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SUN 3 IS THE BEST RECOMMENDED FRYING OIL : EFFECT OF OIL BLEND AND HEATING TIME ON THE CHARACTERISTICS OF ABSORBED OIL DURING DEEP FRYING OF POTATO FINGERS

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ABSTRACT

Quality attributes of absorbed oils by potato fingers as affected by prolonged heating and deep frying in 3 different oils (i.e . soybean oil, sunflower oil and cottonseed oil) in addition to 13 of their blends at different ratios were investigated in the present study. The batches of potato fingers (Diamond var) were deep fried at zero time and at 2 hr intervals for total time of 24 hr. the temperature was maintained at 100°C between batches then elevated to 180°C for deep frying . The effect of heating time on sensory evaluation of fried potato fingers was much pronounced than the type of oil and/ or oil blend. Free fatty acids (%) , peroxide value , p-anisidine value , totox value , dienes and trienes , and polar compounds were significantly increased, while iodine value decreased markedly as affected by prolonged heating and deep frying of potato fingers . It was obvious that ,as the heating was proceeded as the extent of changes was more pronounced . Data showed highly significant correlation between all quality attributes understudy .In the light of data and despite diversity of change rates depending on the type of oil and/ or oil blend, it can be stated that except oil blends containing sunflower oil: soybean oil or cottonseed oil (3:1 w/w), the other oil samples and oil blends can be discarded after heating for 16 and 22 hrs, respectively. Notwithstanding, the former two oil blends can be successfully reused up to 24 hr of heating . Generally , oil blends seemed to be more efficient as frying oil rather than their pure oils. The linear regression equations were also discussed to predict the deterioration of oil blends.

Keywords:Frying oils, sunflower oil, soybean oil, cottonseed oil, oil blends , heating time, deep-fat frying , potato fingers , deteriorative effects, sensory evaluation , free fatty acids , iodine value , peroxide value , p-anisidine , totox value, polar compounds, dienes and trienes.

INTRODUCTION

Frying as a method of preparing food was used as early as 1600 BC by the ancient Egyptians (Banks,1996) . Deep fat frying is a very important method of cooking because it is fast, convenient, and deep-fat fried foods are generally liked for flavour and texture. However ,the use of fat and oil for frying could be considered as one of the most popular methods for the preparation of food despite the current health trends (Mc Savage & Trevisan, 2001). In deep fat frying, often the fat which kept hot for long periods of time at 180 °C and moisture and air are mixed into the hot oil. The fried foods absorb this heated fat and it becomes part of our diet (Alexander,1978) . The properties of the absorbed oil will influence the eating quality of the finished product (Mc Savage & Trevisan,2001). During deep-frying , fats and oils are repeatedly used at elevated temperature in the presence of atmospheric oxygen and receive maximum oxidative and thermal abuse (Tyagi & Vasishtha, 1996). Heating in the presence of air causes partial conversion of

fats and oils to volatile chain-scission products, nonvolatile oxidized derivatives and dimeric , polymeric , or cyclic substances (change et al , 1978) that may pose health hazards (Cuesta et al ,1993) . Moreover, there is some evidence that highly oxidized and heated fats may have carcinogenic properties because of potentially toxic substances (Tyagi and Vasishtha, 1996). The absorbed oil becomes an ingredient that induces chemical alterations during prolonged heating periods. The limits for alteration of the oils were established at 25% polar lipids and 1% free fatty acids (Cella et al,2002). As the oil was degraded the flavour of the fried foods decreased proportionally . Panelists distinguished the quality of fried foods prepared with different degrading oils , but it was difficult to distinguish highly deteriorated oils containing more than 15% polar compounds (Harda et al ,2004) . In Egypt , there is a great shortage in edible oils and accordingly , large amount are imported to overcome this problem. Oil plants tend to blend oils, mainly cotton seed oil , sunflower oil and soybean oil to produce blends have wide purposes of use . These blends are used in deep fat frying of foods at elevated temperature for long periods no matter of their deteriorative effect. Researches in this respect are scarce specially for the absorbed oil by food which actually makes up a significant portion of the final food product . The present study was carried out to investigate the quality attributes of absorbed oils by potato fingers as affected by prolonged heating (up to 24 hr) of such oil (i.e. cottonseed oil ,sunflower oil and soybean oil) and / or their blends at different ratios.

MATERIALS AND METHODS

Materials:

Fresh oils: soy bean (sb) , sunflower (sf) and cottonseed (cs) oils were kindly secured by the company of Extracted Oils and Derivatives Egypt. Samples(S) and blends(B) "w/w" were as follows : S1 , (sb,100%), S2 (sf, 100%) , S3 (cs, 100%) , B1 (sb + sf, 1:1) ,B2(sb +cs , 1:1) , B3 (sf + cs , 1:1) , B4 (sb + sf + cs , 1:1:1) , B5 (sb + sf + cs , 2:1:1) , B6 (sb + sf , 3:1) , B7 (sb + cs, 3:1) , B8 (sb + sf + cs , 1:1:2) , B9 (sb + sf + cs , 1:2:1) , B10 (sb + cs , 1:3) , B11 (sb + sf , 1:3), B12 (sf + cs , 3:1) , and B13 (sf + cs , 1:3) .

Potatoes : One hundred and fifty kgs of potatoes (Diamond var.) were brought from Maba Company , Egypt .

Methods:

Technological methods:

The potato tubers were washed , peeled , cut into fingers equal in length (5 cm) , width (1 cm) and thickness (1 cm) and submerged in water until needed. The oil sample or oil blend (1.5 kg) was placed in 2 L capacity stainless steal pan for frying of potatoes at laboratory scale and heated at 180 ^{o}C . Potato fingers were fried in 250 g batches. The batches were fried at zero time and at 2 hr intervals for total time of 24 hr (i.e . 8 hr x 3 consecutive days).

The temperature was maintained at 100 ^{o}C between batches then elevated to 180^{o}C for frying the next batch . After the 8 hr of heating , the

pans were let to cool to room temp. for 16 hr , then reheated in the next day. The frying potato fingers , soon after frying , were divided into 2 parts. One part was taken for sensory evaluation by 10- well trained panlists whom asked to evaluate the colour, flavour , texture and overall acceptability of potato fingers using a hedonic scale of 10 points: 9-10 excellent, 7-8 (good) , 5-6 (fair) , 3-4 (poor) and 1-2 (very poor) as outlined by Kramer and Twigg (1970). The second part was taken for oil extraction . The absorbed oil in potato fingers was extracted successive four times (5 min each) in a waring blendor using a solvent mixture composing of chloroform and methanol (2:1, v/v) . Potato fingers to solvent ratio used was 1:5 (w/v) The resultant extracts were combined and the solvent was evaporated by a rotary evaporator at 40 ^{o}C . extracted oils were kept at – 18 ^{o}C until used for subsequent analysis (Youssef et al , 1989).

Oil analysis:

American Oil Chemists Society methods (1983) were used for determining % free fatty acids (FFA) (Methods Cd 3a , 63) , peroxide value (PV) (Method Cd 8- 53) ,iodine value (AV)(Method Cd 1-25) . The anisidine value (AV) was determined by the IUPAC method (1987). In this method , the extracted oil was treated with P- anisidine reagent in isooctane solution and the reaction products were determined spectrophotometrically at 350 nm . Total oxidation value (Totox value)was calculated from the following equation: Totox value = 2 PA + AV

The absorbances due to the conjugated dienes and trienes were measured at 232 and 268 nm , respectively in 1% oil solution in octane as described by Danopolus and Ninni (1972).

Determination of polar compounds was carried out using the column chromatography method described by IUPAC (1987) . The eluation solvent used was light petroleum and diethyl ether (87+ 13, v/v) .

Statistical analysis:

Data were subjected to analysis of variance and Duncan's Multiple Range test to separate the treatment means and the correlation coefficients (r) between each pair of analytical values understudy and overall acceptability were calculated as outlined by Steel and Torrie (1980) . Simple regression analysis were carried out using Excell Program "Windows 2000".

RESULTS AND DISCUSSION

Sensory evaluation of fried potato fingers:

Since data for colour , flavour and texture of fried potato fingers as affected by heating time and/or type of oil/ oil blend were significantly correlated with the overall acceplability ($r = 0.905^{**}$, 0.918^{**} and 0.923^{**}, respectively), data for overall acceptability only are shown in Table (1). It was clear that the effect of heating time was much pronounced than the type of oil / oil blend did. The elongation of heating time negatively affected the sensory evaluation of fried potato fingers significantly. The remarks reported by the panelists showed that fried potato fingers should be rejected after 18-20 hr of heating under the experiment conditions except potato fingers fried in B10,

B11 and B12 which were accepted up to 24 hr of heating . The rejection mainly focused on the greasy surface and appearance of slight burnt flavour.

Data in Table (2) represent the effect of heating and frying processes on the FFA (%) of oil absorbed by potato fingers. It is clear that all oil samples and oil blends showed gradual but highly significant increases in FFA (%).The steady rise in free fatty acids can be attributed partly to both the hydrolysis of triglyceride of oil and to the carboxylic groups present in the formed polar polymeric products during frying (Perkins , 1967; Peled et al , 1975).

However , The two points of interest are :

1- The FFA (%) were more or less the same in all oil samples and their blends up to 4hr of heating.
2- The heated oil blends had significantly less FFA (%) during the rest heat treatments and up to 24hr of heating compared with the three heated oil samples. Data presented here obviously indicate that the oils and their blends utilized in the present study underwent severe hydrolytic rancidity . However , the FFA (%) of absorbed oil blends only rather than oil samples were found under the maximum recommended FFA (%) by codex (1.5 %) up to 24hr of heating.

Data for the iodine values of the oil absorbed by potato fingers are shown in Table (3). No significant changes were shown during the first 6 hr of heating and frying. Dramatic and significant declines were noticed after this period up to the end of experiment. Notwithstanding ,oils absorbed belong to B3, B11, B12, B13 showed significantly the lowest changes in the iodine value (up to 18-19%) in contrary to the rest samples (declines were more than 23%) . However, the oil samples (i.e S1,, S2 & S3) showed much pronounced decline of iodine value than the absorbed oil blends did . The decline of iodine value up to 21.7% reduction was reported by Robertson and Morrison (1977) after heating sunflower oil for 8hr/day at 182 ^{o}C . The decrease of iodine value as affected by heating and frying was further confirmed by Aggelousis and Lalas (1997) , Narasimhamurthy and Raine (1998) , Tyagi et al (1998) and Combe (2003) .

Table (4) illustrates the peroxide values of oil absorbed by potato fingers . In general , the peroxide value increased significantly due to heating and frying processes and this was true for all absorbed oils understudy . However, the rate of the dramatic increase was varied significantly from oil/ oil blend to another . The peroxide value reached the figure 10 mequi . O_2 / kg oil after 16hr and 20-22hr of heating for oil samples and oil blends, respectively. It was clear that the lowest values up to 24hr of heating were recorded for B11 and B12 in which sunflower oil is the dominant in these blends . The peroxide value of oil represents the net effect of peroxide formation and peroxide degradation (Guillamin , 1979) .

Table 1 : Overall acceptability of potato fingers fried on different oil samples and blends *.

