtained from the product store of three companies, Chipsy (com 1), Egypt Foods Companies (com 2) and Sinuoreta (com 3) with three flavors (ketchup, cheese and chili). Cairo Egypt.

1.2. Chemicals and reagents:

Methanol, ethanol, acetone, chloroform, hexane, di-ethyl ether, glacial acetic acid, potassium iodide, potassium hydroxide, sodium hydroxide, Sodium thiosulphate, phenolphthalein and methyl orange, were obtained from El-Nasr Pharmaceutical Company, Cairo Egypt.

2. Methods:

2.1. Storage:

All snack samples were brought to laboratory, and analyzed immediately for oil properties (acid, peroxide and TBA values) at the beginning of the experiments and reported as freshly prepared (zero time), rest samples were stored packaged at room temperature (25 ± 2°C) for the end of shelf life (90 days for extruded corn snacks and 6 months for potato chips), and the samples were analyzed in time intervals at 15,30,45,60,75 and 90 days for extruded corn snacks and 1,2,3, 4,5 and 6 months for potato chips.

2.2. Analytical methods:

2.2.1. Extraction of oil:

A 50-g of sample was homogenized in a mincer and 100 ml of chloroform-methanol (2:1, v/v) was added. The extraction was performed by magnetic stirring of the mixture for 30 min, then solid residue was separated by paper filtering whatman No I, and re-extracted for 30 min with the same volume of the solvent mixture. The residue was separated again by filtering and then 50 ml of the solvent was added to rinse it. The three extracted fractions were collected in a separator funnel and 35 ml of a saturated sodium chloride solution was added to help the separation of the chloroform phase. This phase was filtered through anhydrous sodium sulphate and recovered in a 250-ml round-bottomed flask while solvent was

evaporated by a vacuum rotatory evaporator at 40° C. (Rafecas *et al.*, 1998).

2.2.2. Acid value (AV):

Acid value was determined according to (A.O.A.C. 2003). Three gm of oil were dissolved in 25 ml ethanol; the mixture was titrated by 0.1 N alcoholic potassium hydroxide using phenolphethalein as indicator and was calculated as follows:

$$AV = \frac{56.1 \times N \times (V1 - V2)}{W}$$

Where:
N = Normality of KOH.
W = Weight of oil in gm.
V1 = Volume (ml) of KOH used for Sample of oil.
V2 = Volume (ml) of KOH used for blank.
56.1= Molecular weight of KOH.

2.2.3. Peroxide value (PV):

Peroxide value was determined according to (A.O.A.C. 2003) by dissolving 3 gm oil in 30 ml glacial acetic acid-chloroform solution (2:1;v/v), one ml of saturated potassium iodide was added and stored for 5 min in dark, finally 30 ml distilled water were added and one drop of starch soluble solution 1% (as an indicator). The mixture was titrated using sodium thiosulphate (0.1 N). The peroxide value was expressed as ml equivalent of active oxygen/kg of oil by the following equation:

$$PV = \frac{V \times N \times 1000}{W}$$

Where:
V = Volume of sodium thiosulphate. (Blank corrected in ml).
N = Normality of sodium thiosulphate.
W = Weight of oil sample (gm).

2.2.4. Thiobarbituric acid value (TBA):

Thiobarbituric acid (TBA) was determined according to the method described by Pearson, (1970). Ten gram of snack food samples were macerated with 50 ml water for 2 min then washed into a distillation flask with 47.5 ml water. Added 2.5 ml of 4 M hydrochloric acid to bring PH to 1.5. The flask was heated by means of an electric mantle so that 50 ml distillate is collected in 10 min from the time boiling commences. Five ml of distillate was pipette into a glass-Stoppard tube, and 5ml TBA reagent (0.2883g/100 ml of 90 per cent glacial acetic acid) was added, Stoppard, shacked and heated in boiling water for 35 min. the blank was prepared similarly using 5 ml water with 5 ml reagent. The tubes cooled in water for 10 min and the absorbance (OD) measured against the blank at 538 nm using spectrophotometer (unico – 2802 PC, USA). TBA No. (As mg malonaldehyde per kg sample)= 7.8 x OD.

2.2.5. Statistical analysis:

Statistical analysis was done using analysis of variance (ANOVA), least significant difference (LSD) were obtained to compare the means of treatments, using Costat version 6.311 (copyright 1998 – 2005, Cohort software). Duncan's multiple range test (Duncan 1955) was used to compare between the treatments means. The mean values within each column followed by same letters are not significantly different at 5 % level of probability.

RESULTS AND DISCUSSION

1. Oil characteristics of different types of freshly prepared corn snacks:

Generally, chemical characteristics (acid value, peroxide value and TBA value) of oil extracted from different types of freshly prepared corn snack samples with different flavors collected from three companies were represented in table (1). Significant ($p \leq 0.05$) difference was observed in acid value (mg KOH/ 100 gm oil) in all freshly prepared corn snacks. The highest value was observed in snacks with ketchup flavor produced by company 3 (0.42 mg KOH/ 100 gm oil), whereas the lowest value were noticed in snacks with cheese flavor produced by company 2 (0.19 mg KOH/ 100 gm oil).

