EFFECT OF ADD SOME AROMATIC PLANTS ON THE STABILITY OF THE OXIDE FRYING OILS

Dr. Gehan Ibrahim Abd El-Wahab1, Prof. Dr. Ekbal Mahmoud Mohamed2, Prof. Dr. Ibrahim Mohamed Hassan3, Prof. Dr. Adel Mohamed Bakeer4, Prof. Dr. Akila Saleh Hamza5 and Ahmed Zaki Amin Hassona6

1. Lecturer of Nutrition and Food Sciences Faculty of Specific Education, Ain Shams University, Cairo, Egypt
2. Professor of Food Sciences Department, Faculty of Specific Education, Ain Shams University
3. Professor of Food Science and Technology, Faculty of Agriculture, Ain Shams University
4. Professor of Pathology, Faculty of Veterinary Medicine, Cairo University
5. Head Research Regional Center for Food and Feed, Agric. Res. Center, Giza, Egypt
6. Researcher Assistant of Regional Center for Food and Feed, Agricultural Research Center, Giza, Egypt

Abstract:
The present study was carried out to achieve the following objectives:

1. Studying the time-temperature relationships during frying operations using designed frying protocol.
2. Investigating the effect of frying process on the quality parameters of frying oil used. The different suggested treatments that carried out in this investigation could be summarized with their abbreviations as follows:

Treatment (T): Control Without any additives

Palm olein (PO)
T1 PO+ 0.2% rosemary extracted (RE)
T2 PO+ 0.2% Sage extracted (SE)
T3 PO+ 0.2% Basil extracted (BE)

T4 PO+ 0.2% Butylated hydraxy touloene (BHT). The palm olein was heated to 60°C before addition of oil extracts (0.2%) rosemary; sage or basil then stirred to ensure that it was completely dissolved. BHT- containing palm olein (0.02%) and control samples (without any antioxidant) were used as positive and negative control. All frying oil samples were heated at frying temperature in about 2 minutes to elevate temperature from 25 to 180°C, followed by addition of potato chips at a rate of 400 g in 5 liters frying oil for 21/2 minutes to complete frying process in the 1st cycle of frying. The 2nd (heating and cooling) cycle of frying
process was carried out after 1/2 min. When the frying oil temperature raised again from about 170 to 180°C and potato chips was added at a rate of 400 g to 4970cm³ frying oil no need to oil loss compensation due to loss of this small amount of frying oil (0.6%). This process was repeated 10 times at the 1st day of the experiment. The experimental ended after 50 frying processes at the 5th day. Samples were withdrawn at 0 time (60°C) then after 10, 30 and 50 frying processes at the 5t day. Samples size was 250ml for chemical and physicochemical analysis and 250 ml for biological assay. Deep frying experiments were carried out simultaneously using an aluminium open fryer with a concave shape which is almost used in all frying restaurants in Egypt and mainly sold in El-Qamalyia district. This frying pan capacity was 10 litre oil and equipped with autolift aluminum basket. The oil in each fryer was filtered to remove debris using separate filters. The same frying process was repeated three times in three consecutive weeks and withdrawn samples from each trial were mixed together to form a representative composite sample. After frying operations, the frying products were weighed and after each 10 fryings, samples were withdrawn and stored in brown bottles in a deep freezer at -20°C until analysis. Oil (250ml) was sampled from each frying medium to represent 0, 10, 30 and 50 frying cycles, consecutive up to 5 days, and was kept in amber bottles. Oil samples were flushed with slow bubbles of nitrogen free the bottom of the bottles and stared in freezer at 20°C for physical and chemical analysis. The same sample weight was also withdrawn for biological evaluation.

After frying, the chips were removed from the frying pan and sensory evaluation was conducted in the same day using all batches of potato chips (0, 10, 30 and 50 fryings). The ratio between potato weight and frying oil volume (w/v) was almost stable depending on oil loss two samples of oil, each weighing 225gm, one for physical and chemical analysis and the 2nd one for biological assay were taken. The whole procedure was repeated consecutively for 7 days. Results showed that. The No. of frying (times of frying) has a significant effect on peroxide value of all samples. The peroxide values increased with increasing no. of fryings until the 50th frying, artificial (BHT) or natural (rosemary, sage and basil) did not have the ability to inhibit peroxide formation even after only 10 fryings. On the other side, these antioxidants reduced the percentage of peroxide formation from about 65% to only 20-22% (rosemary, sage, basil and BHT). Ansidine value was clearly affected by No.of fryings as a general trend in case of T1, T2 and T3 similar to that of control one. it could be report that using chemical (artificial) antioxidant did not prevent the detrimental effect of frying times compaired with using natural antioxidants. On the other hand, use of natural or artificial antioxidants (T1, T2, T3, T1 and T4) minimized anisidine value by about 1.1 folds from control sample at any number of frying. Totox value of unheated palm olein with or without antioxidants was ranged between 17.90 to 20.17. It is of great importance to mention that there was no significant difference between all samples either untreated or treated with natural or artificial antioxidants at F0. Addition of herb extracts (0.2%) was significantly natural or artifical extracts lowered the totox value significantly (P≤ 0.05) compared to the control after 10 fryings with about 1.2 folds (for all treatments) less than control one. Totox value of unheated palm olein with or without antioxidants was ranged between 17.90 to 20.17. It is of great importance to mention that there was no significant difference between all samples either untreated or treated with natural or artificial antioxidants at F0.
Addition of herb extracts (0.2%) was significantly natural or artificifical extracts lowered the totox value significantly (P≤ 0.05) compared to the control after 10 fryings with about 1.2 folds (for all treatments) less than control one. Iodine number did not affect by the type of antioxidant use as seen at F0 treatment; i.e. no significance was found (values were around 56-58). Thiobarbituric acid number (TBA) value did not affect by only the type of antioxidant (as seen at F0 treatment). But, when frying process was taken place the TBA value was increased by about 2 folds after 10 fryings for all treatments. After 30 times of frying, the increasing in TBA value reached to be 3 folds for all treatments and sharply increased to be about 4.5 folds that of their initial values (at F0) for all treatments. Acid value of various treatments was praparationaly correlated with No. of fryings. A significant difference was also noticed between treatments. The (F50) treatment recorded the highest acid value. Frying times (No. of fryings) were clearly affected such parameter (viscosity) in case of T3 and T4 treatments. It reached to 107.14 and 109.13 in T3 and T4, respectively after 50 times of frying. Meanwhile, it was ranged between 84.41 to 96.89 in other treatments after the same No. of fryings. the higher the frying times, the higher the polar value; i.e. there is a proportional relationship between polar value and number of fryings. No significant differences were detected between treatments as affected by using natural (Sage, rosemary and basil) and or artificial antioxidant (BHT). Such finding was noticed in all organalyptially evaluated parameters, i.e. appearance, odor, color, taste, texture and overall acceptability. Mean values were between 6.33-8.33. It could be concluded that using antioxidant either natural or artificial one did not organalooptically effect by type of antioxidant when the product or used oil were considered.

**Key words:** Aromatic plants, palm olein, peroxide value, ansidinevlaue, iodine value.

**Introduction:**

Deep-fat frying is one of the most commonly used practices in food preparation and manufacture all over the world. The increased consumption of fired foods is due to an increased number of restaurants serving convenience foods such as fried chicken, French fries and potato chips. More than 500 million pounds of edible fats and oils, for example, are used annually for the manufacture of potato chips in the United States alone (Irwardi&Che Man 1999).

Deep fat frying is a popular way to prepare a variety of foods. When food is fried in heated oil, many complex chemical reactions occur and the oil begins to degrade. The triglyceride molecule breaks down into both volatile and nonvolatile compounds which are soluble in the oil. These components contribute to both the desirable and undesirable sensory characteristics of food fried in oil. Natural triglycerides comprising an oil are considered non polar material. The products of the oil degradation are defined as polar compounds (Hassan, 2001).
The scientific literature is replete with studies questioning the safety of heated fats and oils. It is well established that heating of fats can result in formation of compounds with antinutritional properties. Compounds formed may be enzyme inhibitors, vitamin destroyers, lipid oxidation products, gastrointestinal irritants and/or potential mutagens (Hassan, 2001).

Materials and Methods:

1. Materials:

1.1 Essential oils:

Essential oils of sage (Salvia officinalis), basil (Ocimum basilicum) and rosemary (Rosmarenus officinalis) were obtained from unit of pressing and extracting natural oils, National Research Centre, Giza, Egypt.

1.2. Potato:

From Local markets.

1.3. Palm olein oils:

Refined bleached and deodorized palm olein free from additives was kindly supplied from Arma Food Industry Company, 10th Ramadain City, Cairo Egypt.

1.4. Chemicals:

All solvents and chemicals were used either analar or of analytical grade unless otherwise specified. Acetic acid-isooctane-potassium iodide-sodium thiosulphate and starch were obtained from Sigma-Aldrich GmbH, Steinheim.

1.5. Treatments:

The different suggested treatments that carried out in this investigation could be summarized with their abbreviations in Table (1).