S / t	S_1	S_2	S_3	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}	B_{12}	B_{13}
0	$^{c}8.2^{a}$	$^{a}9.1^{a}$	$^{ab}9.0^{a}$	$^{cd}8.7^{a}$	$^{bc}8.8^{a}$	8.5^{a}	$^{ab}9.0^{a}$	$^{bc}8.8^{a}$	$^{d}8.5^{a}$	$^{c}8.2^{a}$	$^{bc}8.8^{a}$	$^{ab}9.0^{a}$	$^{ab}9.0^{a}$	$^{abc}8.9^{a}$	$^{abc}8.9^{a}$	$^{cd}8.7^{a}$
2	$^{ef}8.3^{a}$	$^{a}9.2^{a}$	$^{ab}9.0^{a}$	$^{ef}8.3^{b}$	$^{cd}8.7^{a}$	$^{cd}8.6^{a}$	$^{de}8.5^{b}$	$^{fg}8.2^{b}$	$^{de}8.5^{a}$	$^{g}8.0^{a}$	$^{de}8.5^{b}$	$^{de}8.5^{b}$	$^{bc}8.8^{a}$	$^{cd}8.7^{b}$	$^{ef}8.3^{b}$	$^{ef}8.3^{b}$
4	$^{fg}7.8^{b}$	$^{b}8.6^{b}$	$^{a}9.1^{a}$	$^{ef}8.0^{c}$	$^{cd}8.3^{b}$	$^{bc}8.5^{a}$	$^{de}8.2^{c}$	$^{ef}8.0^{b}$	$^{ef}8.0^{b}$	$^{fg}7.6^{b}$	$^{cd}8.3^{b}$	$^{ef}8.0^{c}$	$^{cd}8.3^{b}$	$^{bcd}8.4^{c}$	$^{cd}8.3^{b}$	$^{fg}7.7^{cd}$
6	$^{hi}7.2^{c}$	$^{abc}8.3^{bc}$	$^{a}8.5^{b}$	$^{def}8.0^{c}$	$^{abc}8.3^{b}$	$^{de}8.0^{b}$	$^{de}8.0^{c}$	$^{fg}7.7^{c}$	$^{bcd}8.2^{b}$	$^{fg}7.6^{b}$	$^{ab}8.4^{b}$	$^{i}7.7^{d}$	$^{de}8.0^{c}$	$^{cd}8.1^{d}$	$^{de}8.0^{c}$	$^{ef}7.9^{c}$
8	$^{ij}7.4^{c}$	$^{ab}7.9^{cd}$	$^{a}8.1^{c}$	$^{a}8.1^{c}$	$^{ab}7.9^{c}$	$^{cd}7.5^{c}$	$^{bc}7.7^{d}$	$^{e}7.0^{d}$	$^{bc}7.7^{c}$	$^{e}7.1^{c}$	$^{a}8.0^{c}$	$^{de}7.3^{e}$	$^{bc}7.7^{d}$	$^{ab}7.9^{de}$	$^{a}8.0^{c}$	$^{ij}7.4^{e}$
10	$^{ij}6.5^{d}$	$^{a}8.0^{cd}$	$^{a}8.2^{bc}$	$^{b}7.7^{d}$	$^{de}7.2^{d}$	$^{b}7.6^{c}$	$^{de}7.2^{e}$	$^{de}7.1^{d}$	$^{cd}7.3^{d}$	$^{i}6.8^{d}$	$^{bc}7.5^{d}$	$^{cd}7.0^{f}$	$^{cd}7.3^{e}$	$^{b}7.6^{e}$	$^{ij}7.7^{d}$	$^{bc}7.5^{de}$
12	$^{i}6.3^{d}$	$^{bc}7.2^{e}$	$^{bc}7.1^{d}$	$^{b}7.3^{e}$	$^{c}7.0^{de}$	$^{c}7.0^{e}$	$^{de}6.6^{f}$	$^{cd}6.8^{e}$	$^{b}7.3^{d}$	$^{c}7.0^{cd}$	$^{c}7.0^{ef}$	$^{ef}6.5^{g}$	$^{b}7.3^{e}$	$^{a}7.7^{e}$	$^{a}7.8^{d}$	$^{cd}6.8^{f}$
14	$^{cd}6.6^{d}$	$^{c}7.0^{e}$	$^{cd}6.8^{d}$	$^{c}7.0^{f}$	$^{cd}6.8^{e}$	$^{bc}7.1^{d}$	$^{hi}6.0^{g}$	$^{fg}6.3^{g}$	$^{de}6.6^{e}$	$^{ef}6.4^{e}$	$^{bc}7.1^{e}$	$^{gh}6.1^{h}$	$^{c}7.0^{f}$	$^{a}7.5^{e}$	$^{ab}7.3^{e}$	$^{c}6.9^{f}$
16	$^{i}5.4^{e}$	$^{bc}6.5^{f}$	$^{cde}6.3^{e}$	$^{g}6.6^{g}$	$^{ab}6.8^{e}$	$^{g}6.6^{f}$	5.5^{h}	$^{bc}6.5^{f}$	$^{g}6.1^{f}$	$^{de}6.2^{e}$	$^{ab}6.8^{f}$	$^{i}5.8^{i}$	$^{a}6.9^{f}$	$^{bcd}6.4^{f}$	$^{bc}6.5^{f}$	$^{cde}6.3^{g}$
18	$^{hi}5.1^{e}$	$^{ef}5.8^{g}$	$^{de}5.9^{f}$	$^{cde}6.0^{h}$	$^{bcd}6.1^{f}$	$^{bc}6.2^{f}$	$^{fg}5.6^{h}$	$^{cde}6.0^{h}$	$^{cde}6.0^{f}$	$^{de}5.9^{f}$	$^{ab}6.3^{g}$	$^{g}5.4^{j}$	$^{a}6.5^{g}$	$^{cde}6.0^{g}$	$^{de}5.9^{h}$	$^{g}5.5^{i}$
20	$^{i}4.2^{f}$	$^{hi}5.0^{h}$	$^{ef}5.4^{g}$	$^{fg}5.3^{i}$	$^{def}5.5^{g}$	$^{bcd}5.7^{g}$	$^{gh}5.1^{i}$	$^{def}5.5^{i}$	$^{bcd}5.7^{g}$	$^{def}5.5^{g}$	$^{ab}5.9^{h}$	$^{hi}5.0^{k}$	$^{a}6.1^{h}$	$^{def}5.5^{h}$	$^{cde}5.6^{i}$	$^{bc}5.8^{h}$
22	$^{i}4.2^{f}$	$^{e}4.6^{i}$	$^{de}4.8^{h}$	$^{cd}5.0^{i}$	$^{cd}4.9^{h}$	$^{bc}5.1^{h}$	$^{cd}4.9^{i}$	$^{bc}5.1^{j}$	$^{bc}5.1^{h}$	$^{bc}5.1^{h}$	$^{a}5.4^{i}$	$^{cd}4.9^{k}$	$^{a}5.3^{i}$	$^{abc}5.2^{i}$	$^{cd}5.2^{j}$	$^{cd}5.0^{j}$
24	$^{bc}4.3^{f}$	$^{d}4.0^{j}$	$^{d}4.0^{j}$	$^{bc}4.4^{k}$	$^{d}4.0^{j}$	$^{b}4.5^{j}$	$^{d}4.0^{j}$	$^{a}4.8^{k}$	$^{bc}4.3^{h}$	$^{cd}4.2^{j}$	$^{a}4.9^{j}$	d4.0^{j}	$^{a}5.0^{j}$	$^{a}5.0^{j}$	$^{a}5.0^{j}$	$^{a}4.8^{j}$

Means not sharing the same superscript are significantly different at p< 0.01., Left letters (among samples within the same time , in raw)., Right letters (among times within the same sample , in a column) . * : S: sample , t: time/hour , Foil : fresh oil .

Table 2 : Free fatty acid (%) of oil samples and blends absorbed by potato fingers as affected by heating for different periods *.

S / t	S_1	S_2	S_3	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}	B_{12}	B_{13}
Foil	$^{ab}0.12^{l}$	$^{ab}0.14^{l}$	$^{a}0.2^{l}$	$^{ab}0.14^{l}$	$^{ab}0.14^{k}$	$^{ab}0.11^{k}$	$^{ab}0.13^{k}$	$^{ab}0.12^{l}$	$^{ab}0.14^{k}$	$^{b}0.10^{k}$	$^{ab}0.12^{l}$	$^{ab}0.13^{k}$	$^{ab}0.12^{k}$	$^{ab}0.11^{k}$	$^{ab}0.13^{k}$	$^{ab}0.11^{k}$
0	$^{a}0.16^{l}$	$^{a}0.18^{l}$	$^{a}0.17^{l}$	$^{a}0.16^{l}$	$^{a}0.17^{k}$	$^{a}0.18^{k}$	$^{a}0.18^{k}$	$^{a}0.16^{l}$	$^{a}0.15^{k}$	$^{a}0.15^{k}$	$^{a}0.17^{l}$	$^{a}0.18^{k}$	$^{a}0.15^{k}$	$^{a}0.16^{k}$	$^{a}0.17^{k}$	$^{a}0.18^{k}$
2	$^{a}0.21^{k}$	$^{a}0.26^{k}$	$^{a}0.30^{k}$	$^{a}0.26^{k}$	$^{a}0.25^{k}$	$^{a}0.23^{j}$	$^{a}0.27^{jk}$	$^{a}0.26^{k}$	$^{a}0.21^{k}$	$^{a}0.22^{j}$	$^{a}0.27^{j}$	$^{a}0.29^{j}$	$^{a}0.28^{j}$	$^{a}0.26^{j}$	$^{a}0.28^{j}$	$^{a}0.28^{j}$
4	$^{e}0.29^{k}$	$^{abcde}0.37^{k}$	$^{ab}0.41^{j}$	$^{bcde}0.35^{kl}$	$^{bcde}0.34^{kl}$	$^{de}0.30^{j}$	$^{bcde}0.35^{ij}$	$^{bcde}0.32^{kl}$	$^{abc}0.40^{j}$	$^{bcde}0.36^{kl}$	$^{cde}0.31^{j}$	$^{ab}0.41^{j}$	$^{a}0.45^{j}$	$^{bcde}0.37^{kl}$	$^{abcde}0.39^{j}$	$^{abcde}0.38^{kl}$
6	$^{e}0.33^{j}$	$^{bc}0.48^{j}$	$^{a}0.58^{j}$	$^{abc}0.51^{j}$	$^{abc}0.51^{j}$	$^{bc}0.48^{hi}$	$^{cd}0.43^{j}$	$^{cd}0.42^{j}$	$^{cd}0.44^{ij}$	$^{cde}0.42^{jk}$	$^{de}0.36^{jk}$	$^{ab}0.56^{hi}$	$^{ab}0.54^{jk}$	$^{cd}0.44^{jk}$	$^{abc}0.50^{hi}$	$^{cd}0.43^{jk}$
8	$^{e}0.50^{j}$	$^{abc}0.64^{j}$	$^{a}0.69^{ij}$	$^{abcd}0.60^{hi}$	$^{cde}0.57^{j}$	$^{ab}0.63^{ij}$	$^{cde}0.55^{hi}$	$^{e}0.50^{hi}$	$^{de}0.53^{hij}$	$^{e}0.50^{ghi}$	$^{abcd}0.60^{hi}$	$^{ab}0.68^{ij}$	$^{bcde}0.59^{ghi}$	$^{de}0.52^{ghi}$	$^{cde}0.58^{gh}$	$^{e}0.50^{hi}$
10	$^{ef}0.60^{hi}$	$^{ab}0.74^{hi}$	$^{a}0.83^{ij}$	$^{bcd}0.70^{ij}$	$^{bcde}0.65^{hi}$	$^{bcde}0.69^{ij}$	$^{cd}0.64^{ij}$	$^{i}0.58^{hi}$	$^{def}0.61^{gh}$	$^{i}0.58^{ig}$	$^{bc}0.72^{ij}$	$^{bc}0.73^{ig}$	$^{cdef}0.64^{ij}$	$^{ef}0.60^{ij}$	$^{bcde}0.65^{ij}$	$^{def}0.62^{ij}$
12	$^{cde}0.71^{ij}$	$^{d}0.90^{ij}$	$^{a}1.00^{i}$	$^{bc}0.82^{i}$	$^{cdef}0.73^{ij}$	$^{cd}0.80^{i}$	$^{cde}0.77^{i}$	$^{def}0.72^{ij}$	$^{ef}0.70^{ig}$	$^{i}0.64^{i}$	$^{cd}0.80^{ij}$	$^{bc}0.82^{ef}$	$^{cde}0.77^{i}$	$^{cde}0.74^{i}$	$^{cde}0.77^{i}$	$^{cde}0.74^{i}$
14	$^{def}0.82^{i}$	$^{ab}1.02^{i}$	$^{a}1.09^{i}$	$^{c}0.92^{i}$	$^{cd}0.90^{ij}$	$^{cdef}0.84^{i}$	$^{def}0.82^{ef}$	$^{ef}0.80^{i}$	$^{i}0.78^{i}$	$^{def}0.81^{ef}$	$^{bc}0.93^{i}$	$^{cd}0.90^{ef}$	$^{cdef}0.85^{i}$	$^{cd}0.90^{ef}$	$^{cde}0.88^{ef}$	$^{cd}0.90^{ef}$
16	$^{cd}0.99^{ij}$	$^{ab}1.13^{hi}$	$^{a}1.20^{hi}$	$^{bc}1.04^{hi}$	$^{cd}1.00^{ef}$	$^{cde}0.98^{ef}$	$^{c}1.03^{hi}$	$^{de}0.93^{ef}$	$^{e}0.90^{ef}$	$^{cde}0.95^{gh}$	$^{b}1.05^{ef}$	$^{c}1.03^{gh}$	$^{cde}0.95^{ef}$	$^{cd}1.00^{fg}$	$^{cde}0.95^{ef}$	$^{cd}1.01^{gh}$
18	$^{c}1.11^{hi}$	$^{b}1.22^{hi}$	$^{a}1.35^{gh}$	$^{bc}1.18^{hi}$	$^{bcd}1.16^{gh}$	$^{cdef}1.10^{gh}$	$^{bcde}1.13^{fg}$	$^{e}1.05^{gh}$	$^{f}1.03^{gh}$	$^{e}1.04^{gh}$	$^{bc}1.19^{gh}$	$^{cdef}1.12^{gh}$	$^{def}1.08^{gh}$	$^{bcde}0.13^{k}$	$^{def}1.07^{gh}$	$^{cdef}1.11^{fg}$
20	$^{bcd}1.30^{fg}$	$^{ab}1.39^{fg}$	$^{a}1.48^{fg}$	$^{bc}1.31^{gh}$	$^{cd}1.29^{fg}$	$^{c}1.23^{fg}$	$^{cde}1.28^{gh}$	$^{def}1.21^{fg}$	$^{f}1.18^{fg}$	$^{f}1.17^{fg}$	$^{bc}1.31^{fg}$	$^{cdef}1.25^{fg}$	$^{ef}1.19^{fg}$	$^{cdef}1.25^{gh}$	$^{ef}1.19^{gh}$	$^{cde}1.28^{gh}$
22	$^{b}1.48^{gh}$	$^{b}1.46^{gh}$	$^{a}1.58^{gh}$	$^{bc}1.43^{gh}$	$^{bc}1.45^{gh}$	$^{bcde}1.39^{gh}$	$^{bcde}1.40^{gh}$	$^{e}1.34^{gh}$	$^{e}1.33^{gh}$	$^{cde}1.36^{gh}$	$^{cde}1.36^{gh}$	$^{bcd}1.39^{gh}$	$^{b}1.35^{gh}$	$^{bcde}1.40^{gh}$	$^{e}1.33^{gh}$	$^{bcde}1.40^{gh}$
24	$^{abc}1.57^{gh}$	$^{ab}1.60^{gh}$	$^{a}1.65^{gh}$	$^{cde}1.48^{gh}$	$^{bcd}1.54^{gh}$	$^{bcd}1.49^{gh}$	$^{cde}1.49^{gh}$	$^{cde}1.48^{gh}$	$^{e}1.44^{gh}$	$^{e}1.44^{gh}$	$^{cde}1.48^{gh}$	$^{cde}1.48^{gh}$	$^{de}1.46^{gh}$	$^{de}1.47^{gh}$	$^{de}1.45^{gh}$	$^{cde}1.48^{gh}$

