Physico-Chemical and Sensory Properties of Cakes Supplemented with Different Concentration of Marjoram

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Abstract: The aim of this work, evaluation of some physicochemical and sensory properties of cake supplemented with marjoram as partially substituted of flour at different levels (1, 2 and 3 %). The results showed that phenolic compound of marjoram extract in descending order were ellagic, salicylic, pyrogallol and catechol (157.98, 66.55, 43.24 and 23.86 respectively). While the values of marjoram powder of ellagic, p-oh Benzoic and coumarin in descending manner were 62.20, 55.24 and 33.45 (μg/100g), respectively. The peroxide value and thiobarbituric acid in cakes stored at room temperatures for 28 days of storage period under room temperature decreased with increasing marjoram levels. The crust of the control was lighter and more yellow than any of the other cakes. For crumb color, as the level of marjoram powder increased, the L, a, and b values decreased. No differences were found in crumb color, texture and over acceptability in sensory evaluation. While in taste and odor there were significant differences in control and other concentrations but still acceptable. Overall, marjoram cake could be developed as a food with more effective antioxidant properties.

Key words: Marjoram – Phenolic compounds – Cake – Sensory properties

INTRODUCTION

Plants, including herbs and spices, have many phytochemicals which are a potential source of natural antioxidant, e.g., phenolic diterpenes, flavonoids, alkaloids, tannins and phenolic acids (Amro et al., 2002). Natural antioxidants are known to protect cells from damage induced by oxidative stress, which is generally considered to be a cause of aging, degenerative diseases, and cancer (Ringman et al., 2005). These health promoting effects of antioxidants from plants and spices are thought to arise from their protective effects by counteracting reactive oxygen species (ROS). Spices, like turmeric, fenugreek, mustard, ginger, etc. may offer many health benefits and have been proven to counteract oxidative stress in vitro and in vivo (Modak et al., 2007). Most of these spices have been intensely studied only for their active components like phenolic acids and flavonoids (Manda et al., 2010).

Marjoram is one of the most familiar kitchen herbs. It is cultivated for use of its aromatic leaves for flavoring and other culinary purposes. Sweet marjoram leaves are dry leaves also excellent in salads. The medicinal effects of marjoram are gastrointestinal tract stimulant, tonic, carminative, diaphoretic, hypoglycemic, diuretic as well as antibacterial (Leeja and Thoppil, 2007) and as antioxidant (Handl et al., 2008).

Origanum majorana, a member of the Labiatae family is a widely used plant in folk Saudi Arabia medicine. Marjoram tea (Extract of its leaves and flowers) has been prescribed in folkloric medicine for relieving the symptoms of hay fever, sinus congestion, indigestion, asthma, stomach pain, headache, dizziness, colds, coughs, and nervous disorders. The plant extract contains mainly terpinene, aroma-active compounds, carvacrol and thymol, alkaloids, flavonoids, and essential oils (Novak et al., 2002; Richter and Schellenberg, 2007; Vági et al., 2005).

The anti-genotoxicity of Origanum majorana was reported in one study by El-Ashmawy et al., (2005) which illustrated that ability of O. majorana extracts to significantly reduced the rate of micronucleus, number of aberrant cells and different kinds of chromosomal aberrations which were induced by lead toxicity in mice. The antimutagenic potential of Origanum majorana has not been extensively studied and not well documented, moreover there is no report on the biological effects of Origanum majorana in plant test systems.

In particular, sweet marjoram herb contains up to 3% volatile oil, flavonoid glycosides, tannins, steroids (e.g., δ-sitosterol), and triterpenoids (oleanolic acid and ursolic acid) (Vagi et al., 2002). These different extracts of marjoram possess antioxidant, antimicrobial, and anti-inflammatory effects (Heo et al., 2002).

Bakery products are widely consumed and are becoming a major component of the international food market (Kotsianis et al., 2002). Cake is one of the most common bakery products consumed by people in the world. Nowadays, cake manufacturers face a major problem of lipid oxidation which limits the shelf life of their products (Lean and Mohamed, 1999). Bakery products such as cakes particularly those with high lipid content...
tend to become rancid after prolonged storage owing to the oxidation of polyunsaturated fatty acids (Ray and Husain, 2002; Smith et al., 2004). Foods containing higher content of polyunsaturated fatty acids are more prone to oxidation (van Aardt et al., 2004).

