EFFECT OF DIFFERENT STORAGE CONDITIONS ON CHEMICAL AND ORGANOLEPTIC PROPERTIES OF SNACK EXTRUDED PRODUCTS

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ABSTRACT

This study was carried out to investigate the effect of different storage conditions (laboratory and local market) on chemical and organoleptic properties of snack extruded products widely produced in Egypt and consumed by children and teenagers during their shelf life storage for 3 months. The extruded products purchased from two different companies with different flavours (Lemon'n Chili and Cheese).Gross chemical composition of the extruded products revealed that moisture, ether extract, ash, protein, crude fibers, and carbohydrates ranged between 2.50-3.20, 25.72-28.88, 2.02-2.33, 7.45 – 8.25, 0.47-0.63 and 60.70 – 63.72%, respectively. The moisture content of extruded product purchased from the first company was higher than from the second company. The salt (sodium chloride) content ranged between (2.56 – 3.00)%. The heavy metals of the extruded products ranged between (9.57 to 15.51), (0.00),(3.47 to 6.27) and (12.54 to13.04) ppm for iron, copper, zinc and manganese, respectively.

Moisture content increased during storage period either in laboratory or local market conditions. The effect of storage at local market conditions on moisture content was more pronounced than that at laboratory conditions. Oil content of the extruded product stored in different conditions decreased during storage, the rate of decrease was higher during storage at local market conditions compared with extruded products stored at laboratory conditions.

Peroxide value of the extracted oil increased slowly in the first stage of storage especially in samples stored at laboratory, then the rate of peroxidation increased rapidly especially in samples stored at local market conditions.The peroxide value reached the border line of acceptability after 30 days of storage at laboratory, while, it reached the same level after 15 days only during storage at local market conditions. The rate of change in peroxide value of extruded products with Lemon'n chili flavour was lower than that with cheese flavour. Acid value (AV) and thiobarbituric acid value (TBA) of the extracted oil increased gradually during storage for three months. The rate of increase was higher in extruded products stored at local market conditions.

Fatty acids compositions of extracted oils revealed that in both fresh and stored products the unsaturated fatty acids decreased with increasing storage period, while saturated fatty acids increased. The decreasing rate in fatty acids composition was lower in extruded products stored at laboratory conditions.

The organoleptic properties of extruded products showed that the panelists refused the extruded products stored at local market conditions after 45 days while the period extended to 60 days for those stored at laboratory conditions. The extruded products with cheese flavour had higher acceptability for consumers.

This research proved the need of tight control over factories to make sure that they use fresh oils with low initial peroxide number and must insure that salt content does not exceed the recommended percentage (2%). That is why close inspection should be done on marketing outlets to insure storing, display in proper conditions and validity period should be reduced to insure the quality throughout this period.

INTRODUCTION

Extrusion cooking is one of the most useful food processing operations and is used to produce a wide variety of snacks with unique sensory attributes and display varying shapes, textures and flavours. In general, extruded products are made from mainly cereals as base ingredients which provided mostly energy from carbohydrates and fat. The protein content is about 3.3-8.3 % depending on other ingredients **(Sinthavalai, 1984)**.

Extrusion cooking is a continuous high temperature short time process (HTST) that use both temperature and pressure for expansion. Mechanical shear is combined with heat to gelatinize starch and denature proteinaceous material as they are placticized and destructed to create new texture and shapes. This process lead to the production of fabricated foods consisting primarily of cereals starches and vegetable proteins and has almost limitless applications using various blends. **(Bhattacharya and Hanna, 1988)**. Blends of defatted flour of peanut and sesame as well as chick peas flour; rice broken and wheat bran; broken rice flour, germinated chickpea flour and germinated faba bean flour; soybean isolate and dietary fiber from full fat rice bran were used and added to corn grits to improve protein content of the extrudate **(Salch, Halla, 1996; Singh *et al.* 2000; Abd El-Hak, 2002 and Naivikul, 2002)**.

The processing and conditions encountered during extrusion can significantly reduce lipid stability **(Bjorck and Asp 1983)**. Lipid substance

deteriorated easily by oxidative rancidity from the reaction with atmospheric oxygen and hydrolytic reaction catalyzed by lipases from food or from microorganisms.

Most of high fiber extruded food products have reduced fat content, the low moisture content, high surface area and potential for metal contamination as a result of extrusion increase product susceptibility to oxidation relative to products of the same composition that have not been extruded (**Rao and Artz, 1989**).

Lipid stability decreased with an increase in extrusion temperature. The peroxide value, the conjugable oxidation products value and the oxodiene value, as well as the peroxide value determined by active oxygen method, generally increased with an increase in extrusion temperature (**Rao and Artz, 1989**). During the shelf life of the snacks, two deterioration aspects take place together, one being texture loss due to moisture pick up, the other being rancidity development (**Allen and Hamilton 1983**).

Saleh, Halla (1996) studied the effect of storage period at room temperature for three months on peroxide value, acid value and thiobarbituric acid of extrudates produced from yellow corn grits. Peroxide value increased from 1.1 meq/kg oil at zero time to 2.62 meq. O_2/kg oil after 3 months, acid value increased from 0.41 to 0.92 mg KOH/1 gm oil and thiobarbituric acid increased from 0.05 to 0.41 mg malondialdehyde/kg oil.