Table (1). Oil characteristics of freshly prepared corn snacks with different flavors from three companies.

Oil characteristics	*Ketchup flavor			*cheese flavor			*chili flavor			L.S.D	Standard E.S.S 2142/2005
	Com 1	Com 2	Com 3	Com 1	Com 2	Com 3	Com 1	Com 2	Com 3		
Acid value mg KoH/100 gm oil	0.29 ^{b}	0.24 ^{b}	0.42 ^{a}	0.28 ^{b}	0.19 ^{b}	0.24 ^{b}	0.29 ^{b}	0.2 ^{b}	0.24 ^{b}	0.07	<0.6 mg KOH/gm
Peroxide value meq O_2 /kg oil	0.17 ^{f}	0.21 ^{e}	0.45 ^{a}	0.18 ^{f}	0.18 ^{f}	0.34 ^{c}	0.18 ^{f}	0.28 ^{d}	0.37 ^{b}	0.02	<10 meq O_2 /Kg oil
T.B.A value mg malonaldhyde / kg sample	0.47^{ab}	0.39 ^{b}	0.55 ^{a}	0.38 ^{b}	0.43 ^{b}	0.35 ^{b}	0.45^{ab}	0.45^{ab}	0.39 ^{b}	0.08	NM

Means in the same row with different letters are significantly different at ($p \leq 0.05$).
* Each value is mean of three replicates
NM means not mentioned

Peroxide value was varied in samples of snack. Highest value was observed in snacks with ketchup flavor from company 3 (0.45 meq O_2/ kg oil) followed by snacks with chili flavor from the same company (0.37 meq O_2/ kg oil). Generally, the peroxide values of all samples comply with that stated in the Egyptian standard specifications (should not be more than 10 meq O_2/ kg oil).

On the other hand, the percentage of the lowest value was noticed in snacks with ketchup flavor from company 1(0.17 meq O_2/ kg oil) and it was too close to snacks with chili flavor from company 1, snacks with cheese flavor from both company 1,2 (0.18, 0.18 and 0.18 meq O_2/ kg oil, respectively). On contrary Kabil, (2007) mentioned that peroxide value of extruded corn snacks not noticed at zero time.

Acid values obtained from samples were in the same line with the Egyptian standard specification (ESS 2142/2005) which recommended that acid value should not exceed than (0.6 mg KOH/ 100 gm oil).

There was significant ($p \leq 0.05\%$) difference in TBA value (mg malonaldehyde /kg sample) in all freshly prepared snacks with different flavors from all companies, the highest value were observed in snacks with ketchup flavor from company 3 (0.55 mg malonaldehyde /kg sample) followed by snacks with ketchup flavor from company1, snacks with chili flavor from both company 1, 2 (0.47, 0.45 and 0.45 mg malonaldehyde /kg sample, respectively).

lowest value were noticed in snacks with cheese flavor from company 2, snacks with ketchup flavor from the same company, snacks with chili flavor from company 3, snacks with cheese flavor from company 1 and snacks with cheese flavor from company 3 (0.43, 0.39, 0.39, 38 and 0.35 mg malonaldehyde /kg sample, respectively). No allowed limits concerned TBA in the ESS (1525/2005) of corn snacks or the ESS (2142/2005) of vegetable edible oil.

2. Oil characteristics of freshly prepared potato chips:

Data in table (2) show the properties of oil extracted from different types of freshly prepared potato chips with different flavors (chicken, kebab, chili and cheese). These data indicated that no significant ($p>0.05$) difference in acid value (mg KOH/100 mg oil), which ranged between 0.36 and 0.45 mg KOH/100 mg oil in different samples of potato chips. These results were less than that found by Wojcik-Stopczynska and Grzeszczuk, M. (2003) who reported that the fat extracted from samples of potato chips had very high acid value (> 1.0 mg KOH/100 gm oil). But Nemetes *et al.*, (1970) found that the acid value higher than 2.5 mg KOH/100 gm oil is considered unsuitable for further frying potato chips. Rageh (1998) mentioned that acid value was ranged from 0.87 to 1.09 mg KOH/100 gm oil in all analyzed potato chips samples. On the other hand, there significant ($p \leq 0.05$) difference was in peroxide value (meq O_2/kg oil) in different samples, the highest value was

observed in potato chips with cheese flavor (0.83 meq O_2/kg oil) followed by potato chips with chili flavor (0.79 meq O_2/kg oil) then potato chips with kebab flavor (0.68 meq O_2/kg oil) and finally that with chicken flavor (0.58 meq O_2/kg oil). These results agree with that obtained by Jain and Proctor (2007) which mentioned that the peroxide value of the oil extracted from potato chips was found to be 1 meq O_2/ kg samples, which was within the acceptable commercial standards, also these results were less than that found by Wojcik-Stopczynska and Grzeszczuk, M. (2003) who showed that the fat extracted from samples of potato chips had peroxide value (> 3.0 meq O_2/kg oil) but it still within the standared. Rageh (1998) mentioned that peroxide value of freshly prepared potato chips ranged from 12.7 to 24.2 meq O_2/kg oil. Jain and proctor (2007) mentioned that peroxide value of the oil extracted from potato chips was found to be 1 meq O_2/ kg sample, which was within the acceptable commercial standards.