* : S: sample , t: time/hour , Foil : fresh oil . ** as in Table 1

Table 3 :Iodine value of oil samples and blends absorbed by potato fingers as affected by heating for different periods *.

*** : S: sample , t: time/hour , Foil : fresh oil . ** as in Table 1**

S / t	S_1	B_1	S_2	S_3	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}	B_{12}	B_{13}
Foil	$^{abc}125.7^{a}$	$^{ab}125.9^{a}$	$^{a}126.7^{a}$	$^{d}113.8^{a}$	$^{abcd}121.0^{a}$	$^{abc}124.9^{ab}$	$^{abcd}120.8^{a}$	$^{abcd}121.8^{a}$	$^{a}127.0^{a}$	$^{abcd}119.7^{a}$	$^{bcd}118.7^{a}$	$^{abcd}121.2^{a}$	$^{d}115.3^{a}$	$^{abc}124.8^{a}$	$^{e}117.9^{a}$	$^{d}115.1^{a}$
O	$^{ab}125.3^{a}$	$^{ab}125.7^{a}$	$^{a}126.0^{a}$	$^{d}112.9^{ab}$	$^{abcd}120.3^{a}$	$^{abc}124.0^{ab}$	$^{abcd}120.0^{a}$	$^{abcd}121.3^{ab}$	$^{a}126.0^{ab}$	$^{abcd}118.7^{a-c}$	$^{bcd}118.0^{a}$	$^{abcd}120.3^{a}$	$^{d}114.3^{a}$	$^{abc}124.0^{a}$	$^{e}117.0^{a}$	$^{d}114.5^{ab}$
2	$^{abc}123.9^{ab}$	$^{abc}123.8^{ab}$	$^{a}125.2^{a}$	$^{e}111.1^{ab}$	$^{abcd}120.0^{ab}$	$^{abc}122.7^{ab}$	$^{abcde}118.6^{ab}$	$^{abcd}120.6^{ab}$	$^{ab}124.4^{abc}$	$^{abcde}117.5^{abc}$	$^{bcde}116.9^{ab}$	$^{abcde}118.8^{ab}$	$^{de}114.0^{a}$	$^{abc}122.8^{ab}$	$^{cde}116.3^{ab}$	$^{de}113.9^{ab}$
4	$^{a}122.5^{abc}$	$^{a}121.7^{ab}$	$^{a}122.8^{ab}$	$^{e}108.8^{abc}$	$^{ab}118.6^{ab}$	$^{a}121.2^{abc}$	$^{ab}117.1^{ab}$	$^{ab}118.8^{ab}$	$^{a}122.7^{a-c}$	$^{abc}115.3^{abcd}$	$^{abc}115.6^{ab}$	$^{ab}117.1^{abc}$	$^{be}112.8^{ab}$	$^{a}121.1^{ab}$	$^{abc}114.9^{ab}$	$^{be}111.7^{ab}$
6	$^{a}120.8^{abcd}$	$^{a}120.3^{abc}$	$^{a}119.7^{abc}$	$^{e}105.1^{bcd}$	$^{ab}116.8^{abc}$	$^{a}120.6^{abcde}$	$^{ab}114.7^{abcd}$	$^{ab}116.2^{abcd}$	$^{a}119.0^{bcd}$	$^{ab}113.8^{abcd}$	$^{ab}114.1^{abc}$	$^{ab}116.0^{abcd}$	$^{be}111.0^{ab}$	$^{a}120.3^{abc}$	$^{ab}114.0^{ab}$	$^{be}110.0^{abc}$
8	$^{a}118.3^{abcde}$	$^{a}118.6^{abcd}$	$^{abc}116.1^{bcd}$	$^{d}102.3^{cde}$	$^{abc}115.3^{abc}$	$^{a}118.3^{abcde}$	$^{abc}111.5^{bcde}$	$^{abc}113.8^{bcde}$	$^{ab}116.6^{cde}$	$^{abc}111.1^{bcdef}$	$^{abc}112.3^{abc}$	$^{abc}114.7^{abcde}$	$^{be}109.3^{abc}$	$^{a}118.8^{abc}$	$^{abc}112.5^{abc}$	$^{cd}108.2^{abcd}$
10	$^{a}116.5^{bcde}$	$^{a}116.8^{bcd}$	$^{ab}114.0^{cde}$	$^{e}99.9^{def}$	$^{ab}112.2^{bcde}$	$^{a}116.7^{bcdef}$	$^{ab}109.0^{cdefg}$	$^{ab}110.2^{cdef}$	$^{ab}113.5^{dff}$	$^{ab}109.6^{cdef}$	$^{ab}109.9^{bcd}$	$^{ab}112.0^{bcdef}$	$^{be}107.6^{abcd}$	$^{a}116.9^{abcd}$	$^{ab}110.4^{abc}$	$^{be}106.7^{bcd}$
12	$^{a}115.2^{cdef}$	$^{ab}113.0^{cdef}$	$^{abc}112.8^{cde}$	$^{e}98.1^{defg}$	$^{abcd}110.6^{cdef}$	$^{a}114.5^{cdefg}$	$^{abcd}107.3^{defg}$	$^{abcd}108.8^{defg}$	$^{abcd}110.7^{cdefg}$	$^{abcd}107.8^{defg}$	$^{bcd}106.3^{cdef}$	$^{abcd}110.3^{cdef}$	$^{cde}104.9^{bcdef}$	$^{a}115.2^{bcde}$	$^{abcd}108.5^{bcdf}$	$^{de}103.3^{cde}$
14	$^{a}114.4^{cdef}$	$^{abc}111.3^{def}$	$^{abc}109.7^{def}$	$^{e}96.6^{efg}$	$^{abcd}107.1^{defg}$	$^{ab}112.8^{cdefgh}$	$^{bcd}104.9^{cdefgh}$	$^{abcd}106.6^{cdefgh}$	$^{abcd}108.1^{fgh}$	$^{bcd}105.2^{cdefgh}$	$^{cde}103.9^{cdef}$	$^{abcd}108.8^{cdef}$	$^{de}102.2^{cdef}$	$^{ab}112.7^{cdef}$	$^{bcd}105.3^{cd}$	$^{de}101.4^{cdef}$
16	$^{a}112.6^{ef}$	$^{ab}108.3^{cfg}$	$^{abc}106.6^{cfg}$	$^{d}94.3^{fgh}$	$^{bc}104.5^{cdefgh}$	$^{a}112.8^{cdefghij}$	$^{bcd}102.2^{fghi}$	$^{bc}104.1^{fghi}$	$^{abc}105.3^{dfgh}$	$^{bc}103.8^{fgh}$	$^{cd}100.2^{efg}$	$^{abc}106.8^{eg}$	$^{cd}100.1^{defg}$	$^{ab}110.1^{defg}$	$^{bcd}100.6^{de}$	$^{e}98.7^{ef}$
18	$^{ab}108.0^{fg}$	$^{abc}105.8^{fgh}$	$^{abcd}103.4^{fg}$	$^{e}94.0^{fgh}$	$^{abcd}102.8^{fghi}$	$^{a}109.7^{fghgij}$	$^{bcde}101.5^{ghi}$	$^{abcd}101.9^{ghij}$	$^{abcd}102.8^{hijk}$	$^{bcde}100.7^{ghi}$	$^{de}96.6^{gh}$	$^{abcd}104.2^{fgh}$	$^{cde}98..2^{efg}$	$^{ab}108.8^{efg}$	$^{cde}98.8^{de}$	$^{cd}97.0^{ef}$
20	$^{ab}104.3^{gh}$	$^{abc}103.2^{ghi}$	$^{abcd}100.2^{gh}$	$^{e}92.1^{fgh}$	$^{abcd}100.6^{ghi}$	$^{a}107.3^{ghij}$	$^{bcde}98.8^{hij}$	$^{abcd}100.2^{hij}$	$^{abcd}100.1^{ijk}$	$^{bcde}98.8^{hij}$	$^{de}93.8^{gh}$	$^{abcd}101.0^{ghij}$	$^{bcde}96.9^{fg}$	$^{a}107.1^{fg}$	$^{bcde}97.0^{e}$	$^{de}96.1^{ef}$
22	$^{ab}100.6^{gh}$	$^{ab}100.1^{hi}$	$^{bcd}96.0^{gh}$	$^{d}90.7^{gh}$	$^{abc}98.8^{hi}$	$^{ab}105.1^{ij}$	$^{bcd}96.2^{ij}$	$^{abc}98.8^{ij}$	$^{bcd}96.6^{jk}$	$^{bcd}95.3^{ij}$	$^{cd}92..0^{h}$	$^{bcd}97.1^{hi}$	$^{bcd}95.3^{fg}$	$^{a}105.5^{fg}$	$^{bcd}96.6^{e}$	$^{bcd}94.6^{f}$
24	$^{ab}96.8^{h}$	$^{abc}97.3^{i}$	$^{cd}93.1^{h}$	$^{d}88.8^{h}$	$^{bcd}95.1^{i}$	$^{ab}102.8^{ij}$	$^{cd}93.3^{j}$	$^{abcd}96.0^{j}$	$^{bcd}95.0^{k}$	$^{cd}92.2^{j}$	$^{cd}90.7^{h}$	$^{cd}94.2^{i}$	$^{cd}93.8^{g}$	$^{a}103.1^{g}$	$^{cd}94.8^{e}$	$^{cd}94.6^{f}$