Table (1): Suggested treatments for using various antioxidants (natural and/or chemical) in frying oil.

<table>
<thead>
<tr>
<th>Item</th>
<th>Treatment palm Olein (PO)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Without any additives</td>
</tr>
<tr>
<td>T1</td>
<td>PO+ 0.2% rosemary essential oil (R)</td>
</tr>
<tr>
<td>T2</td>
<td>PO+ 0.2% Sage essential oil (S)</td>
</tr>
<tr>
<td>T3</td>
<td>PO+ 0.2% Basil essential oil (B)</td>
</tr>
<tr>
<td>T4</td>
<td>PO+ 0.02% Butylatedhydroxytoluine (BHT)</td>
</tr>
</tbody>
</table>

T1: Palm Olein + 0.2% Rosemary; T2: Palm Olein + 0.2% Sage; T3: Palm Olein + 0.2% Basil; T4: Palm Olein + 0.02% Butylatedhydroxytoluine
1.6. Preparation of palm olein to frying process:

The palm olein was heated to 60°C before addition of oil extracts (0.2%) rosemary; sage and basil then stirred to ensure that it was completely dissolved. BHT-containing palm olein (0.02%) and control samples (without any antioxidant) were used as positive and negative control, respectively.

1.7. Preparation of potato chips:

1.7.1. Frying protocol:

All frying oil samples were heated at frying temperature in about 2 minutes to elevate temperature from 25 to 180°C, followed by addition of potato chips at a rate of 400 g in 5 liters frying oil for 21/2 minutes to complete frying process in the 1st cycle of frying. The 2nd (heating and cooling) cycle of frying process was carried out after 1/2 min. When the frying oil temp. raised again from about (170 to 180°C) and potato chips was added at a rate of 400 g to 4970cm3 frying oil no need to oil loss compensation due to loss of this small amount of frying oil (0.6%). This process was repeated 10 times at the 1st day of the experiment. The experimental ended after 50 frying processes at the 5th day. Samples were withdrawn at 0 time (60°C) then after 10, 30 and 50 frying processes at the 5th day. Samples size was 250ml for chemical and physicochemical analysis and 250 ml for biological assay.

1.7.2. Description of frying experiments:

Deep frying experiments were carried out simultaneously using an aluminium open fryer with a concave shape which is almost used in all frying restaurants in Egypt and mainly sold in El-Gamalyia district. This frying pan capacity was 10 litre oil and equipped with autolift aluminum basket. The oil in each fryer was filtered to remove debris using separate filters.

The same frying process was repeated three times in three consecutive weeks and withdrawn samples from each trial were mixed together to form a representative composite sample.

After frying operations, the frying products were weighed and after each 10 fryings, samples were withdrawn and stored in brown bottles in a deep freezer at -20°C until analysis.

Oil (250ml) was sampled from each frying medium to represent 0, 10, 30 and 50 frying cycles, consecutive up to 5 days, and was kept in bottles. Oil samples were flushed with slow bubbles of nitrogen free the bottom of
the bottles and stared in freezer at 20°C for physical and chemical analysis. The same sample weight was also withdrawn for biological evaluation.

After frying, the chips were removed from the frying pan and sensory evaluation was conducted in the same day using all batches of potato chips (0, 10, 30 and 50 fryings). The ratio between potato weight and frying oil volume (w/v) was almost stable depending on oil loss two samples of oil, each weighing 225gm, one for physical and chemical analysis and the 2nd one for biological assay were taken. The whole procedure was repeated consecutively for 7 days.

2. Methods of Analysis:

Changes in oil quality attributes, such as; i.e. peroxide value, anisidine value, iodine value, free fatty acids, oxidative stability index (OSI), polar compounds, polymers and colour test were followed by the methods recommended by American Oil Chemists Society Official AOCS (2005). Determination of French fries colour was done using a colorimeter.

3. Sensory evaluation:

Sensory evaluation of potato chips including overall acceptability was evaluated using a 10 point headanic scale where 1= very poor and 10= excellent. Sensory evaluation was done by 10 trained panelists. The frying oil samples were evaluated by its colour, odor and subjected to the same 10 point headonic scale.

6. Statistical analysis:

Each analysis was done in triplicate. The Mini TAB 14 softwear was used to analyze data for determining ANOVA, standard deviation and Duncan's multiple range test for significance level at 5%.

Results and Discussion:

1. Peroxide value (P.V.):

Peroxide value represents primary reaction products of lipid oxidation, which can be measured by their ability to liberate iodine from potassium iodide. Addition of herbs (rosemary, sage and basil) as well as BHT did not affect peroxide value compared to the control as given in Table (2). After 10 fryings, the P. V increased from 4.8 to 7.9 meq/kg oil with about 64.6% increase. Whereas rosemary, sage and basil have increased by 19.88, 22.22 and 20.41%, respectively. An artificial antioxidant (BHT) used in the present investigation did not succeed to resist up to 20 oxidation caused by resist frying operon. On conclusion, artificial (BHT) or natural (rosemary, sage and basil) did not have the ability to inhibit peroxide formation even
after only 10 fryings. On the other side, these antioxidants reduced the percentage of peroxide formation from about 65 to only 20-22% (rosemary, sage, basil and BHT). This indicates that the efficiency of the selected antioxidants either natural or synthetic, at this stage of frying operation have had almost similar efficiency in retarding palm olein oxidation.

The effect of various levels and types of anti-or pro-oxidants could be studied. Phenolic compounds from plants are known to be good natural anti-oxidants. However, the activity ofartificial antioxidant was often observed to be higher than that of natural anti-oxidants (Ningappa et al., 2007). Phenolic compounds, at certain concentrations, markedly slowed down in the rate of conjugated diene formation (Chimi & Cilard, 1991). In their absence, linoleic and concentration decreased dramatically, indicating oxidation. The antioxidant effectiveness of these compounds seemed to be related to their ability to quench peroxyl radicals.

Peroxide values obtained in this study were similar to the trends of the antioxidative effect (Morteza-Semnani et al., 2006). The peroxide value was decreased after some hours of heating, indicating formation of secondary oxidation products, such as ketones, aldehydes, hydrocarbons and epoxides, which could be measured using the anisidine test. Hindered phenols (caffeic acid, venillic acid and ferrulic acid) and crude tea extract reportedly lower the peroxide value and anisidine value at 0.02% concentration in oil (Abdulkarim et al., 2007).

Results of Table (3) also indicate that the No. of frying (times of frying) has a significant effect on peroxide value of all samples. The peroxide values increased with increasing no. of fryings until the 50th frying. In control samples peroxide values increased by 65.48, 180.54 and 255.23% after 10, 30 and 50 fryings, respectively. The peroxide value of rosemary treated palm olein increased by 14.71, 122.06 and 203.97% after 10, 30 and 50 fryings, respectively. Sage treated palm olein subjected to a corresponding increase in peroxide values after 10, 30 and 50 fryings by 41.74, 183.25 and 263.83%, respectively. Basil treated palm olein subjected to a corresponding increase in peroxide values after 10, 30 and 50 fryings by 26.61, 159.88 and 245.97%. Artificial antioxidant, BHT added to palm olein caused an inhibitory effect on peroxide formation that retarded its rate to be 18.56, 135.02 and 224.05% increase compared to the control.

The elucidate the efficiency of each used antioxidant either natural or artificial in the present investigation, the responsibility of frying operation on the rate of peroxide formation (Table 3) could be calculated. For example, in control sample if operation in the 1st 10 fryings caused 6.5%
increase in peroxide value whereas it caused 1.47, 4.17, 2.66, 1.85% in and BHT, respectively.

At the 30th frying, the control shows 6.02% P.V increase/day compared to 4.07, 6.1, 5.3 and 4.5% increase day in R, S, B, and BHT. This indicates that the efficiency of in retarding lipid oxidation is almost disappeared 6.02 versus 6.1 in sage + palm olein samples. All other samples, R, B and BHT, show also less efficiency in retarding lipid oxidation when compared with their efficiencies during the 1st 10 fryings (1.47, 2.66 and 1.85 versus 4.07, 5.3 and 4.5).

This means that, a progressive and dramatic increase in peroxide formation has been occurred from 10th to 30th frying. At the stage between 30th to 50th fryings, the rate of P.V formation was either stable (R and BHT) or became less (control, sage and BHT).