The moisture sorption characteristics of maize based food the effect of storage temperature on total carbonyls (lipid oxidation) and sensory quality was studied by **Lasekan *et al.* (1996)**. Storage at moisture content above the monolayer region reduced greatly the total carbonyl (lipid oxidation in sample). Total carbonyl were found to increase in the products with increase in storage temperature. In addition storage at higher temperature (40C) significantly reduced the sensory acceptability of products stored for 20 and 30 days.

Naivikul *et al.*, (2002) studied the changes in the thiobarbituric acid (TBA) of snacks prepared from 70% corn grits, 10.5% soy protein isolate, 40% full fat soy flour, 10% inactivated full fat rice bran, seasoned with barbecue flavour during storage. The TBA increased from 0.2 to 3.24 mg / 100 gm.

The permeability of packaging material to water vapor and gases especially oxygen in relation to oxidation and transparency of light, are essential properties in the selection of adequate packaging material for food product (**Pfeiffer *et al.*, 1999**).

The production of snack from cereal continue to increase in the Egyptian market and widely consumed by childrens and teenagers. Loss of consumer acceptability comes from loss of crispness and production of off-flavour compounds as a result of rancidity reactions, complaints of rancid crisps of snack which are still within there stated life are often a result of poor storage conditions of some stage in the distribution and selling chain. Thus this study was carried out to investigate the effect of storage conditions in the local market on the chemical and organoleptic properties which affect the quality of these products during their shelf life storage.

MATERIALS AND METHODS

MATERIALS:

The fresh samples of snacks extruded products with different flavours (lemon'n Chili and cheese) were obtained from local different companies for food industries, which have a high production in Egypt. Fresh samples of snacks extruded products were obtained from two companies No 1 (with lemon'n Chili) and No 2 (with lemon'n Chili and with cheese) in Tanta city. The validity date for these samples written on the packages was 3 months. All samples were obtained from these companies in the same day of production, during summer season, 2004.

Extrusion process:

The weighed raw materials were thoroughly mixed. The extruder used to prepare the extruded products was a Brabender single. Screw 20 DN equipped with Do–corder EDCE 330 and feeding screw model Brabender Dusiburg DCE 330. The screw speed was kept constant at 180 rpm throughout the study. The moisture was adjusted to 18% by adding the required calculated amount of water before transferred to the feed hopper of the extruder. The mixed raw materials were fed into the extruder at the rate of (825 Kg/hour) under the following conditions: 180°C barrel temperature. 180 rpm screw speed and 35 rpm feed rate. The shape of the die opening was round hole of 3mm diameter. The speed of rotating knives was adjusted to give an approximate length of the product of 1cm pellets, then transferred to an oven at 170-175°C for about (3-5) minutes until the moisture content was below 2-3 %. The flavours were added to the puffed and dried collect. A popular combination is oil and flavouring materials, and the ingredients are often mixed together in stainless steel kettles before being sprayed on to the collects in a tumbling–type coater. The vegetable oil is generally palm oil at 40-60°C. The extrudates were then carried by head conveyors and channeled to the weighers of the packaging machines, where metallized poly propylene pouches under vaccum were used .

METHODS:

Storage conditions:

All samples extrudates were transferred directly fresh to the Food Tec. Dept., Fac. of Agric., Kafr El-Sheikh, Tanta Univ., for analysis. Two storage experiments were undertaken the first in the laboratory at room temperature (15 – 30°C and 55 – 72% RH). The polypropylene pouches were placed on a table for three months for extruded products. The second experiment was undertaken in conditions like the local market at (12– 55 °C and 20 – 78% RH) were placed on shelfes exposed to direct sunlight and air then in the night transmitted indoor for the same period. The temperature and relative humidity (RH) were measured by hygrometer AC-751, China and the obtained data were recorded three times every day. During the storage period (3 months) the analysis was carried out every 15 days for extruded products.

Preparation of samples for analysis :

All the fresh and stored pouches were opened and the products were crushed to pass through 20 mesh sieve and kept in brown glass jars with tight plastic lids in polyethylene bags in the refrigerator at 5°C until analysed in the same day .

Chemical analysis:

Gross chemical composition:

Moisture content, ether extract, crude protein (N × 5.7), crude fiber, total ash and sodium chloride contents were determined according to the method of **AOAC (2000)**. Total carbohydrates were calculated by difference.

Heavy metals:

Four elements namely manganese (Mn), iron (Fe), zinc (Zn) and copper (Cu) were determined by Flame atomic absorption as described by **Peterburgski (1968).**

Evaluation of extracted oils from some snacks extruded products:

Oil extraction :

The total oil was extracted from the fresh and stored samples using hexane at room temperature according the method described by **Kahlon *et al.* (1992).** The solvent was evaporated using a rotary film evaporator under vaccum at 30 °C. The samples was completed to a known volume of hexane, flushed by nitrogen and kept in brown glass bottles at 5°C until analysis.