Table 4 : peroxide value of oil samples and blends absorbed by potato fingers as affected by heating for different periods *.

S / t	S_1	S_2	S_3	B_1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13
Foil	$^{i}0.59^{k}$	$^{e}0.67^{jk}$	$^{a}0.71^{j}$	$^{a}0.49^{j}$	$^{a}0.51^{k}$	$^{a}0.49^{j}$	$^{a}0.59^{i}$	$^{a}0.67^{i}$	$^{a}0.60^{i}$	$^{a}0.57^{k}$	$^{a}0.49^{i}$	$^{a}0.52^{j}$	$^{a}0.61^{j}$	$^{a}0.97^{j}$	$^{a}0.56^{i}$	$^{a}0.61^{k}$
0	$^{i}0.63^{k}$	$^{e}0.67^{jk}$	$^{a}0.77^{j}$	$^{a}0.55^{j}$	$^{a}0.60^{jk}$	$^{a}0.54^{j}$	$^{a}0.66^{i}$	$^{a}0.73^{i}$	$^{a}0.66^{i}$	$^{a}0.66^{i}$	$^{a}0.55^{i}$	$^{a}0.60^{i}$	$^{a}0.70^{j}$	$^{a}0.52^{j}$	$^{a}0.61^{hi}$	$^{a}0.65^{ijk}$
2	$^{i}1.06^{jk}$	$^{a}1.02^{ijk}$	$^{a}1.18^{ij}$	$^{a}0.81^{ij}$	$^{a}0.71^{k}$	$^{a}0.66^{ij}$	$^{a}0.88^{i}$	$^{a}1.04^{i}$	$^{a}0.72^{ij}$	$^{a}0.80^{j}$	$^{a}0.87^{hi}$	$^{a}0.73^{ij}$	$^{a}0.82^{ij}$	$^{a}0.66^{ij}$	$^{a}0.83^{hi}$	$^{a}0.95^{ijk}$
4	$^{abc}1.59^{ij}$	$^{ab}1.64^{j}$	$^{a}1.85^{i}$	$^{abc}1.28^{i}$	$^{bc}1.01^{jk}$	$^{bc}0.95^{ij}$	$^{bc}1.15^{hi}$	$^{abc}1.34^{hi}$	$^{bc}1.04^{ij}$	$^{abc}1.28^{ij}$	$^{abc}1.33^{ghc}$	$^{a}0.91^{hid}$	$^{bc}0.97^{ij}$	$^{bc}0.98^{ij}$	$^{abc}1.28^{h}$	$^{abc}1.22^{ij}$
6	$^{bc}1.98^{i}$	$^{ab}2.46^{i}$	$^{a}2.77^{h}$	$^{bc}2.05^{h}$	$^{cde}1.48^{ij}$	$^{de}1.24^{hij}$	$^{cde}1.58^{gh}$	$^{bcd}1.82^{gh}$	$^{cde}1.44^{hi}$	$^{cde}1.65^{i}$	$^{bcd}1.82^{g}$	$^{a}1.07^{hij}$	$^{a}1.11^{ij}$	$^{de}1.28^{hi}$	$^{bc}2.05^{g}$	$^{cde}1.60^{i}$
8	$^{bc}2.79^{h}$	$^{b}3.44^{h}$	$^{a}4.88^{g}$	$^{cde}2.55^{h}$	$^{defgh}2.09^{i}$	$^{efgh}1.87^{gh}$	$^{fgh}1.86^{ij}$	$^{cde}2.51^{fg}$	$^{efgh}2.01^{gh}$	$^{cdefg}2.35^{h}$	$^{cde}2.56^{f}$	$^{h}1.55^{gh}$	$^{h}1.47^{i}$	$^{g}1.73^{hi}$	$^{de}2.71^{g}$	$^{cde}2.33^{h}$
10	$^{bc}3.88^{g}$	$^{b}4.19^{g}$	$^{a}6.22^{f}$	$^{cde}3.27^{g}$	$^{ef}2.88^{h}$	$^{fg}2.55^{fg}$	$^{efg}2.60^{f}$	$^{def}3.17^{f}$	$^{fg}2.56^{g}$	$^{bcd}3.82^{g}$	$^{cdef}3.22^{f}$	$^{g}1.92^{g}$	$^{g}2.05^{h}$	$^{fg}2.54^{g}$	$^{bcd}3.58^{f}$	$^{bc}3.89^{g}$
12	$^{bc}5.39^{f}$	$^{b}5.77^{f}$	$^{a}8.04^{e}$	$^{def}4.44^{f}$	$^{efg}4.07^{g}$	$^{fg}3.17^{f}$	$^{gh}3.72^{e}$	$^{d}4.66^{e}$	$^{efg}4.07^{f}$	$^{cde}4.93^{f}$	$^{cde}4.76^{e}$	$^{f}2.47^{f}$	$^{f}2.95^{g}$	$^{fg}3.88^{f}$	$^{def}4.27^{e}$	$^{bc}5.38^{f}$
14	$^{b}7.50^{e}$	$^{bc}7.22^{e}$	$^{a}8.95^{d}$	$^{f}5.74^{e}$	$^{hij}4.88^{f}$	$^{ij}4.79^{e}$	$^{ij}4.54^{d}$	$^{de}6.48d$	$^{fgh}5.56^{e}$	$^{cde}6.56^{e}$	$^{ef}6.11^{d}$	$^{k}3.88^{e}$	$^{jk}4.28^{f}$	$^{ghi}5.22^{e}$	$^{ef}6.05^{d}$	$^{bcd}6.99^{e}$
16	$^{b}8.88^{d}$	$^{bc}8.79^{d}$	$^{a}9.66^{e}$	$^{d}6.89^{d}$	$^{efg}5.95^{e}$	$^{fg}5.88^{d}$	$^{g}5.48^{c}$	$^{e}8.11^{c}$	$^{de}6.59^{d}$	$^{e}8.17^{d}$	$^{d}6.95^{e}$	$^{g}5.22^{d}$	$^{def}6.45^{e}$	$^{d}7.04^{d}$	$^{d}6.88^{e}$	$^{e}8.11^{d}$
18	$^{a}10.17^{c}$	$^{ab}9.85^{c}$	$^{a}10.05^{c}$	$^{d}8.21^{c}$	$^{cd}8.37^{d}$	$^{ef}7.58^{e}$	$^{de}7.94^{b}$	$^{b}9.23^{b}$	$^{cd}8.28^{c}$	$^{bc}8.92^{c}$	$^{ef}7.55^{c}$	$^{f}7.15^{e}$	$^{ef}7.71^{d}$	$^{de}8.05^{c}$	$^{cd}8.35^{b}$	$^{bc}9.28^{e}$
20	$^{a}11.46^{b}$	$^{b}10.57^{b}$	$^{a}11.79^{a}$	$^{cd}9.35^{b}$	$^{cde}9.16^{c}$	$^{cde}9.06^{b}$	$^{de}8.59^{b}$	$^{b}10.15^{a}$	$^{cd}9.35^{b}$	$^{bc}9.79^{b}$	$^{cd}9.28^{b}$	$^{de}8.88^{b}$	$^{ede}9.05^{c}$	$^{de}8.78^{b}$	$^{cde}9.01^{b}$	$^{bc}10.31^{b}$
22	$^{a}12.72^{a}$	$^{ab}12.38^{a}$	$^{c}10.95^{a}$	$^{cd}10.52^{a}$	$^{de}9.95^{b}$	$^{d}10.11^{a}$	$^{e}9.80^{a}$	$^{cd}10.75^{a}$	$^{de}9.88^{ab}$	$^{a}10.35^{b}$	$^{de}9.95^{ab}$	$^{e}9.78^{a}$	$^{e}9.78^{b}$	$^{e}9.48^{a}$	$^{e}9.71^{a}$	$^{b}11.70^{a}$
24	$^{a}13.06^{a}$	$^{a}12.85^{a}$	$^{b}11.38^{a}$	$^{bc}11.18^{a}$	$^{bc}10.71^{a}$	$^{def}10.38^{a}$	$^{def}10.17^{a}$	$^{cd}10.68^{a}$	$^{def}1017^{a}$	$^{bc}11.20^{a}$	$^{cde}10.52^{a}$	$^{def}10.37^{a}$	$^{def}10.15^{a}$	$^{f}9.81^{a}$	$^{e}9.88^{a}$	$^{def}10.30^{b}$

*** : S: sample , t: time/hour , Foil : fresh oil . ** as in Table 1**

The peroxide value increased significantly during deep fat frying of potato chips in soybean oil up to 64hr at 180 °C (Tyagi & Vasishtha, 1996)and in a blend of cottonseed oil and sunflower oil after 10 fryings at 180 °C (Hassan & Abou Arab , 2004) . When 20 batches of potato chips were fried at 170 °C over a period of 4 days , soybean oil underwent the greater change than sunflower oil extracted from potato chips (Coll & Clasell , 1984).

P- Anisidine values of oil absorbed by potato fingers as affected by oil blending and heating time are shown in Table (5) . It was clear that p-anisidine values increased significantly by heating time elongation up to the end of experiment. Moreover , oil blending affected the p-anisidine value significantly. In other words , the differences between oils and/or their blends within the same heating time were significant . The point of interest was that blending of sunflower oil with either soybean oil or cottonseed oil by a ratio (3:1 , w/w) significantly decreased the p-anisidine value of the oils absorbed belong to B11 and B12 as compared with other oil blends.

The calculated totox values of absorbed oils are shown in Table (6) . As the result of the effect of heating process on both peroxide value and p-anisidine value, The totox values elucidate significant increases as the heated process was elongated. As well , the differences between totox values belong to oil samples and/or their oil blends were highly significant within the same heating time . The end of the experiment showed a superior of both B11 and B12 as they had the lowest totox values . However, all oil samples and their oil blends had p-anisidine and totox values within the range reported by Agoub et al (1999).