One of the most important changes that occur to food is lipid oxidation. Lipid oxidation lowers the quality and nutritional value of food (Suja et al., 2005). The susceptibility of lipid to oxidation is one of the major cause oxidative stresses, resulting in the development of rancidity, unpleasant tastes and odors as well as changes in color (Pezzuto and Park, 2002).

Addition of antioxidant is effective in delaying the oxidation and extending the shelf life of food (Decker, 1998; Jadhav et al., 1996). In the food industry, the oxidative deterioration of fats and oils is prevented by synthetic antioxidants such as butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT). Although efficient in preventing oxidation, only a few synthetic compounds are currently approved for use in the food industry because of their potential toxicity and carcinogenic (Botterweck et al., 2000). To satisfy consumers’ preference for natural food additives over synthetic ones, there is increasing importance searching for natural antioxidants from herbs, fruits, vegetables and spices as a less harmful alternatives to synthetic antioxidants (Daker et al., 2008). Recently, special attention has given to the use of natural antioxidant because of the worldwide tend to avoid or minimise synthetic food additives (Krings and Berger, 2001). Plant extracts obtained from some fruits and vegetables have been reported to be effective antioxidants (Vinson et al., 1998; Wang et al., 1996). The aim of this study was to evaluate the effect of different concentrations of Origanum majorana on physico-chemical and sensory properties of cakes.

MATERIALS AND METHODS

1. Materials:
1.1 Source of Samples:
Marjoram (Origanum Majorana) powder was purchased from local market in Egypt.

1.2 Extract Preparation:
Marjoram powder was add to distilled water (1:10 w/v) and mixed for 10 min at 100 °C. The water extracts was filtered.

2. Methods:
2.1 Proximate Composition:
Marjoram powder was analyzed for moisture, ash, protein, fat and crude fiber contents according to AOAC (2002). While total carbohydrates were calculated by difference as following:
Carbohydrates % = 100 - (moisture % + protein % +fat % +ash) according to the methods of the (AOAC, 1995).

2.2 Determination of Phenolic Compounds:
Phenolic compounds of marjoram were determined by HPLC according to the method of Goupy et al. (1999) as follow: 5 g of sample were mixed with methanol and centrifuged at 10000 rpm for 10 min and the supernatant was filtered through a 0.2 μm Millipore membrane filter then 1-3 ml was collected in a vial for injection into HPLC Hewllet Packared (series 1050) equipped with autosampling injector, solvent degasser. Ultraviolet (UV) detector set at 280 nm and quaternary HP pump (series 1100). The column temperature was maintained at 35º C. Gradient separation was carried out with methanol and acetonitrile as a mpbile phase at flow rate of 1 ml/min. phenolic acid standard from sigma CO. were dissolved in a mobile phase and injected into HPLC. Retention time and peak area were used to calculation of phenolic compounds concentration by the date analysis of HEWLLET packared software.

2.3 Cakes Preparation:
200 g of flour, 120 g of sugar, 100ml of skimmed milk, 80 g of fresh whole eggs, 100 g of butter, 8 g of baking powder and 2 g of vanalila were used. All ingredients were mixed during 10 min at speed using a Kitchen-Aid Professional mixer. All ingredients of cake were placed into metallic and lard coated pans (120 mm diameter and 45 mm height), and were baked in an electric oven for 30 min at 200 °C. Wheat flour was substituted by marjoram powder at the 0% (control), 1%, 2% and 3%. After baking, 16 cakes were removed from the pans and left 1 h for cooling. Then, they were placed on coded white plastic plates, and sealed with plastic wraps to prevent drying. Cakes from the groups were used for physical measurements after baking (appearance, texture and color characteristics), and four for texture evaluation after 28 days of storage.

2.4 Chemical Composition of Dried Cakes:
The dried cakes were analyzed for moisture according to AOAC (2000), ash according to AOAC (1995), protein determined by Kjeldatherm; Gerhardt, laboratory instrument and total lipid contents determined by
2.5 Cake Volume Determination:
Cake mass was weighted after 3 hours at room temperature. The volume (cm³) was measured by rapeseed replacement method described in the (AACC, 1983). The specific volume was obtained by dividing the volume of cakes by their weights.