- **Peroxide value (PV) :** Peroxide value of the extracted lipid was determined according to the method described by **Pearson (1976).** The results were always described as meq. O_2 Kg^{-1} of oil extract .
- **Free fatty acids (FFA):** Free fatty acids of the extracted lipid were determined by titration methods of **AOAC (2000).** The free fatty acids was calculated as percent oleic acid.
- **Thiobarbituric acid value (TBA):** Thiobarbituric acid value was carried out according to the method described by **Ottolenghi (1959).** TBA value was calculated as mg. of malondialdehyde/ Kg oil extract = D × 7.8.
- **Fatty acids composition:** Determination of fatty acids composition of the extracted lipids was carried out at the Central Laboratory Faculty of Agriculture, Alexandria University, Egypt. According to **Radwan (1978)** and **Vogel (1975).** The fatty acid methyl esters were analyzed by gas liquid chromatography apparatus (GC model Schimadzu-4cm (PFE) equipped with PID detector and glass column 2.5m × 3mn i.d. The standard fatty acids methyl esters were injected in the apparatus under the same conditions. The weight percentage of each fatty acid was calculated as percentage of the total peaks.

Sensory evaluation:

Colour, odour, taste texture and overall acceptability of extrudates were evaluated subjectively using ten students and staff members of Food Tech. Dept., Fac. of Agric., Kafr El-Sheikh, Tanta Univ. Nine point hedonic scale was used as described by **El-Sheikh (1999).**

RESULTS AND DISCUSSIONS

Chemical composition of some snacks extruded products:

The results of the gross chemical composition of the extruded products purchased from the two different companies with two different flavours (Lemon'n and Cheese) are shown in Table (1). According to **Egyptian Standard Specification (Anon, 1982),** the best pop-corn products should have low moisture content (not more than 5%) and oil content of not less than 10%.

Data present in Table (1) indicates that the moisture, ether extract, ash, protein, crude fiber and carbohydrates are ranged between (2.50-3.20), (25.72-28.88), (2.02-2.33), (7.45 – 8.25), (0.47-0.63) and (60.70 – 60.84)%, respectively. These results are in line of those stated by **(Matz, 1993. and Almeida- Dominguez *et al.*, 1990).** They found that the chemical composition of extruded products ranged between (2.8-3.0), (28.1-29.89),

(2.57-2.90), (7.14-9.00), (0.88-3.50) and (55.89-57.20)%, respectively, for the moisture, ether extract, ash, protein, crude fiber and total carbohydrates.

Salt (sodium chloride) and heavy metals contents in some snacks extruded products:

Sodium chloride content of the extruded products purchased from the two different companies with two different flavours (Lemon'n chili and Cheese) are shown in Table (2).

Sodium chloride content of extruded products ranged from 2.56% to 3.00% for the two companies, these results are in agreement with those mentioned by **E.S.S. (Anon, 1982)** which stated that the extruded products should have not more than 3% sodium chloride.

Table (1): Gross chemical composition of some snacks extruded products (on dry weight basis).

Products / Constituents	Company 1	Company 2	
	Lemon'n chili	Lemon'n chili	Cheese
Moisture	3.20	2.50	2.66
Ether extract	25.72	28.25	28.88
Ash	2.02	2.33	2.24
Protein	7.91	8.25	7.45
Crude fiber	0.63	0.47	0.59
Carbohydrates	60.72	60.70	60.84

Table (2): Salt (sodium chloride) and heavy metals content of some snacks extruded products.

Products / Constituents	Company 1	Company 2	
	Lemon'n chili	Lemon'n chili	Cheese
Sodium chloride (%)	2.97	2.56	3.00
Heavy metals (p.p.m):			
Fe	15.51	9.90	9.57
Cu	0.00	0.00	0.00
Zn	6.27	5.12	3.47
Mn	13.04	12.54	12.87

On the other hand, from the presented data in Table (2) it is noticed that contamination rate of extruded products by heavy metals ranged from 9.57 to15.51, (0.00), 3.47 to 6.27 and 12.54 to 13.04 p.p.m. for Fe, Cu, Zn and Mn, respectively. The contamination by heavy metals may be due to the extruder and mixing equipments. Unfortunately, there is no limit for the allowed content of heavy metals in snack extruded products recommended by the **E.S.S. (Anon, 1982).** As previously mentioned by **Schultz *et al.* (1962) and Allen and Hamilton (1983),** the contamination by heavy metals enhanced the oil oxidation during storage and cause odour and taste deterioration of the product.

Effect of storage conditions on chemical composition of some snack extruded products:

The moisture content:

Moisture content of extruded products (pop-corn products) is an important factor that affects greatly their quality due to the less of crispness. According to the **E.S.S. (Anon, 1982)** the pop-corn products should have low moisture content (not more than 5%).

The data in Table (3) showed the effect of storage under different conditions (laboratory and local market) on the moisture content of extruded products purchased from the two different companies with two different flavours (Lemon'n chili and Cheese).

The results indicated that the moisture content ranged from 2.5 to 3.2 % then increased gradually during storage at laboratory and at local market conditions for 90 days. These results are in line of those mentioned by **Almeida- Dominguez *et al.* (1992).** They found that the moisture content of corn- based snack increased during storage at 50% RH and at 40 and 50 °C for 26 days. Higher increase in the moisture content was noticed in the extruded products stored at local market conditions compared with those stored at laboratory conditions. This was due to the effect of increased temperature on the vapor permeability of the packaging films and was consistent with their barrier properties.

Table (3): Effect of different storage conditions on moisture content (%) of some snacks extruded products.