**Table (2): Peroxide value of different frying oil sample treatment with different antioxidants**

<table>
<thead>
<tr>
<th>No. Frying Treatment</th>
<th>F0</th>
<th>F10</th>
<th>F30</th>
<th>F50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>4.78a±.20</td>
<td>7.91a±.30</td>
<td>13.41a±.09</td>
<td>16.98a±.22</td>
</tr>
<tr>
<td>T1</td>
<td>5.03a±.56</td>
<td>5.77b±.39</td>
<td>11.17a±.77</td>
<td>15.29b±.15</td>
</tr>
<tr>
<td>T2</td>
<td>4.74a±.13</td>
<td>5.62b±.51</td>
<td>11.14b±.16</td>
<td>15.36b±.48</td>
</tr>
<tr>
<td>T3</td>
<td>4.48a±.46</td>
<td>6.35b±.61</td>
<td>12.69a±.63</td>
<td>16.30ab±.78</td>
</tr>
<tr>
<td>T4</td>
<td>4.96a±.25</td>
<td>6.28b±.48</td>
<td>12.89a±.26</td>
<td>17.16a±.49</td>
</tr>
<tr>
<td>LSD</td>
<td>0.655</td>
<td>0.854</td>
<td>0.845</td>
<td>0.870</td>
</tr>
</tbody>
</table>

Each value in the table was obtained by calculating the mean of the three experiments ± S.D. The mean difference is significant at the 0.05 level. T1: Palm Olein + 0.2% Rosemary; T2: Palm Olein + 0.2% Sage; T3: Palm Olein+0.2% Basil; T4: Palm Olein+0.02% Butylatedhydrxytoluine; F0: Not Frying at Zero Time; F10: No Frying at 10 times; F30: No Frying at 30 times; F50: No Frying at 50 times.
Table (3): Efficiency of different antioxidants added to palm olein

<table>
<thead>
<tr>
<th>Treatment</th>
<th>No- of frying</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td>% increase</td>
<td>65.48</td>
</tr>
<tr>
<td>DPV/ D No. frying</td>
<td>6.5%</td>
</tr>
<tr>
<td>Control</td>
<td></td>
</tr>
<tr>
<td>DPV/ D No. frying</td>
<td>14.71</td>
</tr>
<tr>
<td>T1</td>
<td>1.47%</td>
</tr>
<tr>
<td>DPV/ D No. frying</td>
<td>41.74</td>
</tr>
<tr>
<td>T2</td>
<td>4.17%</td>
</tr>
<tr>
<td>DPV/ D No. frying</td>
<td>26.61</td>
</tr>
<tr>
<td>T3</td>
<td>2.66%</td>
</tr>
<tr>
<td>T4 BHT</td>
<td>18.56</td>
</tr>
<tr>
<td>DPV/ D No. frying</td>
<td>1.85%</td>
</tr>
</tbody>
</table>

2. Ansidine value:

Data given in Table (4) indicate ansidine value as affected by various suggested treatments in this study. From these data it could be noticed that, ansidine value was clearly affected by No. of fryings as a general trend in case of T1, T2 and T3 similar to that of control one. Ansidine value was increased by 1.45 folds after ten fryings then raised to be 2 folds (rather than their values at zero time frying) and it continuously raised to be 2.55, 2.66 and 2.81 folds in T1, T2 and T3, respectively. Regarding to T4 treatment it could be seen that earliar incremental trend in insidine value was more detected. The corresponding increasing folds are 1.60, 2.15 and 3.00 after 10, 30 and 50 frying as calculated from table (4). So, it could be report that using chemical (artifichial) antioxidant did not prevent the ditremental effect of frying times compaired with using natural antioxidants (Subramanian et al., 2000 and Buczek and Chwiałkowski 2008).

On the other hand, use of natural or artificial antioxidants (T1, T2, T3 and T4) minimized ansidine value by about 1.1 folds from control sample at any number of frying.

Antioxidants have had a specific activity based on its ability to compensate protons that leave behind free radicals which initiate auto
oxidation reaction chain. Highly mobile and active free radicals react with O2 if the antioxidants proton did not replace that belong to fatty acids free radical which lose their proton. Rosemary was found to be the most active antioxidants when compared not only with other natural ones but also when compared with artificial one called BHT.

Decompose to secondary products, including alcohols, carboxylic acids, aldehydes and ketones, measured as insidine value. The anisidine value was independent of the extract type but was significantly different from the control (Table 4).

Table (4): Anisidine value of different frying oil sample treatment with different antioxidants

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Control</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>LSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>No frying</td>
<td>F0</td>
<td>F10</td>
<td>F30</td>
<td>F50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ±S.D.</td>
<td>9.66±0.44</td>
<td>14.03±0.43</td>
<td>19.32±0.45</td>
<td>26.49±1.07</td>
<td>1.235</td>
<td>0.850</td>
</tr>
<tr>
<td>Mean ±S.D.</td>
<td>8.63±0.57</td>
<td>12.54±0.68</td>
<td>17.25±0.57</td>
<td>22.03±0.87</td>
<td>8.64±0.66</td>
<td>13.86±0.18</td>
</tr>
<tr>
<td>Mean ±S.D.</td>
<td>8.42±0.83</td>
<td>12.28±0.50</td>
<td>16.96±0.45</td>
<td>22.41±1.64</td>
<td>13.04±0.40</td>
<td>17.85±0.17</td>
</tr>
<tr>
<td>Mean ±S.D.</td>
<td>9.07±0.81</td>
<td>13.04±0.40</td>
<td>17.85±0.17</td>
<td>25.51±0.47</td>
<td>18.56±0.58</td>
<td>25.92±1.12</td>
</tr>
<tr>
<td>Mean ±S.D.</td>
<td>8.64±0.66</td>
<td>13.86±0.18</td>
<td>18.56±0.58</td>
<td>25.92±1.12</td>
<td>18.56±0.58</td>
<td>25.92±1.12</td>
</tr>
</tbody>
</table>

Each value in the table was obtained by calculating the mean of the three experiments ±S.D. The mean difference is significant at the 0.05 level.

T1: Palm Olein + 0.2% Rosemary; T2: Palm Olein + 0.2% Sage; T3: Palm Olein + 0.2% Basil; T4: Palm Olein + 0.02% Butylatedhydraxytouloine; F0: Not Frying at Zero Time; F10: No. Frying at 10 times; F30: No. Frying at 30 times; F50: No. Frying at 50 times.

3. Totox value (Total oxidation):

Totox value is the most important in discussing the degree of oxidation process which has been occurred in frying oils (Table 5). Totox value of unheated palm olein with or without antioxidants was ranged between 17.90 to 20.17. It is of great importance to mention that there was no significant difference between all samples either untreated or treated with natural or artificial antioxidants at F0.
Addition of herb extracts (0.2%) was significantly natural or artificical extracts lowered the totox value significantly (P> 0.05) compared to the control after 10 fryings with about 1.2 folds(for all treatments) less than control one Miyagi and Nakajima (2003).

After 10 frying the totox value of control palm olein (B) decreased by, 19.33, 13.77, 11.49 and 21.21% (BHT). Overall results suggested that both natural and synthetic antioxidants were capable of protecting the oil from further oxidation, resulted from frying operations, compared to the control one. The ability to lower the rate of antioxidation was good in both R and BHT (19.33 and 21.21%, respectively) whereas in S and B it was higher (13.77 and 11.49 respectively), i.e. less ability to retard antioxidation process during frying till the 10th frying was still present.

At the 30, 50th frying, another concept could be concluded both S and B loose their ability to retard antioxidation, i.e become either inactive or prooxidant, that is why both of them did not differ significantly with the control are (Table 5) although up to the 30th frying they still act as antioxidants. On the other hand R and BHT were capable of protecting oil form further oxidation compared to the control. Rosemary as antioxidant was comparable to BHT, however there was no significant difference between both as appeared in Table (5).TOTOX = 2PV + P – AV (Shahidi and Wanasundara 2002).

### Table (5): Totox value of different frying oil sample treatment with different antioxidants

<table>
<thead>
<tr>
<th>No frying Treatments</th>
<th>F0 Mean ±S.D.</th>
<th>F10 Mean ±S.D.</th>
<th>F30 Mean ±S.D.</th>
<th>F50 Mean ±S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1922ab±0.28</td>
<td>29.86a±0.91</td>
<td>46.15a±0.61</td>
<td>60.44a±1.01</td>
</tr>
<tr>
<td>T1</td>
<td>2.17a±0.27</td>
<td>24.08b±1.26</td>
<td>39.60b±1.97</td>
<td>52.43b±1.28</td>
</tr>
<tr>
<td>T2</td>
<td>17.90b±1.04</td>
<td>23.52b±1.51</td>
<td>39.25b±0.35</td>
<td>53.13b±2.49</td>
</tr>
<tr>
<td>T3</td>
<td>18.04ab±1.13</td>
<td>25.75b±1.50</td>
<td>43.24a±1.08</td>
<td>58.11a±1.11</td>
</tr>
<tr>
<td>T4</td>
<td>18.56ab±0.94</td>
<td>26.43b±0.80</td>
<td>44.04a±0.66</td>
<td>60.23a±1.83</td>
</tr>
<tr>
<td>LSD</td>
<td>1.500</td>
<td>2.243</td>
<td>0.853</td>
<td>2.9852.985</td>
</tr>
</tbody>
</table>

Each value in the table was obtained by calculating the mean of the three experiments ±S.D. The mean difference is significant at the 0.05 level.