Dienes and trienes in absorbed oils understudy are shown in Tables (7 and 8). As the heating time was elongated the dienes and trienes significantly increased. Deep fat frying produced an increase in the conjugated dienes and trienes when soybean oil was heated at 170,180 and 190 °C up to 70 hr (Tyagi & Vasishtha, 1996). The rate of change was much pronounced for oil samples rather than their oil blends . However , it seemed to be that B11 and B12 were the superior ones since they had significantly the lowest dienes and trienes through heating periods in compared with other oil blends.

Data given in Table (9) generally reveal that as the heating process was proceeded as the % polar compounds (pc) of absorbed oils increased. No significant differences were shown between oil samples and/or oil blends up to two fryings (i.e. frying in fresh oils and after 2 hr of heating) .Then, dramatic increases with significant differences were shown from the third frying up to the end of experiment . However , blending of oils seemed to be a useful process since the PC % reached the value of 25% after 18 hr of heating oil samples compared with 22 hr for different oil blends . The point of interest was that oils absorbed by potato fingers belong to the blends containing 50% or more sunflower oil (i.e. B1, B9, B11 and B12) showed significant lower PC (%) up to 24 hr of heating and frying . According to Paradis and Nawar (1981 a , b) and Blumenthal (1991) fat or oil must be discarded when its polar fraction is more than 25% .

Table (10) shows highly significant correlations between all parameters understudy .

Table 5 : anisidine value of oil samples and blends absorbed by potato fingers as affected by heating for different periods *.

S / t	S_1	S_2	S_3	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}	B_{12}	B_{13}
Foil	^{a}0.899^{k}	^{e}0.667^{k}	$^{+abc}$0.770^{i}	^{ab}0.877^{i}	^{abc}0.807^{i}	^{bc}0.675	^{bc}0.688^{i}	^{abc}0.765^{k}	^{abc}0.780^{i}	^{abc}0.840^{i}	^{abc}0.733^{k}	^{abc}0.718^{i}	^{abc}0.769^{i}	^{bc}0.688^{i}	^{e}0.650^{k}	^{abc}0.717^{i}
0	^{a}1.050^{k}	^{de}0.735^{k}	^{abcd}0.903^{i}	^{ab}0.985^{i}	^{ab}0.995^{i}	^{de}0.717	^{de}0.723^{i}	^{bcde}0.816^{k}	^{bcde}0.825^{kl}	^{abc}0.958^{i}	^{cde}0.765^{k}	^{cde}0.765^{i}	^{bcde}0.797^{i}	^{de}0.735^{i}	^{e}0.668^{k}	^{cde}0.780^{i}
2	^{ab}1.267^{j}	^{de}0.958^{i}	^{a}1.345^{h}	^{bcd}1.103^{hi}	^{ab}1.207^{i}	^{e}0.822	^{abc}1.195^{i}	^{bcd}1.108^{j}	^{abc}1.005^{k}	^{abc}1.195^{i}	^{de}0.923^{k}	^{de}0.955^{k}	^{de}0.948^{i}	^{de}0.979^{i}	^{e}0.805^{ik}	^{de}0.915^{i}
4	^{a}1.538^{i}	^{bc}1.267^{j}	^{a}1.518^{h}	^{bc}1.267^{gh}	^{bc}1.313^{i}	^{de}0.978^{i}	^{d}1.400^{h}	^{b}1.334^{i}	^{bc}1.238^{j}	^{b}1.338^{i}	^{bc}1.265^{j}	^{bcd}1.188^{i}	^{ab}1.115^{i}	^{bcd}1.166^{h}	^{e}0.887^{j}	^{bc}1.226^{i}
6	^{ab}1.626^{hi}	^{cd}1.444^{i}	^{ab}1.733^{g}	^{cd}1.414^{g}	^{bc}1.566^{h}	^{e}1.078^{ij}	^{a}1.789^{h}	^{bc}1.567^{h}	^{bc}1.540^{j}	^{ab}1.642^{h}	^{bc}1.545^{j}	^{ed}1.404^{i}	^{d}1.320h	^{cd}1.397^{g}	^{e}0.965^{j}	^{d}1.333^{hi}
8	^{bc}1.757^{hi}	^{cd}1.667^{h}	$^{+ab}$1.875^{fg}	^{cd}1.675^{f}	^{b}1.800^{g}	^{e}1.276^{i}	^{a}2.067^{g}	^{bc}1.757^{gh}	^{bcd}1.707^{j}	^{bc}1.785^{gh}	^{bc}1.818^{h}	^{bcd}1.677^{h}	^{d}1.515^{h}	^{cd}1.606^{f}	^{e}1.313^{i}	^{de}1.508^{gh}
10	^{cde}1.818^{gh}	^{bc}2.054^{g}	^{bcd}2.049^{cd}	^{cde}1.808^{f}	^{cde}1.845^{g}	^{b}1.583^{h}	^{a}2.277^{f}	^{cde}1.808^{gh}	^{cde}1.954^{k}	^{cde}1.965^{fg}	^{ab}2.194^{g}	^{cde}1.928^{g}	^{gh}1.740^{g}	^{de}1.851^{c}	^{h}1.528^{h}	^{gh}1.689^{g}
12	^{ef}1.957^{fg}	^{cd}2.197^{fg}	^{cd}2.198^{e}	^{cde}2.118^{e}	^{a}2.457^{f}	^{fg}1.808^{g}	^{ab}2.408^{f}	^{ef}1.950^{g}	^{bcd}2.225^{g}	^{cde}2.111^{ef}	^{ab}2.410^{f}	^{abc}2.276^{f}	^{de}2.033^{f}	^{ef}1.995^{e}	^{g}1.747^{g}	^{fg}1.845^{f}
14	^{a}2.083^{ef}	^{ef}2.308^{ef}	^{de}2.373^{d}	^{bcd}2.550^{cd}	^{a}2.788^{e}	^{ef}2.317^{f}	^{abc}2.677^{e}	^{cde}2.200^{i}	^{cd}2.465^{f}	^{ef}2.307^{de}	^{ab}2.733^{e}	^{cde}2.495^{e}	^{efg}2.202^{ef}	^{efg}2.210^{d}	^{g}2.011^{f}	^{fg}2.122^{e}
16	^{a}2.208^{de}	^{ef}2.484^{de}	^{de}2.616^{c}	^{bc}2.875^{bc}	^{a}3.203^{d}	^{cd}2.688^{e}	^{bc}2.851^{c}	^{fg}2.414^{e}	^{bcd}2.788^{e}	^{a}2.458^{d}	^{b}2.900^{c}	^{bcd}2.727^{d}	^{fg}2.361^{de}	^{fg}2.388^{cd}	^{g}2.226^{e}	^{fg}2.376^{d}
18	^{a}2.377^{d}	^{ef}2.667^{d}	^{de}2.731^{bc}	^{b}3.123^{b}	^{a}3.511^{c}	^{bc}3.025^{d}	^{b}3.115^{d}	^{ef}2.678^{d}	^{bc}3.065^{d}	^{d}2.798^{c}	^{b}3.105^{d}	^{cd}2.905^{d}	^{efg}2.533^{d}	^{ef}2.578^{c}	^{fg}2.489^{d}	^{fg}2.515^{c}
20	^{a}2.516^{c}	^{ef}2.954^{c}	$^{+fg}$2.905^{b}	^{ab}3.642^{a}	^{a}3.707^{c}	^{e}3.344^{c}	^{bc}3.505^{c}	^{a}2.922^{c}	^{cd}3.316^{c}	^{fg}2.905^{c}	^{e}3.338^{c}	^{de}3.119^{c}	^{fgh}2.787^{c}	^{fgh}2.818^{b}	^{gh}2.736^{c}	^{hi}2.695^{c}
22	^{a}2.737^{b}	^{cd}3.285^{b}	^{cd}3.216^{a}	^{ab}3.733^{a}	^{a}3.919^{b}	^{b}3.583^{b}	^{a}3.800^{b}	^{cde}3.177^{b}	^{b}3.508^{b}	^{def}3.118^{b}	^{b}3.606^{b}	^{e}3.350^{b}	^{ef}3.008^{b}	^{ef}2.995^{b}	^{ef}2.995^{b}	^{fg}2.919^{b}
24	^{cd}3.132^{a}	^{b}3.792^{a}	^{cd}3.414^{a}	^{b}3.817^{a}	^{a}4.233^{a}	^{b}3.815^{a}	^{a}4.058^{a}	^{cd}3.395^{a}	^{b}3.792^{a}	^{de}3.325^{a}	^{b}3.817^{a}	^{e}3.555^{a}	^{def}3.288^{a}	^{ef}3.144^{a}	^{ef}3.152^{a}	^{f}3.115^{a}

* : S: sample , t: time/hour , Foil : fresh oil . ** as in Table 1

Table 6 :totox value of oil samples and blends absorbed by potato fingers as affected by heating for different periods * .