TBA values (mg malonaldehyde/kg sample) were showed in the same table, the highest value ($p \leq 0.05$) was noticed in potato chips with cheese flavor (0.41 mg malonaldehyde/kg sample) followed by potato chips with chicken, kebab and chili flavors (0.33, 0.31 and 0.31 mg malonaldehyde/kg sample respectively). Our results were higher than that obtained from El-Hafeez *et al* (2001) which stated that TBA values of freshly unstored potato chips ranged from 0.01 to 0.25 mg malonaldehyde/kg sample. While it was lower than that reported by Rageh (1998) which mentioned that TBA values of fresh potato chips ranged from 3.06 to 5.77 mg malonaldehyde/kg sample.

These results comply with those reported in the Egyptian standard specifications (ESS 2142/2005) of oils, which recommended that the acid value should not exceeded o.6 mg koH/100 gm and peroxide value not more than 10 meq O_2 / kg oil, but there is no allowed limit concern the values of TBA in the ESS (1629/2005) concerning potato chips or the ESS (2142/2005) concerning edible oils. All oil extracted potato chips comply with the Egyptian standard (2142/2005) concerning the vegetable edible oil, which mentioned that the acid value should not exceed 0.6 mgKOH/100 gm oil. Also, all potato chips flavor had a lower peroxide value (ranged from 0.31 – 0.41 meq O_2/kg oil) than that mentioned in ESS (2142/2005). Meanwhile, we observed that no limits were mentioned in both ESS (1629/2005) of potato chips and ESS (2142/2005) of oil concern the allowed percent TBA.

Table (2). Characteristics of oil extracted from freshly prepared potato chips.

Oil characteristics	Potato chips flavor				LSD	Standard ESS 2142/2005
	*chicken	*kebab	*Chili	*Cheese		
Acid value (mgKOH/100gm oil)	0.45^{a}	0.45^{a}	0.36^{a}	0.42^{a}	0.09	<0.6 mgKOH/gm
Peroxide value (meq O_2/Kg oil)	0.58^{d}	0.68^{c}	0.79^{b}	0.83^{a}	0.02	<10 meq O_2/Kg oil
TBA (mg malonaldehyde/ Kg sample)	0.33^{b}	0.31^{b}	0.31^{b}	0.41^{a}	0.03	NM

Means in the same row with different letters are significantly different at ($p \leq 0.05$

* Each value is mean of three replicates.

NM means not mentioned

3. Oil characteristics of stored extruded corn snacks with ketchup flavor:

Generally, no significant ($p>0.05$) differences were observed in acid value (mg KOH/ 100 gm oil) of all corn snack foods with ketchup flavor stored at ambient temperature (25 ± 2°C) for three month (Table 3). Acid value ranged from 0.32 to 3.16 mg KOH/ 100 gm oil during storage periods, and these results were less than that obtained by Lin Jenn *et al.,* (2001), they showed that acid value ranged from 1.9 to 6.3 mg KOH/ 100 gm oil.

Peroxide value (meq O_2 /kg oil) increased significantly ($p\leq0.05$) from 1.25 meq O_2 / kg oil after 15 days of storage to 18.92 meq O_2 / kg oil by the end of storage period (90 days), also values of peroxide number considered less than that mentioned by Lin Jenn *et al* (2001), who mentioned that peroxide value ranged from 9 to 90 meq O_2 / kg oil. On contrary Kabil (2007) mentioned that peroxide value still not noticed at the end of the storage time (3 months) in some samples but in the other samples ranged from 0.67 to 0.77 meq O_2 / kg oil and these results still too low when comparing with our mentioned results.

Acid values were up to the permissible limits recommended in the ESS (2142/2005) of oil after 15 days of storage periods, it is consider out of the ESS (2142/2005), zero time only within the range of permissible limits. Meanwhile, peroxide values of all samples from all companies were within the range of permissible limits until 60 days of storage periods (8.38 meq O_2 /kg oil) but the remaining of storage periods were out of permissible limits (75 and 90 days 15.7 and 18.92 meq O_2 /kg oil).

TBA value of snacks with ketchup flavor were increased significantly ($p\leq0.05$) during storage periods from 0.56 mg malonaldehyde/ kg sample (at 15 days) to 1.04 mg malonaldehyde/ kg sample (at 90 days) compared with zero time (0.47 mg malonaldehyde /kg sample). Naivikul *et al.*, (2002) noticed that during storage, thiobarbituric acid of corn snacks increased from 0.20 to 3.24 mg malonaldehyde /kg sample, so it is higher than our results. While TBA value was not mentioned in neither ESS (1525/2005) concerning corn snacks nor ESS (2142/2005) concerning vegetable edible oils.