Storage period (days)	Storage conditions					
	Laboratory			Local market		
	Company1 Lemon'n chili	Company 2		Company1 Lemon'n chili	Company 2	
		Lemon'n chili	Cheese		Lemon'n chili	Cheese
0	3.20	2.50	2.66	3.20	2.50	2.66
15	3.35	2.53	2.83	3.59	3.88	3.14
30	3.80	3.42	3.43	4.37	3.96	3.47
45	3.92	3.60	3.56	4.47	4.44	4.18
60	4.16	3.48	4.60	4.20	4.28	4.53
75	4.30	4.28	4.16	4.37	4.46	4.26
90	4.51	4.54	4.36	4.60	4.74	4.60

Ether extract:

The changes occurred in the ether extract of extruded products purchased from two different companies with two different flavours (Lemon'n chili and Cheese) during storage for 90 days either at laboratory or at local market conditions are shown in Table (4).

From the results in the Table (4), it could be noticed that the ether extract ranged between (25.72-28.88)% at the beginning of storage these results are in accordance with those reported by **Almeida- Dominguez *et al.* (1990) and Matz (1993).** Then decreased with increasing the storage period in all samples stored in the different conditions. The observed decrease in the oil content of pop-corn products during storage could be probably due to the adsorption of some absorbed oil which accumulated at the inner surface of the packaging film.

Table (4): Effect of different storage conditions on ether extract of some snacks extruded products (expressed as% on dry weight)

Storage period (days)	Storage conditions					
	Laboratory			Local market		
	Company1	Company2		Company 1	Company 2	
	Lemon'n chili	Lemon'n chili	Cheese	Lemon'n chili	Lemon'n chili	Cheese
0	25.72	28.25	28.88	25.72	28.25	28.88
15	24.96	28.05	27.79	24.61	28.01	28.70
30	24.26	28.15	29.05	24.42	27.66	28.45
45	24.25	27.96	28.50	23.95	27.44	28.08
60	24.05	27.42	28.44	24.09	27.05	27.70
75	23.83	27.58	29.66	23.77	27.24	27.77
90	23.63	27.51	27.99	23.70	27.20	27.09

The decreasing rate of ether extract was higher in the extrudates stored at the local market conditions than those stored at the laboratory conditions. This could be attributed to the high temperature and relative humidity and oxidative rancidity of fats **(Hafiz *et al.*, 1990).**

Effect of different storage conditions on the oil quality extracted from some snacks extruded products:

Rancidity is an important problem in fried foods. The effect of storage period at different conditions (laboratory and local market) on the quality of yellow corn grits extrudates (extruded products) were evaluated at 0, 15, 30, 45, 60, 75, 90 days. The evaluation parameters were peroxide value (Pv), and thiobarbituric acid content (TBA) as these are the major indices for oxidative rancidity.

Peroxide value:

The peroxide value of the oil extracted from stored extruded products with different flavours (Lemon'n Chili and Cheese) purchased from the two companies for 90 days at lower temperature and relative humidity in laboratory and at higher temperature and relative humidity at local market conditions are given in Fig. (1). From these results, it could be noticed that the peroxide value of the oil extracted from the investigated samples ranged from (5.71 to 6.26 ml. eq. O_2 / kg oil extract) at the beginning of storage period (zero time), these high values probably associated with temperature,

moisture level, and screw speed (retention time) **(Abdeen, 1997).** Peroxide value increased as the storage period increased in all samples.