S / t	S_1	S_2	S_3	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}	B_{12}	B_{13}
Foil	^{a}2.076^{l}	^{a}2.007^{l}	^{a}2.190^{l}	^{a}1.857^{l}	^{a}1.827^{l}	^{a}1.655^{l}	^{a}1.868^{l}	^{a}2.105^{k}	^{a}1.980^{k}	^{a}1.980^{j}	^{a}1.713^{l}	^{a}1.758	^{a}1.989^{k}	^{a}1.709^{k}	^{a}1.770^{k}	^{A}1.937^{k}
0	^{a}2.310^{l}	^{a}2.075^{l}	^{a}2.443^{l}	^{a}2.085^{l}	^{a}2.195^{l}	^{a}1.797^{l}	^{a}2.043^{l}	^{a}2.276^{k}	^{a}2.145^{k}	^{a}2.278^{j}	^{a}1.865^{l}	^{a}1.965^{l}	^{a}2.197^{k}	^{a}1.775^{k}	^{a}1.888^{k}	^{A}2.080^{k}
2	^{ab}3.387^{k}	^{a}2.998^{l}	^{a}3.705^{k}	^{ab}2.723^{l}	^{b}2.627^{l}	^{b}2.142^{ij}	^{a}2.955^{ij}	^{ab}3.188^{jk}	^{b}2.445^{jk}	^{a}2.795^{ij}	^{b}2.663^{kl}	^{b}2.415^{k}	^{b}2.588^{jk}	^{b}2.299^{jk}	^{b}2.465^{k}	^{ab}2.815^{jk}
4	^{ab}4.718^{j}	^{bc}4.547^{k}	^{a}5.218^{j}	^{bcde}3.827^{k}	^{def}3.333^{k}	^{f}2.878^{j}	^{cdef}3.700^{j}	^{bcd}4.014^{j}	^{def}3.318^{j}	^{bcde}3.898^{k}	^{bcde}3.925^{k}	3.008^{jk}	^{def}3.055^{j}	^{def}3.126^{ij}	^{def}3.447^{j}	^{cdef}3.666^{ij}
6	^{bc}5.568^{i}	^{ab}6.364^{j}	^{a}7.273^{i}	^{bc}5.514^{j}	^{d}4.526^{j}	^{f}3.558^{j}	^{cd}4.958^{jk}	^{cd}5.207^{k}	^{d}4.420^{j}	^{cd}4.942^{j}	^{cd}5.185^{j}	^{f}3.544^{k}	^{f}3.540^{ij}	^{ef}3.957^{j}	^{cd}5.065^{k}	^{de}4.533^{j}
8	^{c}7.337^{i}	^{b}8.547^{j}	^{a}11.635^{k}	^{cd}6.775^{k}	^{def}5.980^{j}	^{fg}5.016^{k}	^{ef}5.787^{jk}	^{cd}6.777^{k}	^{ef}5.727^{k}	^{cde}6.485^{k}	^{cd}6.938^{j}	^{g}4.767^{k}	^{g}4.455^{ij}	^{ef}5.066^{k}	^{cd}6.733^{k}	^{de}6.168^{k}
10	^{bc}9.578^{h}	^{b}10.434^{h}	^{a}14.489^{g}	^{cd}8.348^{h}	^{cde}7.605^{h}	^{ef}6.683^{g}	^{de}7.477^{g}	^{cd}8.148^{g}	^{c}7.074^{g}	^{bc}9.605^{h}	^{c}8.634^{h}	^{f}5.768^{h}	^{f}5.840^{h}	^{c}6.931^{g}	^{c}8.688^{g}	^{bc}9.469^{g}
12	^{c}12.737^{g}	^{b}13.737^{g}	^{a}18.278^{f}	^{f}10.998	^{fg}10.597^{g}	^{g}8.148^{f}	^{g}9.848^{f}	^{def}11.270^{f}	^{fg}10.365^{f}	^{cd}11.971^{g}	^{cd}11.93^{g}	^{h}7.216^{g}	^{h}7.933^{g}	^{g}9.755^{f}	^{fg}10.287^{f}	^{c}12.605^{f}
14	^{b}17.083^{f}	^{b}16.748^{f}	^{a}20.273^{e}	^{ef}14.030^{f}	^{b}12.548^{f}	^{h}11.897^{e}	^{hi}11.757^{e}	^{cd}15.160^{e}	^{fg}13.585^{e}	^{cd}15.427^{f}	^{de}14.953^{f}	^{i}10.255	^{i}10.762^{f}	^{gh}12.65^{e}	^{ef}14.111^{e}	^{bc}16.102^{e}
16	^{bc}19.968^{e}	^{ab}20.064^{e}	^{a}21.936^{d}	^{e}16.655^{e}	^{ih}15.103^{e}	^{hi}14.448^{d}	^{ij}13.811^{d}	^{cd}18.634^{d}	^{ef}15.968^{d}	^{cd}18.825^{e}	^{e}16.800^{e}	^{i}13.167	^{ih}15.261^{e}	^{e}16.468^{d}	^{ef}15.986^{d}	^{d}18.596^{d}
18	^{a}22.717^{d}	^{a}22.367^{d}	^{a}22.831^{c}	^{cd}19.545^{d}	^{bc}20.251^{d}	^{efg}18.185^{c}	^{de}18.998^{c}	^{ab}21.138^{c}	^{cd}19.625^{c}	^{b}20.638^{d}	^{efg}18.205^{d}	^{i}17.205	^{hi}17.953^{d}	^{defg}18.678^{c}	^{de}19.189^{c}	^{ab}21.075^{c}
20	^{b}25.437^{c}	^{a}24.094^{c}	^{a}26.485^{c}	^{def}22.342^{c}	^{ef}22.027^{c}	^{fg}21.464^{b}	^{gh}20.685^{b}	^{cd}23.222^{b}	^{ef}22.016^{b}	^{de}22.485^{c}	^{ef}21.898^{c}	^{gh}20.87	^{gh}20.887^{c}	^{h}20.378^{b}	^{gh}20.756^{b}	^{cd}23.315^{b}
22	^{a}28.177^{b}	^{a}28.045^{b}	^{a}25.116^{b}	^{cd}24.773^{b}	^{de}23.819^{b}	^{de}23.803^{a}	^{ef}23.40^{a}	^{cd}24.677^{a}	^{def}23.340^{a}	^{de}23.818^{b}	^{a}23.506^{b}	^{ef}22.916	^{gh}22.568^{b}	^{g}21.955^{a}	^{fg}22.415^{a}	^{b}26.319^{a}
24	^{a}29.252^{a}	^{a}29.492^{a}	^{b}26.174^{a}	^{b}26.177^{a}	^{bc}25.653^{a}	^{de}24.575^{a}	^{de}24.398^{a}	^{cd}24.755^{a}	^{de}24.132^{a}	^{bc}25.725^{a}	^{cd}24.857^{a}	^{de}24.295	^{ef}23.588^{a}	^{f}22.764^{a}	^{f}23.012^{a}	^{ef}23.715^{b}

* : S: sample , t: time/hour , Foil : fresh oil . ** as in Table 1

Table 7 : Dienes of oil samples and blends absorbed by potato fingers as affected by heating for different periods *.

S / t	S_1	S_2	S_3	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}	B_{12}	B_{13}
Foil	$^{a}0.14^{l}$	$^{a}0.18^{l}$	$^{a}0.11^{l}$	$^{a}0.12^{l}$	$^{a}0.11^{m}$	$^{a}0.13^{l}$	$^{a}0.17^{l}$	$^{a}0.11^{m}$	0.15^{m}	$^{a}0.18^{m}$	$^{a}0.11^{m}$	$^{a}0.16^{m}$	$^{a}0.12^{m}$	$^{a}0.11^{m}$	$^{a}0.11^{l}$	$^{a}0.12^{l}$
0	$^{ab}0.17^{l}$	$^{ab}0.23^{l}$	$^{ab}0.15^{l}$	$^{ab}0.15^{l}$	$^{ab}0.16^{lm}$	$^{ab}0.16^{l}$	$^{ab}0.22^{l}$	$^{ab}0.15^{lm}$	$^{ab}0.18^{lm}$	$^{a}0.24^{lm}$	$^{ab}0.15^{lm}$	$^{ab}0.20^{lm}$	$^{ab}0.15^{lm}$	$^{b}0.14^{lm}$	$^{b}0.14^{l}$	$^{ab}0.15^{l}$
2	$^{ab}0.25^{k}$	$^{ab}0.29^{kl}$	$^{ab}0.22^{l}$	$^{b}0.20^{l}$	$^{ab}0.21^{l}$	$^{ab}0.22^{l}$	$^{a}0.30^{kl}$	$^{ab}0.22^{kl}$	$^{ab}0.27^{kl}$	$^{a}0.30^{kl}$	$^{ab}0.21^{kl}$	$^{ab}0.28^{kl}$	$^{ab}0.22^{kl}$	$^{ab}0.21^{kl}$	$^{b}0.20^{l}$	$^{ab}0.21^{kl}$
4	$^{a}0.41^{k}$	$^{ab}0.38^{k}$	$^{ab}0.34^{k}$	$^{ab}0.33^{k}$	$^{b}0.31^{k}$	$^{ab}0.35^{k}$	$^{ab}0.39^{k}$	$^{ab}0.32^{k}$	$^{ab}0.37^{k}$	$^{a}0.41^{k}$	$^{ab}0.35^{k}$	$^{ab}0.37^{k}$	$^{b}0.30^{k}$	$^{b}0.30^{k}$	$^{a}0.32^{k}$	$^{b}0.30^{k}$
6	$^{a}0.68^{j}$	$^{b}0.55^{j}$	$^{bc}0.50^{j}$	$^{bc}0.52^{j}$	$^{bc}0.48^{j}$	$^{b}0.57^{j}$	$^{bc}0.52^{j}$	$^{bc}0.49^{j}$	$^{bc}0.50^{j}$	$^{bc}0.52^{j}$	$^{bc}0.48^{j}$	$^{bc}0.52^{j}$	$^{bc}0.51^{j}$	$^{bc}0.47^{j}$	$^{c}0.44^{j}$	$^{c}0.45^{j}$
8	$^{a}0.89^{i}$	$^{b}0.77^{i}$	$^{bcd}0.72^{i}$	$^{bcde}0.70^{i}$	$^{cde}0.65^{i}$	$^{bcd}0.72^{i}$	$^{bc}0.73^{i}$	$^{bcde}0.68^{i}$	$^{bcd}0.71^{i}$	$^{bc}0.73^{i}$	$^{bcde}0.68^{i}$	$^{bcde}0.70^{i}$	$^{bcde}0.69^{i}$	$^{cde}0.65^{i}$	$^{c}0.61^{i}$	$^{de}0.63^{i}$
10	$^{a}1.13^{h}$	$^{b}0.95^{h}$	$^{b}0.96^{h}$	$^{bcd}0.89^{h}$	$^{de}0.82^{h}$	$^{bc}0.93^{h}$	$^{b}0.96^{h}$	$^{cde}0.85^{h}$	$^{bcde}0.89^{h}$	$^{bc}0.92^{h}$	$^{bcd}0.90^{h}$	$^{bcd}0.91^{h}$	$^{bcde}0.88^{h}$	$^{c}0.80^{h}$	$^{de}0.82^{h}$	$^{c}0.80^{h}$
12	$^{a}1.29^{g}$	$^{abc}1.20^{g}$	$^{ab}1.22^{g}$	$^{cdef}1.12^{g}$	$^{ef}1.09^{g}$	$^{bcde}1.17^{g}$	$^{bcd}1.19^{g}$	$^{cdef}1.07^{g}$	$^{cdef}1.11^{g}$	$^{bcd}1.19^{g}$	$^{bcdef}1.13^{g}$	$^{bcde}1.14^{g}$	$^{def}1.10^{g}$	$^{fg}1.04^{g}$	$^{efg}1.07^{g}$	$^{g}0.98^{g}$
14	$^{a}1.48^{f}$	$^{b}1.37^{f}$	$^{ab}1.42^{f}$	$^{c}1.31^{f}$	$^{cd}1.22^{f}$	$^{bc}1.34^{f}$	$^{abc}1.40^{f}$	$^{d}1.20^{f}$	$^{c}1.32^{f}$	$^{bc}1.37^{f}$	$^{bc}1.33^{f}$	$^{bc}1.38^{f}$	$^{cd}1.24^{f}$	$^{d}1.20^{f}$	$^{cd}1.22^{f}$	$^{f}1.17^{f}$
16	$^{a}1.76^{e}$	$^{bc}1.58^{e}$	$^{b}1.64^{e}$	$^{cde}1.50^{e}$	$^{f}1.40^{e}$	$^{bcd}1.58^{e}$	$^{b}1.63^{e}$	$^{cde}1.50^{e}$	$^{bcd}1.57^{e}$	$^{bcde}1.55^{e}$	$^{def}1.48^{e}$	$^{bcd}1.57^{e}$	$^{def}1.48^{e}$	$^{cde}1.52^{e}$	$^{ef}1.47^{e}$	$^{f}1.40^{e}$
18	$^{a}2.11^{d}$	$^{cd}1.83^{d}$	$^{b}1.95^{d}$	$^{defg}1.76^{d}$	$^{h}1.68^{d}$	$^{cdef}1.79^{d}$	$^{bc}1.88^{d}$	$^{efg}1.71^{d}$	$^{cdef}1.79^{d}$	$^{cde}1.80^{d}$	$^{fg}1.69^{d}$	$^{cd}1.84^{d}$	$^{defg}1.75^{d}$	$^{fg}1.70^{d}$	$^{b}1.69^{d}$	1.63^{d}
20	$^{a}2.35^{c}$	$^{c}2.09^{c}$	$^{b}2.20^{c}$	$^{def}1.95^{c}$	$^{fg}1.89^{c}$	$^{def}1.98^{c}$	$^{cd}2.03^{c}$	$^{ef}1.93^{c}$	$^{def}1.94^{c}$	$^{c}2.09^{c}$	$^{fg}1.88^{c}$	$^{cde}2.00^{c}$	$^{def}1.95^{c}$	$^{ef}1.91^{c}$	$^{fg}1.89^{c}$	$^{def}1.95^{c}$
22	$^{a}2.64^{b}$	$^{bc}2.30^{b}$	$^{b}2.41^{b}$	$^{cd}2.22^{b}$	$^{efg}2.20^{b}$	$^{cde}2.28^{b}$	$^{cde}2.30^{b}$	$^{fg}2.18^{b}$	$^{ef}2.22^{b}$	$^{bcd}2.32^{b}$	$^{def}2.24^{b}$	$^{cde}2.29^{b}$	$^{fg}2.16^{b}$	$^{g}2.11^{b}$	$^{fg}2.17^{b}$	$^{fg}2.16^{b}$
24	$^{a}2.98^{a}$	$^{bc}2.71^{a}$	$^{b}2.77^{a}$	$^{def}2.58^{a}$	$^{fgh}2.49^{a}$	$^{cd}2.63^{a}$	$^{efgh}2.51^{a}$	$^{ghij}2.44^{a}$	$^{ij}2.41^{a}$	$^{de}2.59^{a}$	$^{ij}2.41^{a}$	$^{efg}2.53^{a}$	$^{hij}2.42^{a}$	$^{efgh}2.50^{a}$	$^{i}2.40^{a}$	$^{ghi}2.48^{a}$

* : S: sample , t: time/hour , Foil : fresh oil . ** as in Table 1

Table8 : Trienes of oil samples and blends absorbed by potato fingers as affected by heating for different periods*.