No significant ($p>0.05$) differences were observed in peroxide value and TBA value of all stored snacks with ketchup flavor from different companies. Peroxide value of stored corn snacks was ranged from 7.63 meq O_2/ kg oil (in company 2) to 10.26 meq O_2/ kg oil (in company 3). TBA ranged from 0.65 mg malonaldehyde / kg sample (in company 2) to 0.83 mg malonaldehyde / kg sample (in company 1).

Table (3). Changes in oil characteristics of stored corn snacks with ketchup flavor at ambient temperature 25 ± 2 ° C for 90 days.

Oil characteristics	*Storage period (days)							L.S.D	#samples			L.S.D	Standard E.S.S 2142/2005
	Zero time	15	30	45	60	75	90		Com 1	Com 2	Com 3		
Acid value mg KoH/100 gm oil	0.32	0.76^{a}	1.26^{a}	1.69^{a}	1.94^{a}	2.48^{a}	3.16^{a}	1.86	1.37^{b}	1.22^{b}	3.05^{a}	1.09	<0.6 mg KOH/gm
Peroxide value meq O_2/kg oil	0.28	1.25^{e}	3.15^{de}	4.99^{d}	8.38^{c}	15.7^{b}	18.92^{a}	2.74	8.31^{a}	7.63^{a}	10.26^{a}	8.79	<10 meq O_2/Kg oil
T.B.A value mg malonaldhyde / kg sample	0.47	0.56^{b}	0.61^{b}	0.69^{b}	0.79^{b}	0.79^{b}	1.04^{a}	0.24	0.83^{a}	0.65^{a}	0.75^{a}	0.24	NM

Means in the same row with different letters are significantly different at ($p\leq0.05$

* Each value is mean of nine replicates.

\# Each value is mean of 18 replicates

NM means not mentioned

Corn snacks with ketchup flavor from company 3 had the highest value (3.05 mg KOH/ 100 gm oil), while company 1 and company 2 had 1.37 and 1.22 mg KOH/ 100 gm oil, respectively.

Otegbayo *et al.*, (2002) noticed that storage stability trials of the extruded snacks for six weeks showed that the snack could store for a long period without going rancid, hence producing a reasonable shelf life.

4. Oil characteristics of stored extruded corn snacks with cheese flavor:

Table (4) represents the chemical characteristics of oil extracted from corn snack foods with cheese flavor during storage. Acid value (mg KOH / 100 gm oil) were increased significantly ($p \leq 0.05$) with increasing the storage periods up to 15 days of storage, the highest value was observed in snacks stored for 90 days (2.64 mg KOH/ 100 gm oil). Whereas, the lowest value were noticed in snacks stored for 15 days (0.43 mg KOH/100 gm oil) compared with zero time (0.24 mg KOH/ 100 gm oil). Except zero time, all results obtained during storage period (from 15 days to 90 days) were out of the permissible limits recommended in the ESS (2142/2005) concerning vegetarian edible oils which mentioned that acid value should not exceeded than 0.6 mg KOH/100 gm oil.

The same trend was observed for peroxide value which increased significantly ($p \leq 0.05$) with increasing the storage periods of snacks with cheese flavor. Up to 75 days of storage results was out of permissible limits of ESS (2142/2005) concerning vegetable edible oil which recommended that peroxide value should not exceed 10 meq O_2 / kg oil.

TBA valus also increased significantly ($p \leq 0.05$) with increasing the storage periods of snack foods with cheese flavor, the highest value were noticed in snacks stored for 90 days (0.94 mg malonaldehyde/ kg sample) and the lowest value was obtained at 15 days of storage (0.43 mg malonaldehyde/ kg sample) compared with zero time (0.39 mg malonaldehyde / kg sample). Unfortunately, TBA value not mentioned in neither (1525/2005) concerning corn snacks nor in ESS (2142/2005) of vegetable edible oils.

On the other hand, no significant ($p > 0.05$) difference was noticed among different samples of corn snacks with cheese flavor from different companies. Acid value ranged from 1.76 mg KOH/ 100 gm oil (from company 3) to 1.11 mg KOH/ 100 gm oil (from company 2). Peroxide value ranged from 8.93 meq O_2/ kg oil (from company 1) to 6.79 meq O_2 / kg oil (from company 2). Meanwhile, the TBA value ranged from 0.68 mg malonaldehyde/ kg sample (from company 1) to 0.57 mg malonaldehyde/ kg sample (from company 3).

Table (4). Changes in oil characteristics of stored corn snacks with cheese flavor at ambient temperature 25 ± 2 ° C for 90 days.

Oil characteristics	*Storage period (days)							L.S.D	#samples			L.S.D	Standard E.S.S 2142/2005
	Zero time	15	30	45	60	75	90		Com 1	Com 2	Com 3		
Acid value mg KoH/100 gm oil	0.24	0.43^{c}	0.57^{c}	1.07^{bc}	1.54^{d}	2.02^{ab}	2.64^{a}	0.77	1.27^{a}	1.11^{a}	1.76^{a}	1.09	<0.6 mg KOH/gm
Peroxide value meq O_2 /kg oil	0.23	1.27^{d}	2.98^{d}	3.97^{d}	8.07^{c}	13.09^{b}	16.92^{a}	2.79	8.93^{a}	6.79^{a}	7.43^{a}	7.72	<10 meq O_2 /Kg oil
T.B.A value mg malonaldhyde / kg sample	0.39	0.43^{d}	0.48^{cd}	0.52^{bd}	0.61^{c}	0.76^{b}	0.94^{a}	0.12	0.68^{a}	0.62^{a}	0.57^{a}	0.24	NM

Means in the same row with different letters are significantly different at ($p \leq 0.05$

* Each value is mean of nine replicates.