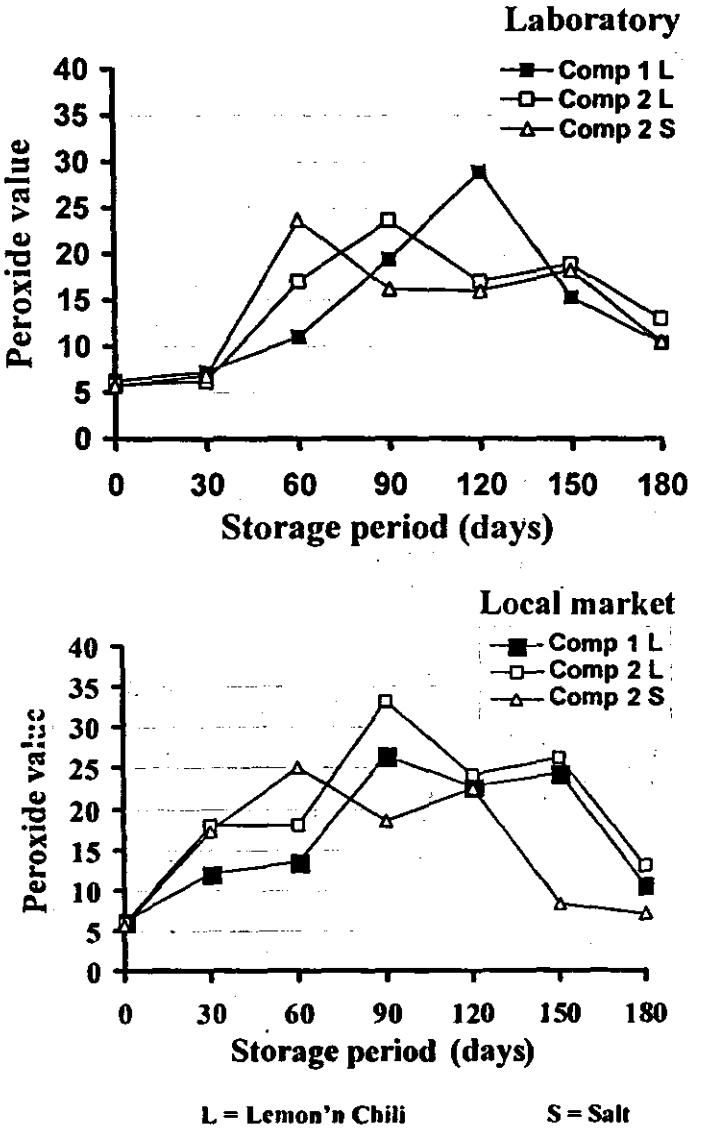

Fig. (1): Effect of different storage conditions on peroxide value (ml.eq.O_2 kg^{-1} oil extract) of some snacks extruded products.

The results are in the line of those reported by **Rao and Artz (1989) and Saleh, Halla (1996).** It could be also noticed that the increasing rate was higher in extruded products stored at local market than stored at

laboratory. The increase in fat oxidation during the storage may be due to the increase in surface area associated with an increase in expansion ratio or due to the increasing metal content in the extrudates after extrusion **(Rao and Artz, 1989).** The results also revealed that the peroxide value of extruded products reached the border line of acceptability (10 ml. eq. O_2 / kg of extracted oil) after the first 15 days of storage at local market conditions. On the other hand, the same border line was reached throughout 30 days of storage in laboratory conditions. These results could be attributed to the effect of direct sunlight and hence the ultraviolet rays.

The lower increasing rate of peroxide value was recorded in these extrudates with Lemon'n Chili flavour which contain ascorbic acid acting as antioxidant.

Free fatty acids (FFA):

The results in Fig. (2) showed the effect of storage under different conditions (laboratory and local market) on the free fatty acids (% as oleic acid) of oil extracted from extruded products purchased from the two different companies with different flavours (Lemon'n chili and Cheese). The results revealed that the free fatty acids at zero time storage ranged from 0.45 to 0.61 % as oleic acid.

From the Table it is noticed also that free fatty acids and acid value tended to increase by different rates in all samples under investigation depending on the storage conditions. These results are in harmony with those obtained by **Harper and Jansen (1981) and Saleh, Halla (1996).** The increasing free fatty acids may be due to the increase in the moisture content during the storage period, which caused hydrolytic rancidity where the oil triglycerides are decomposed to glycerol and free fatty acids.

The highest increase in the free fatty acids was noticed in extrudates with cheese flavour and stored in local market compared to those stored at laboratory conditions.

Thiobarbituric acid value (TBA):

Fig. (3) represent the changes in the secondary oxidation (TBA value determined as mg of malondialdehyde/kg. of oil extract), in the extrudates with two different flavours (Lemon'n chili and Cheese) purchased from the two different companies during storage at different conditions (laboratory and local market) conditions. TBA value of the extracted oil ranged between (0.047 to 0.062 mg. of malondialdehyde / kg. of oil extract) at zero time. **Naivikul *et al.*, (2002),** found that the TBA value of snacks prepared from 70% corn grits, 10.5% soy protein isolate, 4% full-fat soy flour, 10% inactivated full- fat rice bran, seasoned with barbecue flavour was (0.20 mg.

malondialdehyde / kg. of oil extract) at zero time. These differences may be due to the extrusion conditions and the different raw materials. Changes in TBA value which occurred during storage of extrudates for 90 days revealed that the TBA value of the oil increased gradually as the storage period increased and the temperature was raised. These results are in line with those reported by **Salch, Halla (1996) and Naivikul *et al.* (2002).** The increasing rate was higher in extruded product with cheese flavour stored in local market conditions than products stored in laboratory.