T1: Palm Olein + 0.2% Rosemary; T2: Palm Olein + 0.2% Sage; T3: Palm Olein + 0.2% Basil; T4: Palm Olein + 0.02% Butylatedhydroxytouloine; F0: Not Frying at Zero Time; F10: No. Frying at 10 times; F30: No.Frying at 30 times; F50: No.Frying at 50 times.
4. Iodine number:

Table (6) indicate changes in iodine number of different frying oil samples treated with different antioxidants. It could be seen that, such parameter (iodine number) did not affect by the type of antioxidant use as seen at F0 treatment; i.e. no significancy was found (values were around 56-58).

Similar trend was extended till 10 frying but with lesser values (around 49-51). Meanwhile, when frying was carried out to be 30 times, treatments were significantly differed and such findings were also detected in iodine number (with more effect) after 50 fryings (Nor et al., 2008).

Table (6): Iodine number of different frying oil sample treatment with different antioxidants

<table>
<thead>
<tr>
<th>Treatments</th>
<th>F0</th>
<th>F10</th>
<th>F30</th>
<th>F50</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ±S.D.</td>
<td>Mean ±S.D.</td>
<td>Mean ±S.D.</td>
<td>Mean ±S.D.</td>
</tr>
<tr>
<td>Control</td>
<td>57.77a±0.41</td>
<td>48.82a±0.43</td>
<td>39.80a±0.51</td>
<td>33.33c±1.03</td>
</tr>
<tr>
<td>T1</td>
<td>55.81a±1.11</td>
<td>49.84a±0.97</td>
<td>43.26a±1.07</td>
<td>38.56a±0.55</td>
</tr>
<tr>
<td>T2</td>
<td>56.93a±1.18</td>
<td>49.65a±1.23</td>
<td>43.36a±0.43</td>
<td>37.58ab±0.65</td>
</tr>
<tr>
<td>T3</td>
<td>57.24a±0.57</td>
<td>50.91a±0.34</td>
<td>42.55ab±1.37</td>
<td>36.96ab±1.09</td>
</tr>
<tr>
<td>T4</td>
<td>56.28a±0.35</td>
<td>49.04a±0.67</td>
<td>40.41bc±1.24</td>
<td>35.77b±1.05</td>
</tr>
<tr>
<td>LSD</td>
<td>1.467</td>
<td>1.450</td>
<td>1.823</td>
<td>1.643</td>
</tr>
</tbody>
</table>

Each value in the table was obtained by calculating the mean of the three experiments ±S.D. The mean difference is significant at the 0.05 level.

Each value in the table was obtained by calculating the mean of the three experiments ±S.D. The mean difference is significant at the 0.05 level.

T1: Palm Olein + 0.2% Rosemary; T2: Palm Olein + 0.2% Sage; T3: Palm Olein + 0.2% Basil; T4: Palm Olein + 0.02% Butylatedhydroxytoluino; F0: Not Frying at Zero Time; F10: No. Frying at 10 times; F30: No.Frying at 30 times; F50: No.Frying at 50 times.

5. Thiolbarbituric acid (TBA) value:

Thiolbarbituric acid (TBA) values of different frying oil samples that treated with different antioxidants suggested in this study were given in Table (7) from these table and figure it could be concluded that, TBA value did not affect by only the type of antioxidant (as seen at F0 treatment). But, when frying process was taken place the TBA value was increased by about 2 folds after 10 fryings for all treatments. After 30 times of frying, the
increasing in TBA value reached to be close to 4 folds for all treatments and sharply increased to be about 4.5 Folds that of their initial value (at F0) for all treatments as calculated from Table (7). Such findings go in parallel with those, Nguyen et al. (2015).

Table (7): TBA value of different frying oil sample treatment with different antioxidants

<table>
<thead>
<tr>
<th>Treatments</th>
<th>F0</th>
<th>F10</th>
<th>F30</th>
<th>F40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>11.62±0.42</td>
<td>24.93±2.14</td>
<td>41.76±3.59</td>
<td>53.26±4.58</td>
</tr>
<tr>
<td>T1</td>
<td>11.52±1.09</td>
<td>21.37±1.86</td>
<td>37.59±3.26</td>
<td>51.10±0.50</td>
</tr>
<tr>
<td>T2</td>
<td>12.19±0.70</td>
<td>21.05±1.72</td>
<td>37.53±3.07</td>
<td>50.67±4.15</td>
</tr>
<tr>
<td>T3</td>
<td>12.09±0.96</td>
<td>22.81±1.88</td>
<td>38.81±3.24</td>
<td>53.01±4.38</td>
</tr>
<tr>
<td>T4</td>
<td>11.46±0.81</td>
<td>21.88±1.91</td>
<td>38.85±3.39</td>
<td>52.88±4.61</td>
</tr>
<tr>
<td>LSD</td>
<td>1.511</td>
<td>1.912</td>
<td>2.273</td>
<td>2.014</td>
</tr>
</tbody>
</table>

Each value in the table was obtained by calculating the mean of the three experiments ±S.D. The mean difference is significant at the 0.05 level.

T1: Palm Olein + 0.2% Rosemary; T2: Palm Olein + 0.2% Sage; T3: Palm Olein + 0.2% Basil; T4: Palm Olein + 0.02% Butylatedhydroxytoluine; F0: Not Frying at Zero Time; F10: No. Frying at 10 times; F30: No. Frying at 30 times; F50: No. Frying at 50 times.

6. Acid value:

Acid value % as affected by different suggested antioxidants used in this investigation. From these data it could be seen that, from these data it could be seen that, acid value % of various treatments was preparationally correlated with No. of fryings. A significant difference was also noticed between treatments a seen in table (8). The (F50) treatment recorded the highest acid value percent.

Table (8): Acid value % of different frying oil sample treatment with different antioxidants

<table>
<thead>
<tr>
<th>Treatments</th>
<th>F</th>
<th>F10</th>
<th>F30</th>
<th>F40</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ±S.D.</td>
<td>Mean ±S.D.</td>
<td>Mean ±S.D.</td>
<td>Mean ±S.D.</td>
</tr>
<tr>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
7. Viscosity:

Changes in viscosity of frying media that carried out in this investigation were shown in Table (9). It was seen that frying times (No. of fryings) were clearly affected such parameter (viscosity) in case of T3 and T4 treatments. It reached to 107.14 and 109.13 in T2 and T4, respectively after 50 times of frying. Meanwhile, it was ranged between 84.41 to 96.89 in other treatments after the same no. of fryings. These findings are in agreement with those of Lin et al. (1999) and Chatzilazarou et al. (2006).

Table (9): Viscosity value of different frying oil sample treatment with different antioxidants

<table>
<thead>
<tr>
<th>Treatment</th>
<th>F0 Mean±S.D.</th>
<th>F10 Mean±S.D.</th>
<th>F30 Mean±S.D.</th>
<th>F50 Mean±S.D.</th>
<th>LSD (0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>72.86 ±2.40</td>
<td>79.18 ±2.40</td>
<td>84.00 ±2.41</td>
<td>92.86 ±2.04</td>
<td>4.52</td>
</tr>
<tr>
<td>T1</td>
<td>54.45 ±2.40</td>
<td>61.58 ±2.40</td>
<td>71.69 ±2.40</td>
<td>84.41 ±2.40</td>
<td>4.52</td>
</tr>
<tr>
<td>T2</td>
<td>68.71 ±2.40</td>
<td>76.66 ±2.40</td>
<td>86.59 ±2.40</td>
<td>96.89 ±2.40</td>
<td>4.52</td>
</tr>
<tr>
<td>T3</td>
<td>83.38±2.40</td>
<td>91.32±2.40</td>
<td>97.17±2.40</td>
<td>107.14±2.40</td>
<td>0.227</td>
</tr>
<tr>
<td>T4</td>
<td>83.98±2.40</td>
<td>90.93±2.40</td>
<td>98.45±2.40</td>
<td>109.13±2.40</td>
<td>4.52</td>
</tr>
</tbody>
</table>

Each value in the table was obtained by calculating the mean of the three experiments ±S.D. The mean difference is significant at the 0.05 level.

T1: Palm Olein + 0.2% Rosemary; T2: Palm Olein + 0.2% Sage; T3: Palm Olein + 0.2% Basil; T4: Palm Olein + 0.02% Butylatedhydraxytouline; F0: Not Frying at Zero Time; F10: No. Frying at 10 times; F30: No. Frying at 30 times; F50: No. Frying at 50 times.
8. Polar value:

Data given in Table (10) showed that the polar value of frying oil samples as affected by times of frying and/or suggested additives as antioxidants. From this table it could be seen that generally, the higher the frying times, the higher the polar value; i.e. there is a proportional relationship between polar value and number of fryings.

Meanwhile, a contradicted relationship was clearly noticed among type of treatment (natural or artificial one) as seen in the same table. Such relation did not detect at zero time of frying, then a continuous decrease was recorded with various rates depending on type of treatment (Chatzilazarou et al., 2006 and Romero et al., 2006).