\# Each value is mean of 18 replicates

NM means not mentioned

5. Oil characteristics of stored extruded corn snacks with chili flavor:

Table (5), showed the chemical characteristics of oil extracted from corn snack with chili flavor during storage period at ambient temperature for 90 days. Acid value (mg KOH/100 gm oil) was increased significantly ($p \leq 0.05$) by increasing the storage periods up to 15 days of storage, the highest value was observed in snacks stored for 90 days (2.64 mg KOH/ 100 gm oil) and lowest value was noticed in snacks stored for 15 days (0.48 mg KOH/100 gm oil) compared with zero time (0.24 mg KOH/ 100 gm oil).

The same trend was observed in peroxide value which increased significantly ($p \leq 0.05$) with increasing the storage periods, the highest value was observed in snacks stored for 90 days (18.94 meq O_2/ kg oil) and the lowest value was in snacks with chili flavor stored for 15 days (1.37 meq O_2/ kg oil) compared with zero time (0.28 meq O_2 / kg oil).

All obtained acid values (from 15 days to 90 days of storage) were out of the permissible limits of ESS (2142/2005) concerning oil which recommended that acid value should not exceed 0.6 mg KOH/ 100 gm oil. Whereas, peroxide values were with the limits from zero time to 60 days of storage but up to 75 days of storage it was out of the ESS (2142/2005) standard of oil (peroxide value should not exceed 10 meq O_2/ kg oil).

TBA values were increased significantly ($p \leq 0.05$) with increasing storage periods of snack foods with chili flavor, the highest value was obtained in snacks stored for 90 days (1.27 mg malonaldehyde/ kg sample), and lowest value obtained in snacks stored for 15 days was (0.52 mg malonaldehyde/ kg sample) compared with zero time (0.43mg malonaldehyde / kg sample). Singh *et al.*, (2009) mentioned that storage snacks at 30 ± 2 ° C were having highly significant ($p<0.01$) effect of treatment on thiobarbituric acid (TBA) value. We can not decide if the TBA values with or out the standard because it is not mentioned in both (1525/2005) concerning corn snacks and in ESS (2142/2005) of vegetable edible oil.

No significant ($p>0.05$) differences was observed among snack foods with chili flavor from different companies in oil properties. Acid value ranged from 1.11 mg KOH/ 100 gm oil (in company 2) to 1.62 mg KOH/ 100 gm oil (in company 1), peroxide value ranged from 8.19 meq O_2/ kg oil (in company 2) to 9.73 meq O_2/ kg oil (in company 3) and TBA value ranged from 0.69 mg malonaldehyde/ kg sample (in company 3) to 0.97 mg malonaldehyde/ kg sample (in company 1).

Table (5). Changes in oil characteristics of stored corn snacks with chili flavor at ambient temperature 25 ± 2 ° C for 90 days.

Characteristics of oil	*Storage period (days).							L.S.D	#samples			L.S.D	Standard E.S.S 2142/2005
	Zero time	15	30	45	60	75	90		Com 1	Com 2	Com 3		
Acid value mg KoH/100 gm oil	0.24	0.48 ^{d}	0.66 ^{d}	1.12 ^{cd}	1.56 ^{bc}	2.01 ^{b}	2.64 ^{a}	0.6	1.62 ^{a}	1.11 ^{a}	1.51 ^{a}	1.04	<0.6 mg KOH/gm
Peroxide value meq O_2/kg oil	0.28	1.37 ^{f}	3.52 ^{e}	5.61 ^{c}	8.92 ^{c}	14.78 ^{b}	18.94 ^{a}	1.92	8.64 ^{a}	8.19 ^{a}	9.73 ^{a}	8.42	<10 meq O_2 /Kg oil
T.B.A value mg malonaldhyde / kg sample	0.43	0.52 ^{b}	0.62 ^{b}	0.67 ^{b}	0.76 ^{b}	0.96 ^{b}	1.27 ^{a}	0.31	0.97 ^{a}	0.74 ^{a}	0.69 ^{a}	0.35	NM

Means in the same row with different letters are significantly different at (p≤0.05

* Each value is mean of nine replicates.