S / t	S_1	S_2	S_3	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}	B_{12}	B_{13}
foil	$^{a}0.04^{l}$	$^{a}0.02^{k}$	$^{a}0.07^{l}$	$^{a}0.03^{l}$	$^{a}0.05^{l}$	$^{a}0.04^{l}$	$^{a}0.03^{l}$	$^{a}0.02^{k}$	$^{a}\mathbf{0.03}^{l}$	$^{a}0.03^{k}$	$^{a}0.04^{l}$	$^{a}0.02^{l}$	$^{a}0.06^{l}$	$^{a}0.02^{k}$	$^{a}0.03^{l}$	$^{a}0.05^{l}$
0	$^{ab}0.05^{l}$	$^{b}0.02^{k}$	$^{a}0.08^{l}$	$^{ab}0.04^{l}$	$^{ab}0.07^{l}$	$^{ab}0.05^{l}$	$^{ab}0.03^{l}$	$^{ab}0.03^{k}$	$^{ab}0.04^{l}$	$^{ab}0.04^{k}$	$^{ab}\mathbf{0.04}^{l}$	$^{ab}0.03^{l}$	$^{a}0.08^{l}$	$^{b}0.02^{k}$	$^{ab}0.04^{l}$	$^{ab}0.07^{l}$
2	$^{abcd}0.07^{kl}$	$^{cd}0.05^{jk}$	$^{a}0.11^{kl}$	$^{abcd}0.07^{kl}$	$^{a}0.11^{kl}$	$^{abc}0.09^{kl}$	$^{abcd}0.07^{kl}$	$^{bcd}0.06^{jk}$	$^{bcd}0.06^{kl}$	$^{abcd}0.07^{kl}$	$^{abcd}0.08^{k}$	$^{cd}0.05^{kl}$	$^{a}0.11^{kl}$	$^{a}0.04^{jk}$	$^{bcd}0.06^{kl}$	$^{ab}0.10^{kl}$
4	$^{abc}0.10^{jk}$	$^{c}0.07^{ij}$	$^{a}0.14^{k}$	$^{bc}0.09^{ijk}$	$^{a}0.14^{k}$	$^{ab}0.13^{k}$	$^{abc}0.11^{k}$	$^{abc}0.10^{j}$	$^{bc}0.09^{ijk}$	$^{abc}0.10^{j}$	$^{ab}0.12^{jk}$	$^{bc}0.09^{jk}$	$^{ab}0.13^{k}$	$^{c}0.07^{ij}$	$^{bc}0.09^{ijk}$	$^{ab}0.13^{jk}$
6	$^{cde}0.13^{ij}$	$^{c}0.10^{hij}$	$^{a}0.20^{j}$	$^{de}0.12^{ij}$	$^{ab}0.18^{j}$	$^{ab}0.18^{j}$	$^{abcd}0.16^{j}$	$^{bcd}0.15^{i}$	$^{de}0.12^{ij}$	$^{bcd}0.15^{i}$	$^{abcd}0.16^{ij}$	$^{cde}0.13^{j}$	$^{ab}0.18^{j}$	$^{c}0.10^{hi}$	$^{cde}0.13^{i}$	$^{abc}0.17^{j}$
8	$^{bc}0.17^{hi}$	$^{c}0.13^{gh}$	$^{a}0.25^{i}$	$^{bc}0.16^{hi}$	$^{ab}0.23^{i}$	$^{a}0.24^{i}$	$^{ab}0.21^{i}$	$^{b}0.19^{i}$	$^{bc}0.16^{hi}$	$^{ab}0.21^{hi}$	$^{ab}0.22^{i}$	$^{b}0.18^{i}$	$^{ab}0.23^{i}$	$^{c}0.13^{h}$	$^{b}0.18^{i}$	$^{ab}0.22^{i}$
10	$^{efg}0.21^{gh}$	$^{g}0.18^{g}$	$^{a}0.32^{h}$	$^{fg}0.20^{gh}$	$^{abc}0.28^{h}$	$^{ab}0.29^{h}$	$^{bc}0.26^{h}$	$^{cdef}0.24^{h}$	$^{fg}0.20^{gh}$	$^{bcde}0.25^{h}$	$^{bcd}0.27^{h}$	$^{cdef}0.24^{h}$	$^{abc}0.28^{h}$	$^{g}0.19^{g}$	$^{defg}0.23^{h}$	$^{abc}0.28^{h}$
12	$^{fg}0.24^{fg}$	$^{fg}0.22^{fg}$	$^{a}0.39^{g}$	$^{g}0.23^{g}$	$^{ab}0.36^{g}$	$^{bcd}0.34^{g}$	$^{bcde}0.32^{g}$	$^{d}0.30^{g}$	$^{fg}0.24^{g}$	$^{cd}0.31^{g}$	$^{bcde}0.32^{g}$	$^{c}0.29^{g}$	$^{bc}0.35^{g}$	$^{g}0.23^{g}$	$^{d}0.28^{g}$	$^{bcd}0.34^{g}$
14	$^{d}0.28^{ef}$	$^{d}0.26^{ef}$	$^{a}0.48^{f}$	0.28^{f}	$^{b}0.43^{f}$	$^{b}0.42^{f}$	$^{bc}0.40^{f}$	$^{c}0.37^{f}$	$^{d}0.29^{f}$	$^{c}0.37^{f}$	$^{bc}0.40^{f}$	$^{c}0.35^{f}$	$^{bc}0.41^{f}$	$^{d}0.28^{f}$	$^{c}0.35^{f}$	$^{bc}0.40^{f}$
16	$^{f}0.33^{e}$	$^{g}0.29^{e}$	$^{a}0.59^{e}$	$^{f}0.33^{e}$	$^{b}0.52^{e}$	$^{bc}0.50^{e}$	$^{bc}0.48^{e}$	$^{cd}0.43^{e}$	$^{f}0.34^{e}$	$^{cd}0.44^{e}$	$^{bc}0.48^{e}$	$^{b}0.41^{e}$	$^{bc}0.48^{e}$	$^{f}0.33^{e}$	$^{d}0.42^{e}$	$^{c}0.47^{e}$
18	$^{g}0.39^{d}$	$^{h}0.34^{d}$	$^{a}0.69^{d}$	$^{g}0.40^{d}$	$^{bc}0.61^{d}$	$^{b}0.63^{d}$	$^{cd}0.58^{d}$	$^{f}0.50^{d}$	0.39^{d}	$^{cd}0.52^{d}$	$^{de}0.56^{d}$	$^{f}0.48^{d}$	$^{bc}0.60^{d}$	$^{g}0.39^{d}$	$^{f}0.50^{d}$	$^{bc}0.62^{d}$
20	$^{f}0.46^{c}$	$^{g}0.39^{c}$	$^{a}0.83^{c}$	$^{f}0.47^{c}$	$^{b}0.72^{c}$	$^{bc}0.70^{c}$	$^{bc}0.70^{c}$	$^{de}0.59^{c}$	$^{f}0.45^{c}$	$^{d}0.61^{c}$	$^{c}0.67^{c}$	$^{g}0.55^{c}$	$^{bc}0.70^{c}$	$^{f}0.48^{c}$	$^{de}0.58^{c}$	$^{b}0.73^{c}$
22	$^{f}0.58^{b}$	$^{h}0.47^{b}$	$^{a}0.95^{b}$	$^{g}0.57^{b}$	$^{bc}0.86^{b}$	$^{b}0.88^{b}$	$^{b}0.83^{b}$	$^{e}0.68^{b}$	$^{g}0.52^{b}$	$^{e}0.72^{b}$	$^{d}0.79^{b}$	$^{g}0.68^{b}$	$^{b}0.79^{b}$	$^{f}0.60^{b}$	$^{d}0.70^{b}$	$^{d}0.81^{b}$
24	$^{e}0.77^{a}$	$^{e}0.61^{a}$	$^{a}1.06^{a}$	0.69^{a}	$^{e}0.95^{a}$	$^{b}1.01^{a}$	$^{b}0.96^{a}$	$^{e}0.81^{a}$	0.70^{a}	$^{d}0.84^{a}$	$^{e}0.94^{a}$	$^{e}0.81^{a}$	$^{e}0.96^{a}$	$^{d}0.71^{a}$	$^{e}0.81^{a}$	$^{e}0.96^{a}$

* : S: sample , t: time/hour , Foil : fresh oil . ** as in Table 1

Table 9 : Polar compounds of oil samples and blends absorbed by potato fingers as affected by heating for different periods * .