Table (10): Polar value of different frying oil sample treatment with Control different antioxidants

<table>
<thead>
<tr>
<th>Treatment</th>
<th>F0 Mean ±S.D.</th>
<th>F10 Mean ±S.D.</th>
<th>F30 Mean ±S.D.</th>
<th>F50 Mean ±S.D.</th>
<th>LSD (0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>4.45 ±0.46</td>
<td>9.03 ±0.29</td>
<td>17.70 ±2.21</td>
<td>26.19 ±1.00</td>
<td>2.27</td>
</tr>
<tr>
<td>T1</td>
<td>4.14 ±0.15</td>
<td>6.09 ±0.08</td>
<td>12.99 ±0.77</td>
<td>21.39 ±0.28</td>
<td>0.76</td>
</tr>
<tr>
<td>T2</td>
<td>4.07±0.16</td>
<td>8.15 ±0.23</td>
<td>14.37 ±0.92</td>
<td>24.98±0.18</td>
<td>0.89</td>
</tr>
<tr>
<td>T3</td>
<td>4.06±0.07</td>
<td>7.61 ±0.59</td>
<td>14.05 ±0.19</td>
<td>24.05±0.15</td>
<td>4.52</td>
</tr>
<tr>
<td>T4</td>
<td>4.14 ±0.09</td>
<td>6.64 ±0.39</td>
<td>13.17 ±0.22</td>
<td>22.84±0.69</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Each value in the table was obtained by calculating the mean of the three experiments ±S.D. The mean difference is significant at the 0.05 level.

T1: Palm Olein + 0.2% Rosemary; T2: Palm Olein + 0.2% Sage; T3: Palm Olein + 0.2% Basil; T4: Palm Olein + 0.02% Butylatedhydrazytouloine; F0: Not Frying at Zero Time; F10: No. Frying at 10 times; F30: No. Frying at 30 times; F50: No. Frying at 50 times.

9. Fatty acid composition:

Linolenic acid and linoleic are highly sensitive to oxidation because it contains three and two double bands while Oleic acid is less reactive and more heat stable, it contains only one double bond. The fatty acid profile is also relevant to its nutritive quality and how it changes during frying process, (Kris Etherton et al., 2004).

Palm olein it relatively contains a highly amount of C18:2nd and C18:1n9 as 25.033 and 37.783, respectively. This is give the oil or palm
olein health and advantage on stability of oil and cardiovascular disease has
been claimed (Kris Etherton et al., 2004).

The linoleic acid is also precause of long chain omega-3 poly unsaturated
FA (LC n-3 PLFA) by elongation Enzymatic conversion (Simpoulous, 1997). The change is unsaturated Fas during frying is show in Table (16). There was a significant decrease in (18.2n6 to range between 39% -45% along frying process on palolein from F0 up F50, Goli et al. (2012).

The fatty acid profile of edible oil effect during thermal of frying temp.
Both linolenic acid (C18:3) and (C18:2) were highly sensitive to frying
temperature because it contains more than two double bonds, while oleic
acid C18:1 is less reactive as it contains only one double bond. Addition off
different phenolic compounds are show similar effects on C18: 2n6. There
were a failed from 25-037 is control belondioil in to about 11%. Table (11)
shows the statistically result of natural antioxidant roles in stability of oil
waste significantly increase sage frying oil. All moded of palm okinfrying
there were a significant decreases occurred in C18:2nb, follows by
C18.3n3. Vice reverse. There were increased in C18: inq in all frying mode
about 10-15% in comparison to control blend oil (FO), Goli et al. (2012).

The basil extracted when added into palm olein was effected on
increase stability of oil and protect the oil from destruction especially as
show in C18:2nd. In frying Fio, F30 and and F50, 10.406, 10.769 basil
extracted when add in to palmolein. Meanwhile, Rosemary extract in
palmoile in used in frying especially is F50 was protect W-3 fatty acid from
destruction as 9.167 with long time heating. This is means that rosemary
extraction in frying oil were healthy than either basil or sage in frying
palnolein. As a conclusion, Both basil and rosemary extracts were shown
increasing stability of palm olein similar to synthelic antioxidant BHT,
Goli et al. (2012).

9.1. Fatty acids profile of frying samples:

Data given in Tables (7.11) showed the fatty acids profile of different
frying oil sample as affected by adding various natural and /or artificial
antioxidants as well as by times of frying.

9.2. Untreated (control) sample:

From Table (11) that indicated frying number effect on control sample,
it could be noticed that, C16:0 was the predominant saturated fatty acid
(23.806%) and it increased after ten frying till the end of experiment (50
fryings) to be about 37%. The C18:0 was found to be in the second order
with approximathy constant percentage (about 4%).
It is of interest to notice that sum. of saturated fatty acids was continuously raised as number of fryings raised. Such raising was started after ten times of frying them slowly increased by times of frying increased.

From the same Table (11), it could be also seen the unsaturated fatty acids profile as affected by two factors mentioned above. The predominant unsaturated fatty acid was C18:1n9 that behaved similar trend that mentioned above in case of C16:0 but with the percentage of 37.783% increased to be about 43%.

**Table (11): Fatty acid profile (%) of different control frying oil samples**

<table>
<thead>
<tr>
<th>Fatty acid</th>
<th>F0</th>
<th>F10</th>
<th>F30</th>
<th>F50</th>
</tr>
</thead>
<tbody>
<tr>
<td>C12:0 (Lauric)</td>
<td>0.401</td>
<td>0.137</td>
<td>0.252</td>
<td>0.259</td>
</tr>
<tr>
<td>C14:0 (Myristic)</td>
<td>1.938</td>
<td>0.945</td>
<td>0.902</td>
<td>1.094</td>
</tr>
<tr>
<td>C16:0 (Palmitic)</td>
<td>23.806</td>
<td>36.076</td>
<td>36.681</td>
<td>37.392</td>
</tr>
<tr>
<td>C18:0 (Stearic)</td>
<td>4.184</td>
<td>3.706</td>
<td>3.888</td>
<td>4.174</td>
</tr>
<tr>
<td>C20:0 (Arachidic)</td>
<td>0.15</td>
<td>0.333</td>
<td>0.321</td>
<td>0.154</td>
</tr>
<tr>
<td>Sum of SFA</td>
<td>30.479</td>
<td>41.197</td>
<td>42.044</td>
<td>43.073</td>
</tr>
<tr>
<td>C16:1n7 (Palmitoleic)</td>
<td>0.871</td>
<td>0.243</td>
<td>0.282</td>
<td>1.006</td>
</tr>
<tr>
<td>C18:1n9 (Oleic)</td>
<td>37.783</td>
<td>43.317</td>
<td>43.692</td>
<td>42.368</td>
</tr>
<tr>
<td>C18:1n7 (Vissinic)</td>
<td>0</td>
<td>1.203</td>
<td>1.203</td>
<td>1.618</td>
</tr>
<tr>
<td>C18:2n6 (Linoleic)</td>
<td>25.033</td>
<td>11.491</td>
<td>11.279</td>
<td>10.817</td>
</tr>
<tr>
<td>C18:3n3 (Linolenic)</td>
<td>2.106</td>
<td>0.227</td>
<td>0.185</td>
<td>0.222</td>
</tr>
<tr>
<td>Sum of USFA</td>
<td>65.793</td>
<td>56.481</td>
<td>56.641</td>
<td>56.031</td>
</tr>
<tr>
<td>Other Fatty Acids</td>
<td>3.728</td>
<td>2.32</td>
<td>1.31</td>
<td>0.9</td>
</tr>
</tbody>
</table>

F0: Not Frying at Zero Time; F10: No. Frying at 10 times; F30: No.Frying at 30 times; F50: No.Frying at 50 times.

The C18:2n6 that came in the second order (25.033%) was sharply reduced by over 50% of its original percentage as a result of extending frying treatment (number of fryings). The sum of unsaturated fatty acids was minimized after ten fryings by about 9% then still constant till the end of experiment (50 fryings). These findings are in agreement with those.
9.3. Basil sample:

Table (12) indicated that fatty acids profile of different frying oil samples as affected by adding basil extract (as a natural antioxidant) as well as by times of frying. From this table it could be seen that C16:0 fatty acid was a predominant one with about 39%. It did not affect by extending the times of frying (till 50 times).

The C18:0 came in the second order with values around 4% and it behaved similar trend that noticed earlier. Generally, it could be noticed that sum. of SFA (about 45%) did not affect by times of frying comparing with control sample (Table 11) as shown earlier. It means that basil extract plays a noticeable role as antioxidant.

On the other hand, C18:1n9 was appeared as a predominant unsaturated fatty acid with about 41%. Similar detected basil effect as a good antioxidant was recorded as a function of time of frying. In the second order with about 11%, C18:2n6 also approximately not affected by times of frying (till 50 times). The total USFA also did not affect awing to frying times. It was about 54%, this assures the role of basil as antioxidant.