Each value is mean of 18 replicates

NM means not mentioned

6. Oil characteristics of stored potato chips:

Table (6) showed the chemical characteristics of oil extracted from different types of potato chips distributed in the local markets during storage at ambient temperature 25 ± 2°C for 6 months. Acid value (mg KOH/ 100 gm oil) increased significantly ($p \leq 0.05$) by increasing storage periods. Highest value of acid number was observed in potato chips stored for sixth month (5.21 mg KOH/ 100 gm oil) and lowest value was noticed in potato chips stored for one month (0.86 mg KOH/100 gm oil) compared with zero time (0.42 mg KOH/ 100 gm oil). Ezekiel (2006) mentioned that during storage of potato chips, acid value increased up to 30 days of storage, but it was decreased up to 3 months. All results of acid value which obtained from analysis of potato chips samples with four flavors either from zero time or by the end of storage period were out of permissible limits recommended in the ESS (2142/2005) of oil, which mentioned that acid value should not exceed 0.6 mg KOH/100 gm oil.

Peroxide value (meq O_2/kg oil) were also increased significantly ($p \leq 0.05$) with increasing the storage periods, the highest value was observed in potato chips stored for sixth month (27.75 meq O_2/kg oil) while the lowest value was noticed in samples stored for one month (4.47%), whereas it was 0.72 meq O_2/kg oil at zero time. Our results are in the same trend reported by Houhoula and Oreopoulou (2004), and Aminlari *et al.*, (2005) which showed that peroxide value increased with storge time. Meanwhile, these results were less than that obtained by Zia-Ur Rehman (2003) which found that peroxide value after six months of storage was 29-30 meq O_2/kg oil.

Ezekiel (2006) mentioned also that peroxide value increased during storage, it was 4.5 meq O_2 /kg oil after one month then increased to 40.3 meq O_2/kg oil after the fourth month. Augustin and Berry (1984) showed that after 43 days the peroxide value increased from 4.6 to 79 meq O_2/kg oil. Also indicated that peroxide values increased from 0.0 to 34.9 meq/kg oil. Amreeta *et al.*, (2007) stated that during storage peroxide value increased in potato chips and intensity of oxidative rancidity and off-flavor increased also in stored potato chips.

Peroxide value was in range of permissible limits recommended in the ESS (2142/2005) of oil from zero time to third month (0.72 to 9.55 meq O_2/kg oil) which E.S.S (2142/2005) of oil mentioned that peroxide value should not be more than 10 meq O_2/kg oil but up to the fourth month until the end of storage periods it was out of the standard.

TBA value (mg malonaldehyde/ kg sample) was increased significantly ($p \leq 0.05$) with increasing storage periods, highest value of TBA content was observed in potato chips stored for sixth month (1.39 mg malonaldehyde/ kg sample) and lowest value was recorded in stored potato chips at first month (0.47 mg malonaldehyde/ kg sample) compared with zero time (0.34 mg malonaldehyde/ kg sample). Even thought TBA value was not mentioned in both ESS (1629/2005) of potato chips and in ESS (2142/2005) of vegetable edible oil.

On the other hand, no significant ($p > 0.05$) differences were observed in chemical characteristics of oil extracted from different types of potato chips (acid, peroxide and TBA values). The acid number in potato chips ranged from 2.57 mg KOH/100 gm oil (in potato with kebab flavor) to 3.35 mg KOH/100 gm oil (in potato with cheese flavor). Peroxide value ranged from 12.51 meq O_2/ kg oil (in potato with chili flavor) to 15.41 meq O_2/ kg oil (in potato with chicken flavor). TBA was ranged from 0.72 mg malonaldehyde / kg sample (in potato with cheese flavor) to 0.84 mg malonaldehyde / kg sample (in potato with chicken and kebab flavor).

Conclusion

The effect of storage (3 months to extruded corn snacks and 6 months to potato chips) at ambient temperature, increased significantly ($p \leq 0.05$) in the chemical properties of oil extracted from all snack samples (acid, peroxide and TBA values) at the end of storage periods and these increase up to the permissible limits of the ESS (2142/2005) concerning oils, TBA value was did not included in both ESS(2142/2005) concerning oils and ESS concerning snacks (1629/2005 for potato chips and 1525/2005 for corn snacks).

Table (6). Changes in oil characteristics of stored potato chips at ambient temperature 25 ± 2 ° C for 90 days.

Oil characteristics	*Storage period (months)							LSD	#Samples (flavor)				LSD	Standard E.S.S 2142/2005
	Zero time	First	Second	Third	Fourth	Fifth	Sixth		Chicken	Kebab	Chili	Cheese		
Acid value mg KoH/100 gm oil	0.42	0.86^{d}	1.57^{c}	2.19^{c}	3.29^{b}	4.64^{a}	5.21^{a}	0.69	2.69^{a}	2.57^{a}	3.13^{a}	3.35^{a}	2.06	<0.6 mgKOH/gm
Peroxide value meq O_2/kg oil	0.72	4.47^{e}	8.09^{d}	9.55^{d}	13.27^{c}	23.16^{b}	27.75^{a}	2.54	15.41^{a}	14.17^{a}	12.51^{a}	13.78^{a}	10.67	<10 meq O_2 /Kg oil
T.B.A value mg malonaldhyde / kg sample	0.34	0.47^{c}	0.56^{c}	0.63^{c}	0.76^{c}	0.99^{b}	1.39^{a}	0.23	0.84^{a}	0.84^{a}	0.73^{a}	0.72^{a}	0.42	NM

Means in the same row with different letters are significantly different at (p≤0.05

* Each value is mean of 12 replicates.