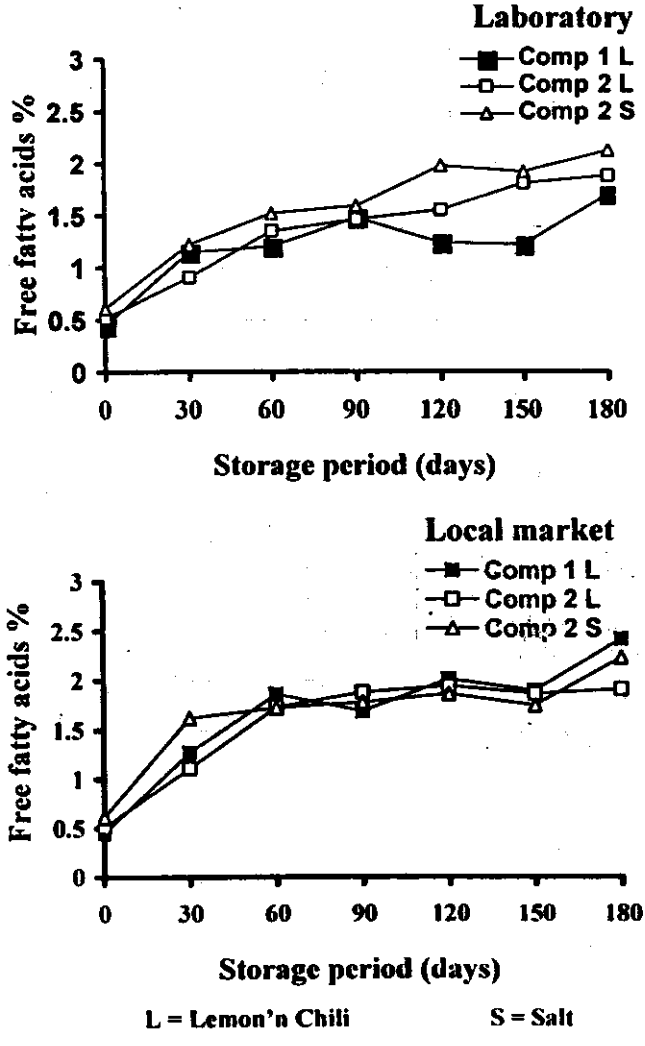

Fig. (2): Effect of different storage conditions on FFA (% as oleic acid) of some snacks extruded products.

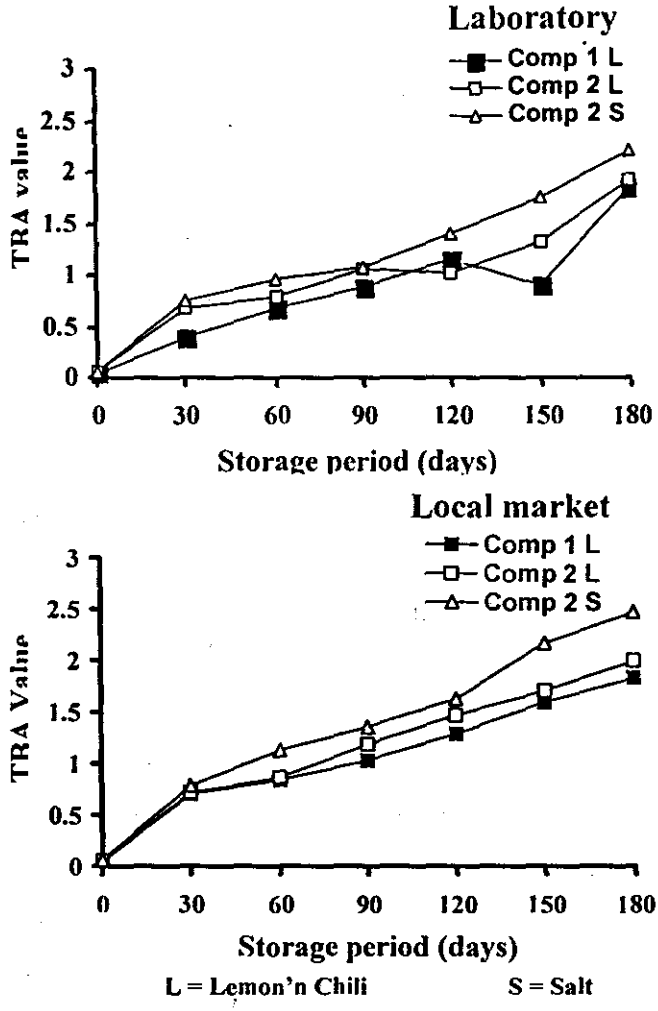

Fig. (3): Effect of different storage conditions on TBA value of some snacks extruded products.

From the previous results (PV, FFA and TBA values) it could be noticed that the storage at laboratory conditions (at lower temperature and relative humidity) considered the best conditions for storage of extruded products made from corn grits. Lemon'n chili flavour delayed the rancidity and hence may prolong the shelf life of the extruded products stored at laboratory and local market conditions.

Fatty acids composition:

Table (5) shows the fatty acids composition of palm oil extracted from fresh extruded products purchased from the two different companies with

different flavours (Lemon'n chili and cheese) and the fatty acids changes during storage at different conditions (laboratory and local market).

The fatty acids composition of the oil extracted from fresh extruded products under investigation ranged from Lauric ($C_{12:0}$), (0.50 to 0.72), myristic ($C_{14:0}$), (1.30 to 1.89), palmitic (($C_{16:0}$), (32.22 to 33.80), stearic ($C_{18:0}$), (4.02 to 4.56), palmitoleic ($C_{16:1}$), (1.26 to 1.44), oleic ($C_{18:1}$), (42.32 to 43.61), linoleic ($C_{18:2}$), (13.50 to 14.95) and linolenic acid ($C_{18:3}$), (1.67 to 1.91) %. Oleic and linoleic acids are the major fatty acids present. These results are correlated with that obtained by **Formo *et al.* (1979), Weiss (1983) and Matz (1993).** It is also clear from the same data that unsaturated fatty acids decreased with increasing storage period, the decrease in linolenic was higher than that of linoleic. The decreasing rate of unsaturated fatty acids are much higher in those samples stored at local market conditions compared to these stored at laboratory conditions. The decrease of the unsaturated fatty acids linolenic and linoleic was accompanied by increase of oleic acid and the saturated fatty acids.

Table (5). Effect of different storage conditions on fatty acids composition of oil extracted from some extruded products (% of total fatty acids).