Table (12): Fatty acid profile (%) of Basil different basil frying oil samples

<table>
<thead>
<tr>
<th>Fatty acid</th>
<th>F0</th>
<th>F10</th>
<th>F30</th>
<th>F50</th>
</tr>
</thead>
<tbody>
<tr>
<td>C12:0 (Lauric)</td>
<td>0.149</td>
<td>0.17</td>
<td>0.17</td>
<td>0.171</td>
</tr>
<tr>
<td>C14:0 (Myristic)</td>
<td>0.92</td>
<td>0.972</td>
<td>0.991</td>
<td>0.973</td>
</tr>
<tr>
<td>C16:0 (Palmitic)</td>
<td>39.405</td>
<td>39.862</td>
<td>38.772</td>
<td>38.682</td>
</tr>
<tr>
<td>C18:0 (Stearic)</td>
<td>3.972</td>
<td>4.12</td>
<td>4.421</td>
<td>4.552</td>
</tr>
<tr>
<td>C20:0 (Arachidic)</td>
<td>0.326</td>
<td>0.329</td>
<td>0.324</td>
<td>0.131</td>
</tr>
<tr>
<td>Sum of SFA</td>
<td>44.772</td>
<td>45.453</td>
<td>44.678</td>
<td>44.509</td>
</tr>
<tr>
<td>C16:1n7 (Palmitoleic)</td>
<td>0.216</td>
<td>0.202</td>
<td>0.604</td>
<td>0.759</td>
</tr>
<tr>
<td>C18:1n9 (Oleic)</td>
<td>41.139</td>
<td>41.526</td>
<td>40.757</td>
<td>41.166</td>
</tr>
<tr>
<td>C18:1n7 (Vissinic)</td>
<td>1.087</td>
<td>0.971</td>
<td>0.967</td>
<td>1.259</td>
</tr>
<tr>
<td>C18:2n6 (Linoleic)</td>
<td>10.229</td>
<td>10.406</td>
<td>10.769</td>
<td>11.135</td>
</tr>
<tr>
<td>C18:3n3 (Linolenic)</td>
<td>0.165</td>
<td>0.174</td>
<td>0.231</td>
<td>0.288</td>
</tr>
<tr>
<td>Sum of USFA</td>
<td>52.836</td>
<td>53.279</td>
<td>53.328</td>
<td>54.607</td>
</tr>
<tr>
<td>Other Fatty Acids</td>
<td>2.392</td>
<td>1.268</td>
<td>1.994</td>
<td>0884</td>
</tr>
</tbody>
</table>

F0: Not Frying at Zero Time; F10: No. Frying at 10 times; F30: No. Frying at 30 times; F50: No. Frying at 50 times.
Fatty acids profile of various frying oil samples treated with rosemary extract and exposed to many frying times was given in Table (17). It could be easily seen that C16:0 (the predominant one) did not affect till 10 times of frying then decreased till the end of experiment (50 times).

The C12:0 that came in the second order with about 4% did not affect by frying times. On the other hand, the total SFA behaved similar trend that found in case of C16:0 fatty acid.

Regarding to USFA, C18:1n9 (about 41%) was minimized to be about 36% after 30 and 50 times of frying. Meanwhile, the C18:2n6 (the second main unsaturated fatty acid) was continuously decreased by increasing frying times.

The total unsaturated fatty acids was approximately not affect till 30 times of frying them increased at 50 times of frying.

Table (13): Fatty acid profile (%) of different rosemary frying oil samples

<table>
<thead>
<tr>
<th>Number of frying</th>
<th>Fatty acid</th>
<th>F0</th>
<th>F10</th>
<th>F30</th>
<th>F50</th>
</tr>
</thead>
<tbody>
<tr>
<td>C12:0 (Lauric)</td>
<td>F0</td>
<td>0.189</td>
<td>0.221</td>
<td>0.164</td>
<td>0.727</td>
</tr>
<tr>
<td>C14:0 (Myristic)</td>
<td>F10</td>
<td>1.034</td>
<td>0.932</td>
<td>0.854</td>
<td>0.815</td>
</tr>
<tr>
<td>C16:0 (Palmitic)</td>
<td>F30</td>
<td>39.577</td>
<td>40.285</td>
<td>36.01</td>
<td>35.577</td>
</tr>
<tr>
<td>C18:0 (Stearic)</td>
<td>F50</td>
<td>4.149</td>
<td>3.989</td>
<td>3.587</td>
<td>3.644</td>
</tr>
<tr>
<td>C20:0 (Arachidic)</td>
<td>F0</td>
<td>0.376</td>
<td>0.336</td>
<td>0.111</td>
<td>0.111</td>
</tr>
<tr>
<td>Sum of SFA</td>
<td>F10</td>
<td>45.325</td>
<td>45.763</td>
<td>40.726</td>
<td>40.874</td>
</tr>
<tr>
<td>C16:1n7 (Palmitoleic)</td>
<td>F30</td>
<td>0.227</td>
<td>0.145</td>
<td>5.116</td>
<td>4.35</td>
</tr>
<tr>
<td>C18:1n9 (Oleic)</td>
<td>F50</td>
<td>41.85</td>
<td>41.283</td>
<td>36.187</td>
<td>36.852</td>
</tr>
<tr>
<td>C18:1n7 (Vissinic)</td>
<td>F0</td>
<td>0.901</td>
<td>1.139</td>
<td>0.786</td>
<td>0.77</td>
</tr>
<tr>
<td>C18:2n6 (Linoleic)</td>
<td>F10</td>
<td>10.335</td>
<td>9.451</td>
<td>7.878</td>
<td>4.16</td>
</tr>
<tr>
<td>C18:3n3 (Linolenic)</td>
<td>F30</td>
<td>0</td>
<td>0.154</td>
<td>1.028</td>
<td>9.167</td>
</tr>
<tr>
<td>Sum of USFA</td>
<td>F50</td>
<td>53.313</td>
<td>52.172</td>
<td>50.995</td>
<td>55.299</td>
</tr>
<tr>
<td>Other Fatty Acids</td>
<td>F0</td>
<td>1.362</td>
<td>2.065</td>
<td>8.279</td>
<td>3.827</td>
</tr>
</tbody>
</table>

F0: Not Frying at Zero Time; F10: No. Frying at 10 times; F30: No. Frying at 30 times; F50: No. Frying at 50 times.
Use of sage as natural antioxidant for frying oil samples and its behaviour throughout 50 times of frying was followed and recorded in Table (13). No changes were detected in fatty acids profile saturated or unsaturated one showing sage as a good natural antioxidant that could be use in frying processes.

Table (14): Fatty acid profile (%) of different sage frying oil samples

<table>
<thead>
<tr>
<th>Fatty acid</th>
<th>F0</th>
<th>F10</th>
<th>F30</th>
<th>F50</th>
</tr>
</thead>
<tbody>
<tr>
<td>C12:0 (Lauric)</td>
<td>0.223</td>
<td>0.238</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C14:0 (Myristic)</td>
<td>0.978</td>
<td>1.01</td>
<td>0.987</td>
<td>0.892</td>
</tr>
<tr>
<td>C16:0 (Palmitic)</td>
<td>40.93</td>
<td>40.529</td>
<td>40.535</td>
<td>39.476</td>
</tr>
<tr>
<td>C18:0 (Stearic)</td>
<td>4.012</td>
<td>4.083</td>
<td>4.297</td>
<td>4.361</td>
</tr>
<tr>
<td>C20:0 (Arachidic)</td>
<td>0.324</td>
<td>0.231</td>
<td>0.379</td>
<td>0.392</td>
</tr>
<tr>
<td>Sum of SFA</td>
<td>46.467</td>
<td>46.091</td>
<td>46.198</td>
<td>45.121</td>
</tr>
<tr>
<td>C16:1n7 (Palmitoleic)</td>
<td>0.256</td>
<td>0.886</td>
<td>0.336</td>
<td>0.557</td>
</tr>
<tr>
<td>C18:1n9 (Oleic)</td>
<td>41.975</td>
<td>41.718</td>
<td>41.359</td>
<td>40.03</td>
</tr>
<tr>
<td>C18:1n7 (Vissinic)</td>
<td>1.14</td>
<td>0.886</td>
<td>0.856</td>
<td>1.152</td>
</tr>
<tr>
<td>C18:2n6 (Linoleic)</td>
<td>9.924</td>
<td>9.897</td>
<td>10.117</td>
<td>10.861</td>
</tr>
<tr>
<td>C18:3n3 (Linolenic)</td>
<td>0.173</td>
<td>0.179</td>
<td>0.09</td>
<td>0.164</td>
</tr>
<tr>
<td>Sum of USFA</td>
<td>53.468</td>
<td>53.006</td>
<td>52.758</td>
<td>52.764</td>
</tr>
<tr>
<td>Other Fatty Acids</td>
<td>0.065</td>
<td>0.903</td>
<td>1.044</td>
<td>2.115</td>
</tr>
</tbody>
</table>

F0: Not Frying at Zero Time; F10: No. Frying at 10 times; F30: No. Frying at 30 times; F50: No. Frying at 50 times.