Each value is mean of 24 replicates

NM means not mentioned

REFERENCES

A.O.A.C. (2003). Association of Official Analytical Chemists. Official Methods of Analysis, (17th Ed.). International Revision I, USA.

Aminlari, M., R. Ramezani and M. H. Khalili (2005). Production of protein- coated low- fat potato chips. Food Science and Technology International. 11: 177- 181.

Amreeta, D., D. Manish and S. M. Khurana (2007). Flavor and storage stability of potato chips fried in different cooking oils. Potato Journal. 34: 187- 192.

Anton, A. A. and F. B. Luciano (2007). Instrumental textural evaluation of extruded snack foods: A review. Ciencia Tecnologia Alimentaria, 54: 245–251.

Augustin, M. A. and S. K. Berry (1984). Stability of tapioca chips fried in RBD palm olein treated with antioxidants. Journal of the American Oil Chemists' Society, 61: 873–877.

Capriles, V. D., R. A. M. Soares and J. A. G. Areas (2009). Storage stability of snacks with reduced saturated and *trans* fatty acids contents. Cienciae Technologia de Alimentos. 29: 690 – 695.

Duncan, D. B. (1955). Multiple range and Multiple F. Tests. Biometrics, 11: 1 – 42.

Egyptian Standard Specification for Cereal Based Foods, No. 1525/ 2005: The Egyptian Organization for Standardization and quality control. Ministry of Industry, Cairo, Egypt.

Egyptian Standard Specification for Edible Fats and Oils, No.2142/1992: The Egyptian Organization for Standardization and Quality Control. Ministry of Industry, Cairo, Egypt.

Egyptian Standard Specification for potato chips, No. 1629/ 2005: The Egyptian Organization for Standardization and Quality Control. Ministry of Industry, Cairo, Egypt.

El- Hafeez, M. A. A., A. A. El-Dashlouty, W. Z. Mohamed and M. H. Ghaly (2001). Palatable snacks supplemented with chicken meat. Egyption Journal of Agriculture Research. 79: 245 – 257.

Ezekiel, R. and Manju Rani (2006). Oil content of potato chips: relationship with dry matter and starch contents, and rancidity during storage at room temperature. Potato Journal. 33: 44-49.

Hamilton, E. M., E. N. Whitney and F. S. Sizer (1993). Concepts and controversies. 5th ed., St. Paul, USA, West Publishing Co.

Harper, J. M. (1981). Extrusion of Foods (Vol. 1). Boca Raton, FL: CRC Press Inc..

Houhoula, D. P. and V. Oreopoulou (2004). Predictive study for the extent of deterioration of potato chips during storage. Journal of Food Engineering. 65: 427- 432.

Huang, R. C. (2006). The study of optimum operating conditions of extruded snack food with tomato powder. Journal of Food Process Engineering. 29: 1-21.

Jain, V. P. and A. Proctor (2007). Production of conjugated linoleic acid-rich potato chips. Journal of Food Science. 72: 75 –78.

Kabil, E. M. (2007). Technological and nutritional studies on some snacks. M.Sc. (Food Sci. and Technology), Fac. Of Agriculture., El-Minufiya University, Egypt.

Lin, J. H., J. J. Chen, C. P. Hsu and L. Y. Liu (2001). Study on the quality, lipid and Trans fatty acid contents of snack food. Taiwanese Journal of Agriculture Chemistry and Food Science. 39: 218 – 222.

Naivikul, O., P. Boonyasirikool, D. Hengsawadi, K. Jangchud, T. Suwansichon and A. Suksomboon (2002). Functional snack food. Kasetsart Journal, Natural Sciences. 36: 44 – 54.

Nemets, S.M., L.P. Khakhina, N.V. Dremina, L. Li, L.S. Sviridova and L.M. Kagan (1970). Chemical changes of fat during production of potato chips. Tr., Vses. Nauch-Issled Inst. Konserv. Ovoshchesush. Prom., 13: 161 – 174

Otegbayo, B. O., F. O. Sobande and J. O. Aina (2002). Nutritional quality of soy-plantain extruded snacks. Ecology of Food and Nutrition. 41: 463 – 474.

Pearson, D. (1970). The chemical analysis of food. Nutrition college of Food Technology, University of Reading, Weybridge, Surrey, J and A. Chrechill. UK

Peters, M. J. (2001). Near Infra red analyzers in the snack food industry, Cereal Foods world. 6: 246 – 247.

Rafeacas, M., G. Francesc, I. Miquel, C. Rafael and B. Josep (1998). Liquid chromatographic determination of phenolic antioxidants in bakery products. Journal of chromatography A, 822 : 305 – 309.

Rageh, D.M. (1998). Chemical and nutritional evaluation of some local market foods consumed by children. M. s.c. (Home Economics), AL- Minufiya University, Egypt.