Fatty acids	Products														
	Company 1					Company 2									
	Lemon'n chili					Lemon'n chili					Cheese				
	0	90 days		180 days		0	90 days		180 days		0	90 days		180 days	
		Lab.	Mar.	Lab.	Mar.		Lab.	Mar.	Lab.	Mar.		Lab.	Mar.	Lab.	Mar.
Saturated :															
Lauric ($C_{12:0}$)	0.50	0.53	0.58	0.56	0.54	0.64	0.49	0.59	1.42	0.66	0.72	0.51	0.41	0.76	0.56
Myristic ($C_{14:0}$)	1.30	1.35	1.46	1.41	1.30	1.89	1.46	1.77	1.69	1.41	1.80	1.54	1.36	1.51	1.44
Palmitic ($C_{16:0}$)	33.80	34.17	34.34	34.32	35.00	32.22	32.87	33.33	34.16	33.89	33.34	36.28	36.64	36.88	36.87
Margaric($C_{17:0}$)	0.24	0.36	0.21	0.40	0.45	0.47	0.64	0.53	0.42	0.47	0.36	0.50	0.45	1.56	1.32
Stearic ($C_{18:0}$)	4.02	4.31	4.47	4.91	4.83	4.56	5.03	5.48	5.65	4.96	4.41	4.65	4.98	4.58	5.41
Total SFA	39.83	40.72	41.06	41.61	42.12	39.76	40.49	41.70	42.34	42.39	40.63	43.48	43.84	44.29	44.60
Unsaturated :															
Palmioleic($C_{16:1}$)	1.44	0.94	1.00	1.01	0.97	1.26	1.32	1.36	0.92	0.98	1.28	1.27	1.02	1.13	1.26
Oleic ($C_{18:1}$)	43.61	43.67	43.72	43.75	43.95	42.32	42.84	42.89	42.56	44.27	42.76	42.02	42.55	42.60	44.10
Linoleic ($C_{18:2}$)	13.50	13.24	13.01	12.51	12.00	14.95	14.09	12.93	13.24	11.47	13.65	12.00	11.54	11.08	10.25
Linolenic($C_{18:3}$)	1.91	1.43	1.20	1.11	0.95	1.70	1.26	1.11	0.94	0.88	1.67	1.22	1.05	0.89	0.79
Total USFA	61.16	59.28	58.93	58.38	57.87	60.23	59.51	58.29	57.66	57.60	59.36	56.51	56.16	55.70	55.40

Storage conditions : Laboratory (Lab.) : 15-30°C and 55-72% RH.
Local market (Mar.) : 12-55°C and 20-78% RH.

Effect of different storage conditions on organoleptic properties of some snacks extruded products:

Sensory evaluation scores (colour, odour, taste, texture and overall acceptability) of the extruded products with different flavours (Lemon'n chili and cheese) purchased from the two companies were made by ten panelists. The results are shown in Table (6).

Taste and odour were the major sensory attributes affecting the quality of extruded products during the storage. It could be seen from the Table that the texture of extrudates decreased by increasing storage period. This decrease is probably due to absorption of water through packaging materials. These results are in agreement with those obtained by **Zahran (2000)**. It is also noticed that extruded products with Lemon'n chili flavour was more acceptable for consumers. This may be due to the Lemon'n chili flavour effect which led to disappear the off-flavour arise in stored extruded products.

Table (6): Organoleptic properties of some snacks extruded products stored under different conditions.

Storage period (days)	Products	Storage conditions					
		Laboratory			Local market		
		Company 1	Company 2		Company 1	Company 2	
		Lemon'n chili	Lemon'n chili	Cheese	Lemon'n chili	Lemon'n chili	Cheese
0	Colour	9.0	9.0	9.0	9.0	9.0	9.0
	Odour	9.0	9.0	9.0	9.0	9.0	9.0
	Taste	9.0	9.0	9.0	9.0	9.0	9.0
	Texture	9.0	9.0	9.0	9.0	9.0	9.0
	Overall Acceptability	9.0	9.0	9.0	9.0	9.0	9.0
15	Colour	9.0	9.0	9.0	8.0	8.0	8.0
	Odour	9.0	9.0	8.0	8.0	8.0	7.0
	Taste	9.0	9.0	9.0	8.0	8.0	7.0
	Texture	9.0	9.0	8.0	8.0	8.0	8.0
	Overall Acceptability	9.0	9.0	8.5	8.0	8.0	7.5
30	Colour	9.0	8.0	8.0	8.0	7.0	7.0
	Odour	8.0	9.0	8.0	7.0	8.0	6.0
	Taste	8.0	9.0	8.0	7.0	7.0	6.0
	Texture	7.0	8.0	7.0	7.0	8.0	7.0
	Overall Acceptability	8.0	8.5	8.8	7.3	7.5	6.5
45	Colour	8.0	9.0	8.0	6.0	6.0	6.0
	Odour	7.0	8.0	7.0	5.0	5.0	4.0
	Taste	8.0	8.0	7.0	5.0	5.5	4.0
	Texture	7.0	7.0	7.0	4.0	4.0	4.0
	Overall Acceptability	7.5	8.0	7.3	5.0	5.0	4.5
60	Taste	5.0	4.0	4.0	2.0	3.0	2.0
	Odour	4.0	5.0	4.0	3.0	3.0	2.0
	Colour	5.0	5.0	5.0	3.0	3.0	3.0
	Texture	4.0	4.0	4.0	2.0	3.0	2.0
	Overall Acceptability	4.5	5.0	4.3	2.5	3.0	2.3

Score sheet: Liked extremely 9, Liked very much 8, Liked moderately 7, Liked slightly 6, Neither liked nor disliked 5, Disliked slightly 4, Disliked moderately 3, Disliked very 2, Disliked extremely 1

The extruded products stored at local market conditions was not accepted by the panelists after 45 days storage, while the samples stored at

laboratory conditions was not accepted after 60 days storage, after the aforementioned periods of storage off-flavour appeared and the extruded products lost its crispness, although the validity date of these samples was 90 days.