As expected, otherwise normally use of BHT as artificial antioxidant no changes were detected in fatty acid profile (saturated or unsaturated ones) owing to number of fryings as seen in Table (20).
Table (15): Fatty acid profile (%) of different BHT frying oil samples

<table>
<thead>
<tr>
<th>Fatty acid</th>
<th>F0</th>
<th>F10</th>
<th>F30</th>
<th>F50</th>
</tr>
</thead>
<tbody>
<tr>
<td>C12:0 (Lauric)</td>
<td>0.151</td>
<td>0.158</td>
<td>0.157</td>
<td>0.148</td>
</tr>
<tr>
<td>C14:0 (Myristic)</td>
<td>0.94</td>
<td>0.971</td>
<td>0.951</td>
<td>0.88</td>
</tr>
<tr>
<td>C16:0 (Palmitic)</td>
<td>40.251</td>
<td>40.329</td>
<td>38.53</td>
<td>38.15</td>
</tr>
<tr>
<td>C18:0 (Stearic)</td>
<td>4.165</td>
<td>4.211</td>
<td>4.431</td>
<td>4.464</td>
</tr>
<tr>
<td>C20:0 (Arachidic)</td>
<td>0.324</td>
<td>0.361</td>
<td>0.325</td>
<td>0.131</td>
</tr>
<tr>
<td>Sum of SFA</td>
<td>45.831</td>
<td>46.03</td>
<td>44.394</td>
<td>43.955</td>
</tr>
<tr>
<td>C16:1n7 (Palmitoleic)</td>
<td>0.316</td>
<td>0.265</td>
<td>0.702</td>
<td>0.838</td>
</tr>
<tr>
<td>C18:1n9 (Oleic)</td>
<td>41.542</td>
<td>41.596</td>
<td>41.302</td>
<td>41.604</td>
</tr>
<tr>
<td>C18:1n7 (Vissinic)</td>
<td>1.196</td>
<td>0.92</td>
<td>1.033</td>
<td>1.295</td>
</tr>
<tr>
<td>C18:2n6 (Linoleic)</td>
<td>10.307</td>
<td>10.026</td>
<td>10.605</td>
<td>10.982</td>
</tr>
<tr>
<td>C18:3n3 (Linolenic)</td>
<td>0.185</td>
<td>0.206</td>
<td>0.154</td>
<td>0.127</td>
</tr>
<tr>
<td>Sum of USFA</td>
<td>53.456</td>
<td>53.013</td>
<td>53.796</td>
<td>54.846</td>
</tr>
<tr>
<td>Other Fatty Acids</td>
<td>0.713</td>
<td>0.957</td>
<td>1.81</td>
<td>1.199</td>
</tr>
</tbody>
</table>

F0: Not Frying at Zero Time; F10: No. Frying at 10 times; F30: No. Frying at 30 times; F50: No. Frying at 50 times.

4.10. Organolyptic evaluation:

Data given in Table (16) showed mean value of organolyptic evaluation of crispy potatoes that used artificial and natural antioxidants with different frying periods. No significant differences were detected between treatments as affected by using natural (Sage rosemary and base) and or artificial antioxidant (BHT). Such finding was noticed in all organolyptially evaluated parameters, i.e. appearance, odor, color, taste, texture and overall acceptability as seen in Table (17). Mean values were between 6.33-8.33.

In addition, oil samples were also organolyptically evaluated and its statistical analysis was given in Table (21). From these data it could be seen no significant difference were detected in various characteristics of frying oil used in this study. Such characteristics are appearance, odor, color, viscosity and overall acceptability with the mean values ranged between 5.00 -8.67.

It could be concluded that using antioxidant either natural or artificial one did not organallytopically effect by type of antioxidant when the product or used oil were considered.
Table (16): Organoleptic evaluation of oil according to use artificial and natural antioxidant with different frying period.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Appearance</th>
<th>Odor</th>
<th>Color</th>
<th>Viscosity</th>
<th>Overall acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ±S.D.</td>
<td>Mean ±S.D.</td>
<td>Mean ±S.D.</td>
<td>Mean ±S.D.</td>
<td>Mean ±S.D.</td>
</tr>
<tr>
<td>Control</td>
<td>8.33a±0.6</td>
<td>7.00b±0.0</td>
<td>8.33b±0.6</td>
<td>8.67a±0.6</td>
<td>8.33a±0.6</td>
</tr>
<tr>
<td>T1</td>
<td>7.67b±0.6</td>
<td>8.00a±1.0</td>
<td>9.00a±0.0</td>
<td>8.67a ±0.6</td>
<td>8.67a±0.6</td>
</tr>
<tr>
<td>T2</td>
<td>7.33b±0.6</td>
<td>8.00a±1.0</td>
<td>7.00c±0.0</td>
<td>7.67c±0.6</td>
<td>7.67b±0.6</td>
</tr>
<tr>
<td>T3</td>
<td>5.67c±0.6</td>
<td>5.00c±0.0</td>
<td>5.67d±0.6</td>
<td>7.33c±0.6</td>
<td>7.00c±1.0</td>
</tr>
<tr>
<td>T4</td>
<td>8.00a±0.0</td>
<td>7.00b±0.0</td>
<td>6.33d±0.6</td>
<td>8.00b±1.0</td>
<td>6.67c±0.6</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>0.49</td>
<td>1.41</td>
<td>0.81</td>
<td>1.24</td>
<td>1.24</td>
</tr>
</tbody>
</table>

Each value in the table was obtained by calculating the mean of the three experiments ±S.D. The mean difference is significant at the 0.05 level.

Table (17): Organoleptic evaluation of crispy potatoes according to use artificial and natural antioxidants with different frying period.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Appearance</th>
<th>Odor</th>
<th>Color</th>
<th>Taste</th>
<th>Texture</th>
<th>Overall acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ±S.D.</td>
<td>Mean ±S.D.</td>
<td>Mean ±S.D.</td>
<td>Mean ±S.D.</td>
<td>Mean ±S.D.</td>
<td>Mean ±S.D.</td>
</tr>
<tr>
<td>Control</td>
<td>8.33a±0.6</td>
<td>8.00a±1.0</td>
<td>7.00b±0.0</td>
<td>8.33a±0.6</td>
<td>8.00b±0.0</td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>8.00a±1.0</td>
<td>8.00a±0.0</td>
<td>8.00a±1.0</td>
<td>8.00a±0.0</td>
<td>7.33b±0.6</td>
<td>7.67a±0.6</td>
</tr>
<tr>
<td>T2</td>
<td>7.67a±2.2</td>
<td>7.00b±1.0</td>
<td>7.33b±0.6</td>
<td>7.00b±1.0</td>
<td>7.00b±0.0</td>
<td>7.33b±0.6</td>
</tr>
<tr>
<td>T3</td>
<td>6.33c±0.6</td>
<td>6.33c±0.6</td>
<td>7.00b±1.0</td>
<td>7.33b±0.6</td>
<td>6.67b±0.6</td>
<td>6.67b±0.6</td>
</tr>
<tr>
<td>T4</td>
<td>7.33b±0.6</td>
<td>7.67a±1.1</td>
<td>7.33b±0.6</td>
<td>7.33b±0.6</td>
<td>7.00b±0.0</td>
<td>7.33b±0.6</td>
</tr>
<tr>
<td>LSD(0.05)</td>
<td>1.24</td>
<td>1.56</td>
<td>1.33</td>
<td>1.15</td>
<td>0.81</td>
<td>0.49</td>
</tr>
</tbody>
</table>

Each value in the table was obtained by calculating the mean of the three experiments ±S.D. The mean difference is significant at the 0.05 level.
References:


تأثير إضافية بعض الزيوت النباتية العطرية على أكساء زيوت التحمير

د. جيهان إبراهيم وآخرون
قسم الاقتصاد المنزلي - كلية التربية النوعية - جامعة عين شمس

الملخص:

أجريت هذه الدراسة لتحقيق الأهداف التالية:
1- دراسة علاقة الوقت ودرجة الحرارة أثناء عملية الزيت المهملة من خلال بروتوكول محدد.
2- دراسة تأثير عملية الزيت على مقياس جودة زيت الزيت المستخدم.

مقارنة استخدام مضادات الأكساء الطبيعية والصناعية على جودة الزيت أثناء عملية الزيت المختلفة.
5- دراسة تأثير إضافة مضادات الأكساء الطبيعية على جودة الزيت أثناء عملية الزيت المختلفة.
وكانت المعادلات المفترضة في هذه الدراسة هي:

- معاملة الدكترول (أولين النخيل بدون إضافات).
- معاملة أولين النخيل + 0.2% مستخلصات نبات الرؤوووعي (الرهان).
- معاملة أولين النخيل + 0.2% مستخلصات نبات السدوا (الرمي).
- معاملة أولين النخيل + 0.2% مستخلصات نبات الرياح.
- معاملة أولين النخيل + 0.2% بيوتونات هيدروكسي توليوين.

تجهيز أولين النخيل لعملية الزيت:

تم تسخين أولين النخيل لدرجة 60° مئوي قبل إضافة مستخلصات كل من الرؤوووعي أو الرياح أو المرمية (نسبة 0.2%) ثم أجريت عملية تقلب دائرية لتأكيد اكتمال نوجان هذه المستخلصات - واستخدمت المعادلة بدون أي إضافات كعينة ضابطة سالبة والمعاملة المضافة إليها بيوتونات هيدروكسي توليوين كعينة ضابطة موجبة.