Singh, V. P., S. K. Mendiratta, R. K. Agarwal, M. K. Sanyal and P. C. Dubey (2009). Storage stability of aerobically packaged chicken snacks at ambient temperature (30 ± 2 °C) Journal of Veterinary public Health. 7: 45- 51.

Smith, O. (1987). Potato chips. In: Potato processing. Edited by Talburt, W.F., and Smith, O., 4 the Edition published by Van No strand Reinhold Company, New York, USA.

Stauffer, C. E. (1993). corn –based snacks. Cereal Food World: 28 – 301.

Wojcik-Stopczynska, B. and M. Grzeszczuk (2003). Quality estimation of potato chips samples purchased in the retail network. Acta Scientiarum Polonorum- Technologia Alimentaria. 2: 139 – 147.

Zia- Ur Rehman (2003). Evaluation of antioxidant activity of methanolic extract from peanut hulls in fried potato chips. Plant Foods for Human Nutrition. 58: 75 – 83.

تأثير التخزين على خواص الزيت فى بعض منتجات السناكس

علاء الدين السيد البلتاجى[١] ، على عبد العال بكر[٢] ، رجاء عبد الرءوف جاويش[٣] ، دعاء ظريف صالح البسيونى[١]

[١] قسم علوم وتكنولوجيا الأغذية – كلية الزراعة – جامعة المنوفية – شبين الكوم.

[٢] عميد معهد القاهرة العالى للسياحة والفنادق بالمقطم – القاهرة

[٣] قسم البساتين– كلية الزراعة – جامعة المنوفية – شبين الكوم.

الملخص العربى

تهدف هذه الدراسة الى تقييم أمان وجودة بعض أنواع منتجات السناكس المتداولة فى السوق (بطاطس الشبسى بطعومه المختلفة من الفراخ، الكباب، الشطة والجبنة وكذلك منتجات الذرة المبثوقة بطعوم مختلفة من كاتشب ، جبنة وشطة).

وقد تم تقدير الخصائص الكيميائية للزيت (رقم الحامض، رقم البيروكسيد ورقم حمض الثيوباربتيوريك)فى المنتجات المعدة حديثا وكذلك المخزنة على درجة حرارة الغرفة (لمدة ٦ شهور لمنتجات البطاطس الشبسى ولمدة ٣ شهور لمنتجات الذرة المبثوقة).

وأظهرت النتائج أن منتجات الذرة المبثوقة والمطعمة بطعم الكاتشب المنتجة من الشركة رقم ٣ احتوت على أعلى قيمة من كل من رقم الحامض والبيروكسيد ورقم حمض الثيوباربتيوريك (٠.٤٢ مجم بوتاسا كاوية/ ١٠٠ جم زيت، ٠.٤٥ مليمكافىء الاكسجين النشط/ كجم زيت، ٠.٥٥ مجم مالونالدهيد/ كجم عينة، على الترتيب).

بينما احتوت عينات الشبسى بطعم الجبنة على أعلى قيمة للبيروكسيد و رقم حمض الثيوباربتيوريك (٠.٧٩ مليمكافىء الاكسجين النشط / كجم زيت و ٠.٤١ مجم مالونالدهيد / كجم عينة).

أظهرت جميع العينات المخزنة زيادة معنوية بزيادة مدة التخزين، حيث تراوحت قيمة رقم الحامض فى بطاطس الشبسى المخزنة بين ٠.٨٦ و ٥.٢١ مجم بوتاسا كاوية/ ١٠٠ جم زيت وتراوحت قيمة رقم البيروكسيد من ٤.٤٧ الى ٢٧.٧٥ مليمكافىء الاكسجين النشط / كجم زيت ، ورقم الثيوبربتيوريك تراوح من ٠.٤٧ الى ١.٣٩ مجم مالونالدهيد / كجم عينة.

احتوت منتجات الذرة المبثوقة بطعم الكاتشب على أعلى قيمة لرقم الحامض ورقم حمض الثيوباربتيوريك (٣.١٦ و ١.٢٧مجم مالونالدهيد / كجم عينة) بينما احتوت نفس المنتجات بطعم الشطة على القيمة الاعلى للبيروكسيد (١٨.٩٤ مليمكافىء الاكسجين النشط / كجم زيت).

تشير النتائج بوضوح الى أن قيمة كل من رقم الحامض ورقم البيروكسيد فى جميع العينات قد تخطت الحدود المسموح بها فى المواصفة القياسية المصرية الخاصة بالزيت وذلك بنهاية مدة التخزين ، كما أن كل من المواصفة القياسية المصرية الخاصة بالسناكس سواء البطاطس أو منتجات الذرة ، أو الخاصة بالزيت لم تحتويا على أى حدود مسموح بها لرقم حمض الثيوباربتيوريك.

وعلى الرغم من أهمية ثوابت الزيت فى تحديد درجة جودة وأمان منتجات السناكس وتأثيرها على صحة الانسان الا أنه لم تحتوى كل من المواصفة القياسية الخاصة بالبطاطس أو المواصفة القياسية الخاصة بمنتجات الذرة المبثوقة على أى حدود مسموح بها لثوابت الزيت.