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الملخص العربى

"تأثير ظروف التخزين المختلفة على التركيب الكيمياني والخواص العضوية الحسية لمنتجات الذرة المبثوقة"

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أجرى هذه البحث بهدف تقييم جودة بعض الأغذية الخفيفة الأكثر تداولا وقبولا لدى جميع فئات المستهلكين (أطفال – بالغين) مثل منتجات الذرة المبثوقة والمنتجة حديثاً من بعض شركات الصناعات الغذائية الأكثر إنتاجاً وتوزيعاً داخل جمهورية مصر العربية.

حيث تم دراسة تأثير كل من ظروف التخزين (المعمل – السوق المحلي بمدينة كفرالشيخ) والطعوم المضافة (الشطة والليمون – الجبن) علي التركيب الكيمياني والخواص العضوية الحسية لهذه الأغذية المنتجة حديثاً خلال فترة الصلاحية (٣شهور). حيث أشارت النتائج المتحصل عليها ما يلى:ـ

- أوضح التركيب الكيماوى لمنتجات الذرة المبثوقة والمنتجة حديثاً أن قيم الرطوبة، المستخلص الأثيرى ، الرماد ، البروتين ، الألياف الخام والكربوهيدرات كانت تتراوح بين (٢,٥٠ – ٣,٢٠) ، (٢٥,٧٢ – ٢٨,٨٨) ، (٢,٠٢ – ٢,٣٣) ، (٧,٤٥ – ٨,٢٥ ، (٠,٤٧ – ٠,٦٣) و(٦٠,٧٠ – ٦٣,٧٢) ٪ على الترتيب، حيث كان محتوى الرطوبة لمنتجات الذرة المبثوقة من الشركة رقم ١ أعلى من الشركة رقم ٢.
- محتوى الملح (كلوريد الصوديوم) تراوح بين (٢,٥٦ – ٣,٠٪). ومن المعادن الثقيلة المقدرة (كجزء فى المليون) كالحديد (٩,٥٧ –١٥,٥١) ، الزنك (٣,٤٧ – ٦,٢٧) والمنجنيز (١٢,٥٤ – ١٣,٠٤) والنحاس صفر.

- لـــوحظ أيضا أن تخزين منتجات الذرة المبثوقة فى ظروف السوق المحلى أدى الى زيادة محتواها من الرطوبة و انخفاض المحتوي الدهني بدرجة اكبر مقارنة بالتخزين فى ظروف المعمل.
- لـــوحظ أن رقـــم البيروكسيد للزيت المستخلص من منتجات الذرة المبثوقة ازداد ببطء فى الـــبداية خاصـــة فى حالة التخزين فى ظروف المعمل ، ثم أزداد معدل الأكسدة بعد ذلك بسرعة خاصة فى حالة التخزين للعينات فى ظروف السوق المحلى. كما وصل هذا الرقم إلـــى الحد الذى ترفض عنده العينات (١٠ملليمكافئات أوكسجين / كيلوا جرام من الزيت المـــستخلص) بعـــد ٣٠ يوم من التخزين فى المعمل وبعد ١٥ يوما فقط من التخزين فى ظـــروف الـــسوق المحلى وكان معدل هذا التغير فى رقم البيروكسيد للمنتجات التى بطعم الشطة والليمون أقل من التى بطعم الجبنة.
- حـــدوث زيادة فى نسبة الأحماض الدهنية الحرة و رقم الـــ T.B.A أثناء تخزين العينات لمـــدة ثلاث شهور حيث كان معدل الزيادة أعلى فى المنتجات المخزنة فى ظروف السوق المحلى عن المخزنة فى ظروف المعمل ، وكذلك معدل الزيادة كان أقل فى حالة المنتجات التى بطعم الشطة والليمون عن التى بطعم الجبنة .
- نـــسبة الأحمـــاض الدهنـــية للزيت المستخلص من منتجات الذرة المبثوقة تغيرت بتغير ظـــروف التخـــزين، حيث حدث نقص فى نسبة الأحماض الدهنية الغير مشبعة بالتخزين بدرجة أعلى فى العينات المخزنة فى ظروف السوق المحلى مقارنة بظروف المعمل .
- الاختـــبارات الحـــسية أثبـــتت أن المحكمين لم يتقبلوا المنتجات المبثوقة بعد ٤٥ يوما من التخـــزين فى ظروف السوق المحلى وبعد ٦٠ يوما من التخزين فى ظروف المعمل على الـــرغم من عدم انتهاء فترة الصلاحية . وكانت العينات بطعم الشطه والليمون اكثر قبولا لدى المحكمين.

وفـــى النهاية يجب تشديد الرقابة على هذه الشركات بواسطة هيئة سلامة وجودة الأغذية وخفض فترة الصلاحية وتشديد الرقابة على منافذ البيع وظروف عرض هذه المنتجات للحصول على منتجات ذات جودة أفضل للمستهلكين.