أعراض النبات:

تم تسخين عينات زيت الزيت لدرجات الزيت لمدة حوالى دقيقةتين لرفع درجة الحرارة من 25 إلى 180° م بهدف إضافة مراقبة البطاطس بمعدل 40 جم في 5 لتر زيت لمرة 2.5 دقيقة لتأكيد عملية الزيت في مرحلة الأولى، ثم أجريت مراقبة القلق الثانية (التدريب والتخزين) بعد نصف دقيقة، ثم إضافة رقائق البطاطس بعد رفع درجة الحرارة مرة أخرى من 170 إلى 180° م.

وتكرر هذه العملية 10 مرات في اليوم الأول وانتهت التجربة في اليوم الخامس بعد إجراء 50 عملية قلي.

وتم تسجيل النتائج عند وقت الصفر (60° م)، 10، 30، 50 مرة من مرات الزيت وكان حجم عينة زيت الزيت المأخوذة للتحليل هو 250 مل للتحليقات الكيمياوية والبيولوجية وعينة أخرى 250مل للكيماوي. يمكن تحليل النتائج المتحصل عليها كالذي:

- رقم البيروكسي:

azard رقم البيروكسي بعد عشر مرات قلي من 4.8 - 7.9 مليمكالري و/0.100 كجم زيت بنسبة زيادة حوالي 64.4%، بينما كانت نسبة الزيادة 19.88، 22.22، 22.22% عند استخدام الزيتي والمريمية والرياح (BHT) أو مضادات الأكساء الطبيعية (الروزماري والمريمية والرياح) في تثبيت كوكين البيروكسي حتى بعد 10 مرات قلي. ومن ناحية أخرى قللت مضادات الأكساء نسبة كوكين البيروكسي من حوالي 65 إلى 15%، 22 و20% عند مرات الزيت، وتأثر عنزي على رقم البيروكسي في كل العينات، وإزداد رقم البيروكسي بنسبة زيادة عند مرات الزيت حتى 50 مرة. وحندت زيادة في كوكين البيروكسي بصورة كبيرة ودرازانية بما بين 10 - 30 مرة، بينما يمرحلنا ما بين 30 - 50 مرة قلي كان معدل زيت كوكين البيروكسي ثابتًا أو أقل.
2- رقم الأسنان:
تأثر رقم الأسنان بصورة واضحة بعد مرات القلي بحيث كان بصفة عامة مشابهاً في المعاملات T3, T2.

3- رقم التتوكس (الأكسدة الكليّة):

4- الرقم اليودي:
لم يتآثر الرقم اليودي بنوع مضاد الأكسيدة المستخدم وذلك في بداية عملية القلي بمعنى عدم وجود معونة حيث تراوحت الفئات بين 56 – 58، واستمر هذا الاتجاه حتى 10 مرات قلي ولكن بقيم أقل (49 - 51) بينما بعد 30 مرة قلي اختفت المعاملات معوية وذلك بعد 50 مرة قلي ولكن بدرجات أكثر تآثراً.

5- رقم حمض الثيوبربيتريك:
لم يتآثر رقم حمض الثيوبربيتريك بنوع مضاد الأكسيدة المستخدم ولكن تآثر بعد مرات القلي حيث ازداد بمقدار حوالي 2 ضعفاً بعد 10 مرات قلي لكل المعاملات وبلغت الزيادة 3 ضعفاً في كل المعاملات بعد 30 مرة قلي ثم ازدادت بصورة حادة لتتصدى 4.5 ضعفاً بالمقارنة بقيمتها الأولى.

6- رقم الحموضة:
تناسب رقم الحموضة طردياً مع عدد مرات القلي ولاحظ اختلاف معين بين المعاملات وسجلت المعاملة F_{50} أعلى قيمة رقم حموضة.

7- اللدغة:
أثر عدد مرات القلي معينأ في هذا المقياس (النحو) وذلك في المعاملات T4, T3 حيث بلغت 109.13 107.14 (ستينبواز) على الترتيب بعد 50 مرة قلي في حين تراوحت بين 84.41 – 96.89 (ستينبواز) في باقي المعاملات بعد نفس العدد من مرات القلي.

8- رقم القطبية:

9- التقييم الحيمي:
لم توجد أي اختلافات معين أو بين المعاملات نتيجة استخدام مضادات الأكسيدة سواء الطبيعية أو الصناعية وذلك بالنسبة لكل من العظم والرئتين واللوان والطم والقوام والقولع حيث تراوحت متوسط القيم بين 8.33 – 6.33 وذلك بالنسبة لدرجة البطاطس المقلية.
بالإضافة لذلك تم تقييم عينات زيت القلي حسباً ولم توجد اختلافات معنوية في جميع صفات الزيت (الظهير، الرائحة، اللون، اللزوجة، القبول العام) حيث تراوح متوسط القيم بين 5 - 8.67، أي أن استخدام مضادات الأكسدة سواء الطبيعية أو الصناعية لم يؤثر حسباً بنوع المضادات سواء بالنسبة للزيت أو المنتج المستخدم.

10. تركيب الأحماض الدهنية:

- لوحظ انخفاض معنوي في الدهون الدهنية تراوح بين (C18:2 n6) تراوح بين 39% - 45% خلال معامل الزيت حتى 50 مره قلي وتأثر مستخلص الزيوت في زيادة نسبتي الزيت واتجاهه من النتائج خاصة بالنسبة لل�始 (C18:2 n6) حيث كانت القيمة %10.406 , 10.769 , 11.135. بعد 10 , 30 , 50 مره قلي،

أما بالنسبة للروزماري فقد أدى لحماية الحمض أمومياً 3 من النتائج وكانت القيمة 9.167 خلال فترة التسخين الطويلة مما يعكس الدراسة الصحية للروزماري بالمقارنة بالريحان والمريمية.

تركيب الأحماض الدهنية لعينات زيت القلي:

أولاً: عينة الكنترول:

كان الحمض الدهني السائد (C16:0) هو الحمض الدهني في المركبة الثانوية %40 وازداد بعد 10 مرات قلي واتح النهاية التجربي 40 مره لتصبح 37.86% تزايد حتى 39% على C18:0 في المركبة الثانوية بنسبة ثانياً تقريباً (حوالي 4%).

والجدير بالذكر أن مجموع الأحماض الدهنية المشبعة قد تزايد باستمرار بتزايد عدد مرات الزيت بدءاً من 10 مرات قلي ثم تزايد ببطء تزايد مرات الزيت.

- وصلت نسبة الدهون غير المشبعة في المركبة الثانوية %29.333، 43% في 50 مره وتزايد حتى 37.783% وازداد قلي حتى 50 مره.

- وكان الحمض الدهني السائد %39% ولم يتغير بعد مرات القلي (حتى 50 مره) - وجاء الحمض الدهني في المركبة الثانوية بقيم حوالي 4% ونسبة سلك الحمض الساق ولم يتغير مجموع الأحماض الدهنية المشبعة (حوالي 45%) بعد مرات الزيت مقارنة بالعينة الكنترول.

- ومن ناحية أخرى ظهرت نسبة الحمض الدهني غير مشبع بنسبة 41% أما مجموع الدهون الدهنية غير المشبعة فلم يتغير بعد مرات الزيت.

ثانياً: عينة الريحان:

- لم يتغير الحمض الدهني السائد (C16:0) بعد مرات القلي حتى 10 مرات ثم بدأ الانخفاض حتى النهاية (C17:0) وجاءت نسبة C16:0 في المركبة الثانوية بنسبة 4% ولم يتغير أيضاً وسليك كلي مجموع الأحماض الدهنية المشبعة نسبة سلك الحمض الساق ولم يتغير مجموع الأحماض الدهنية غير المشبعة حتى 30 مره قلي ثم تزايد بعد ذلك (50 مره) ونسبة (C16:0 n9) لتصبح 36% ونسبة (C16:0 n9) لتصبح 36% بعد 30 , 50 مره قلي بينما تناقصت نسبة مراة الزيت.

ثالثاً: عينة الروزماري:

- لم يتغير الحمض الدهني السائد (C16:0) بعد مرات القلي حتى 10 مرات ثم بدأ الانخفاض حتى النهاية (C17:0) وجاءت نسبة C16:0 في المركبة الثانوية بنسبة 4% ولم يتغير أيضاً وسليك كلي مجموع الأحماض الدهنية المشبعة نسبة سلك الحمض الساق ولم يتغير مجموع الأحماض الدهنية غير المشبعة حتى 30 مره قلي ثم تزايد بعد ذلك (50 مره) ونسبة (C16:0 n9) لتصبح 36% ونسبة (C16:0 n9) لتصبح 36% بعد 30 , 50 مره قلي بينما تناقصت نسبة مراة الزيت.

رابعاً: عينة الروزماري:

- لم يلاحظ تغيرات في تركيب الأحماض الدهنية المشبعة وغير المشبعة مظهرة بذلك عشب المريمية كمضاد أكسدة طبيعي جيد يمكن استخدامه في عملية القلي.