S / t	S_1	S_2	S_3	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}	B_{11}	B_{12}	B_{13}
Foil	$^{a}1.0^{l}$	$^{a}0.7^{l}$	$^{a}0.9^{lm}$	$^{a}0.8^{l}$	$^{a}0.8^{l}$	$^{a}0.8^{m}$	$^{a}0.9^{l}$	$^{a}0.9^{l}$	$^{a}0.9^{l}$	$^{a}0.9^{l}$	$^{a}0.7^{l}$	$^{a}0.9^{l}$	$^{a}0.9^{l}$	$^{a}0.9^{m}$	$^{a}0.8^{l}$	$^{a}0.9^{l}$
0	$^{a}1.1^{l}$	$^{a}0.8^{l}$	$^{a}0.9^{lm}$	$^{a}0.8^{l}$	$^{a}0.8^{l}$	$^{a}0.9^{lm}$	$^{a}1.0^{l}$	$^{a}1.0^{l}$	$^{a}1.0^{l}$	$^{a}0.9^{l}$	$^{a}0.8^{l}$	$^{a}0.9^{l}$	$^{a}1.0^{l}$	$^{a}0.9^{lm}$	$^{a}0.9^{l}$	$^{a}0.9^{l}$
2	$^{a}2.1^{l}$	$^{a}1.7^{l}$	$^{a}1.9^{l}$	$^{a}1.7^{l}$	$^{a}1.7^{l}$	$^{a}2.0^{l}$	$^{a}1.8^{k}$	$^{a}1.9^{l}$	$^{a}1.6^{l}$	$^{a}1.6^{l}$	$^{a}1.7^{l}$	$^{a}1.5^{kl}$	$^{a}1.7^{l}$	$^{a}1.5^{lm}$	$^{a}1.3^{kl}$	$^{a}1.7^{l}$
4	$^{a}3.6^{k}$	$^{a}3.5^{k}$	$^{ab}3.3^{k}$	$^{abc}2.9^{k}$	$^{abc}3.2^{k}$	$^{a}3.7^{k}$	$^{abc}2.8^{k}$	$^{a}3.5^{k}$	$3^{ab}3^{k}$	$^{abc}3.0^{k}$	$^{abc}3.2^{k}$	$^{bc}2.4^{k}$	$^{ab}2.8^{k}$	$^{bc}2.4^{k}$	$^{c}2.2^{k}$	$^{abc}2.9^{k}$
6	$^{ab}5.4^{j}$	$^{a}5.9^{j}$	$^{abc}5.2^{j}$	$^{def}4.2^{j}$	$^{bcdef}4.5^{j}$	$^{abc}5.2^{j}$	$^{def}4.2^{j}$	$^{bcd}4.9^{j}$	$^{bcdef}4.5^{j}$	$^{bcde}4.7^{j}$	$^{bcd}4.9^{j}$	$^{def}4.1^{j}$	$^{cdef}4.4^{j}$	$^{f}3.7^{j}$	$^{ef}3.9^{j}$	$^{bcde}4.8^{j}$
8	$^{a}8.4^{i}$	$^{ab}8.0^{i}$	$^{abc}8.2^{i}$	$^{ef}6.6^{i}$	$^{cdc}6.9^{i}$	$^{ab}8.1^{i}$	$^{ef}6.7^{i}$	$^{abc}7.8^{i}$	$^{de}6.8^{i}$	$^{bcde}7.3^{i}$	$^{abc}7.8^{i}$	$^{fg}5.8^{i}$	$^{de}6.8^{i}$	$^{efg}6.0^{i}$	$^{g}5.5^{i}$	$^{abcd}7.7^{i}$
10	$^{ab}11.6^{h}$	$^{a}11.9^{h}$	$^{ab}11.3^{h}$	$^{e}8.9^{h}$	$^{ef}8.5^{h}$	$^{a}10.8^{h}$	$^{e}8.9^{h}$	$^{cd}10.3^{h}$	$^{ef}8.0^{h}$	$^{de}9.8^{h}$	$^{cd}10.1^{h}$	$^{ef}8.1^{h}$	$^{ef}8.4^{h}$	$^{ef}8.5^{h}$	$^{f}7.8^{h}$	$^{e}9.3^{h}$
12	$^{a}14.2^{g}$	$^{a}14.7^{g}$	$^{ab}13.9^{g}$	$^{de}11.1^{g}$	$^{d}11.7^{g}$	$^{a}13.2^{g}$	$^{cd}10.6^{g}$	$^{c}12.9^{g}$	$^{de}11.5^{g}$	$^{c}12.9^{g}$	$^{c}12.7^{g}$	$^{de}11.1^{g}$	$^{def}10.9^{g}$	$^{ef}10.3^{g}$	$^{f}10.0^{g}$	$^{d}11.6^{g}$
14	$^{bc}16.8^{f}$	$^{a}18.3^{f}$	$^{b}17.0^{f}$	$^{efgh}13.8^{f}$	$^{defg}14.2^{f}$	$^{cd}15.0^{f}$	$^{fg}12.8^{f}$	$^{def}14.5_{f}$	$^{fgh}13.7^{f}$	$^{de}14.7^{f}$	$^{d}14.8^{f}$	$^{hij}12.9^{f}$	$^{hij}12.9^{f}$	$^{j}12.6^{f}$	$^{j}12.7^{f}$	$^{ghij}13.3^{f}$
16	$^{b}19.7^{e}$	$^{a}21.5^{e}$	$^{b}20.2^{e}$	$^{de}16.5^{e}$	$^{d}16.6^{e}$	$^{c}18.2^{e}$	$^{fgh}14.9^{e}$	$^{d}17.0^{e}$	$^{ef}15.6^{e}$	$^{d}16.7^{e}$	$^{de}16.3^{e}$	$^{fgh}14.7^{e}$	$^{fg}15.0^{e}$	$^{gh}14.3^{e}$	$^{h}14.0^{e}$	$^{ef}15.4^{e}$
18	$^{b}22.4^{d}$	$^{a}24.7^{d}$	$^{b}23.1^{d}$	$^{defgh}18.8^{d}$	$^{def}19.0^{d}$	$^{c}20.9^{d}$	$^{i}17.9^{d}$	$^{d}19.7^{d}$	$^{ghi}18.2^{d}$	$^{de}19.2^{d}$	$^{defgh}18.9^{d}$	$^{b}16.7^{d}$	$^{efgh}18.3^{d}$	$^{ij}8.8^{d}$	$^{ij}17.2^{d}$	$^{hij}18.0^{d}$
20	$^{b}24.9^{c}$	$^{a}27.3^{c}$	$^{b}25.5^{c}$	$^{gh}21.9^{c}$	$^{efgh}22.6^{c}$	$^{d}23.7^{c}$	$^{h}21.7^{c}$	$^{de}23.3^{c}$	$^{efg}22.7^{c}$	$^{def}23.0^{c}$	$^{fgh}22.2^{c}$	$^{i}19.8^{c}$	$^{fgh}22.1^{c}$	$^{i}19.9^{c}$	$^{i}19.7^{c}$	$^{gh}21.9^{c}$
22	$^{bc}27.2^{b}$	$^{a}30.5^{b}$	$^{b}28.1^{b}$	$^{fg}23.6^{b}$	$^{de}24.9^{b}$	$^{cd}26.6^{b}$	$^{ef}24.5^{b}$	$^{d}25.7^{b}$	$^{c}24.6^{b}$	$^{cd}26.6^{b}$	$^{d}25.8^{b}$	$^{g}23.0^{b}$	$^{de}25.3^{b}$	$^{g}22.3^{b}$	$^{g}23.0^{b}$	$^{ef}24.4^{b}$
24	$^{b}31.3^{a}$	$^{a}35.9^{a}$	$^{bc}30.5^{a}$	$^{hi}25.8^{a}$	$^{de}28.8^{a}$	$^{c}30.2^{a}$	$^{gh}26.8^{a}$	$^{de}29.1^{a}$	$^{g}27.0^{a}$	$^{cd}29.7^{a}$	$^{d}28.2^{a}$	$^{i}25.3^{a}$	$^{fg}27.5^{a}$	$^{i}24.8^{a}$	$^{i}25.4^{a}$	$^{gh}26.9^{a}$

* : S: sample , t: time/hour , Foil : fresh oil . ** as in Table 1

Table: (10) correlation coefficient for quality attributes of absorbed oils as affected by prolonged heating and frying :

	Overall acceptability	Dienes	Trienes	Iodine Value	Free Fatty Acid(%)	Peroxide Value	Anisidine Value	Totox Value	Polar Lipids
Overall acceptability	1.000	-0.934**	-0.889**	-0.889**	-0.947**	-0.895**	-0.923**	-0.934**	-0.955**
Dienes		1.000	0.932**	-0.878**	0.934**	0.959**	0.943**	0.928**	0.980**
Trienes			1.000	0.902**	0.914**	0.908**	0.920**	0.910**	0.899**
Iodine Value				1.000	-0.884**	-0.886**	-0.864**	-0.848**	-0.880**
Free Fatty Acid(%)					1.000	0.946**	0.916**	0.973**	0.971**
Peroxide Value						1.000	0.917**	0.964**	0.947**
Anisidine Value							1.000	0.941**	0.932**
Totox Value								1.000	0.936**
Polar Lipids									1.000

** Highly significant correlation at p< 0.01 .

Generally, positive correlations were noticed between each one of all parameters except overall acceptability and iodine value which correlated negatively with them.

Table 11: The linear regression equations for predicting the frying time of the best two oil blends.

Dependant Variables	Regression equation	
	B11*	B12**
Overall acceptability	Y=9.1868-0.1701 x	Y=9.0736-0.1632 x
Free fatty acids(%)	Y=0.1148+0.0561 x	Y=0.1675+0.0512 x
Iodine value	Y=125.02-0.891 x	Y=119.12-1.038 x
Peroxide value	Y=-0.8129-+0.4518 x	Y=-0.2800+0.4413 x
p-Anisidine value	Y=0.7825+0.1006 x	Y=0.4860+0.1103 x
Totox value	Y=-0.8473+1.0052 x	Y=0.0857+0.9946 x
Dienes	Y=-0.0484+0.0964 x	Y=-0.0615+0.0977 x
Trienes	Y=-0.0531+0.0273 x	Y=-0.0353+0.0306 x
Polar compounds (%)	Y=-1.365+1.0368 x	Y=-1.722+1.0640 x

*** B11: sunflower oil + soybean oil, 3:1 (w/w).**
**** B12 : sunflower oil + cottonseed oil, 3:1 (w/w).**

The linear regression equations for predicting the frying time of the best two oil blends recommended to use as frying oils (i.e. B11 and B12) are shown in Table (12) .It is easy to predict the heating time of such two oil blends by determining any one of the mentioned parameters understudy . On the other hand , these regression equations are useful for predicting the deteriorative effect of heating and frying such two oil blends as a function of heating time (hr)

In conclusion, from the nutritional point of view , it is very important to study the absorbed oil by fried food rather than the heated oil itself. The heating and frying processes affect the absorbed oil significantly mainly due to the deteriorative effects of thermal decomposition and forming undersirable constituents that may pose health hazard (El-sayed , 2002 and Ali , 2004). In the light of data presented concerning the deterioration of absorbed oil by fried potato fingers , it could be concluded that except oil blends B11 and B12 , the tested oil samples and their oil blends should not be reused after 16 hr and 22 hr of heating at 180 ^{o}C , respectively . However, blending of sunflower oil and each of soybean oil or cottonseed oil by a ratio 3:1 (w/w) is recommended as frying oil blend since they can be used for frying up to 24hr at 180 ^{o}C . The simplified equations of linear regression obtained in this study can be easily used for prediction of both the deteriorative effect and heating time for the recommended frying oil blends.

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تأثير كل من خلط الزيوت وزمن التسخين على خواص الزيت الممتص بواسطة أصابع البطاطس أثناء التحمير العميق

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تمت دراسة تأثير إطالة زمن التسخين والتحمير العميق فى ثلاثة زيوت (فول الصويا – عباد الشمس – بذرة القطن) فضلاً عن ١٣ مخلوطا مختلفا أعدت من هذه الزيوت على محددات جودة الزيت الممتص بواسطة أصابع البطاطس حيث تم تحمير أصابع البطاطس (صنف ديامونت) تحميرا عميقا فى الزيت و/ أو المخلوط عند زمن صفر ثم كررت العملية كل ساعتين وحتى ٢٤ ساعة مع إحتفاظ الزيت بدرجة حرارة ١٠٠ °م فيما بين عمليات القلى التى تمت على ١٨٠°م وقد تأثرت الخواص العضوية الحسية للبطاطس المقلاة تأثيرا سلبيا عالى المعنوية بزيادة زمن تعرض الزيت للحرارة وبدرجة أكبر من تأثرها بنوع الزيت و/أوالمخلوط ، كما أوضحت النتائج أن كل من % للأحماض الدهنية الحرة ، رقم البيروكسيد ، البارا–أنسيدين ، قيمة التوتكس ، المركبات المحتوية على روابط ثنائية وثلاثية متبادلة و% للمركبات القطبية قد إزدادت زيادة عالية المعنوية مع التقدم فى زمن التسخين وذلك على النقيض من الرقم اليودى . هذا وقد تزايد معدل التغير مع التقدم فى زمن التسخين . كما أوضح معامل التلازم أن هناك إرتباطاً معنوياً فيما بين جميع محددات الجودة تحت الدراسة ، وفى ضوء النتائج المتحصل عليها ورغم التباين فى معدلات التغير الحادث تبعاً لنوع الزيت و/أو المخلوط فإنه يمكن القول بأن الزيوت والمخاليط فيما عدا تلك المحتوية على زيت عباد الشمس ، زيت فول الصويا أو زيت بذرة القطن (١:٣ وزن/وزن) يجب ألا تستخدم بعد التسخين لمدة ١٦ ساعة ، ٢٢ ساعة على التوالى ، بينما المخلوطان الاخران (م١١ ، م١٢) فيمكن إستخدامهما حتى ٢٤ ساعة من التسخين . وبوجه عام فإن عملية خلط الزيوت تعد أكفأ من إستخدام الزيوت النقية فى التحمير . كما تم فى هذه الدراسة مناقشة معادلات الإرتداد الخطى التى يمكن من خلالها التنبؤ بتدهور مخاليط الزيوت الموصى بها .