2.6 Color Measurements:
Crumb and crust color of fresh cake was measured with a Hunter lab DP 9000 D 52L optical sensor using L*, a* and b* color scale. The instrument was standardized each time with a white and black ceramic plate. The samples were scanned at five different locations and the mean values of L, a, B were recorded. The total color change (ΔE) of each cake was calculated as described by Mai Tran et al., (2007) as follows:

\[ ΔE = \left[ (L_0 - L)^2 + (a_0 - a)^2 + (b_0 - b)^2 \right]^{1/2} \]  (1)

Where \[ L_0, a_0 \] and \[ b_0 \] are the lightness, redness and yellowness color score respectively at time zero. The L, a, and b represented the instantaneous individual reading.

2.7 Sensory Evaluation:
Evaluation of the baked cake quality characteristics was carried out following cooling to room temperature for 2 h. Sensory evaluation was performed by ten trained panelists who were graduate students and staff members of the Department of Home Economics, Faculty of Education, Ain Shams University. Cakes were randomly assigned to each panelist. The panelists were asked to evaluate each cake for appearance, crumb texture, crumb grain, crust color, taste, odor and overall acceptability. A 10 point scale was used where 10”excellent and 1”extremely unsatisfactory (A.A.C.C. 1996).

2.8 Statistical Analysis:
Analysis of variance (ANOVA) was carried out using SPSS program (version. 16). The cakes characteristics of wheat flour with or without marjoram were analyzed using ANOVA. When the treatment factor effect was found significant, indicated by a significant F-test (p< 0.05), differences between the respective means were determined using least significant difference (LSD) and considered significant when p < 0.05. Mean ± standard deviation of three replicates were used.

RESULTS AND DISCUSSION

1. Proximate Chemical Composition:
Marjoram contained 5.66 % moisture, 5.62% ash, 12.80% crude protein, 3.75% fat, 19.52 crude fibres and 72.18 carbohydrates (by difference).

These results were agreement with (Abd El-Ghany and Nanees 2010) who reported that the chemical composition of marjoram leaves showed nutrient value of ash, protein, carbohydrate and fiber in dry weight (DW) as the values were 16.21±0.13 , 12.34±0.47, 66.73±0.55 and 19.69±0.02 (g/100g), respectively. Chemical composition of Origanum majorana (Marjoram) depends on the origin of the plants according to USDA (2009).

Table 1: Chemical composition of marjoram powder (g/100g).

<table>
<thead>
<tr>
<th>Sample</th>
<th>Moisture</th>
<th>Ash</th>
<th>Protein</th>
<th>Fat</th>
<th>Crude Fibers</th>
<th>Carbohydrates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marjoram</td>
<td>5.66</td>
<td>5.62</td>
<td>12.798</td>
<td>3.75</td>
<td>19.52</td>
<td>72.18</td>
</tr>
</tbody>
</table>

2. Separation and Identification of Some Phenolic Compounds:
Phenolic compound of marjoram alcoholic extract in descending manner were ellagic, salicylic, pyrogallol and catechol (157.98, 66.55, 43.24 and 23.86 respectively). While the values of marjoram water extracted of ellagic, p-oh Benzoic and coumarin in descending manner were 62.20, 55.24 and 33.45 (μg/100g), respectively as shown in Table (2) and Fig (1).

Petr et al.,(2008) found that marjoram (Origanum majorana L.) contains phenolic terpenoids (thymol, carvacrol), flavonoids (diosmetin, luteolin, apigenin), tannins, hydroquinone, phenolic glycosides (arbutin, methyl arbutin, vitexin, orientin- thymonin), triacontan, sitosterol, acids (oleanolic acid) and cis-sabinene hydrate.
Table 2: Phenolic compound (mg/100mg) of alcoholic and water extract of marjoram.

<table>
<thead>
<tr>
<th>No</th>
<th>Phenolic Compound</th>
<th>Alcoholic extract</th>
<th>Water extract</th>
<th>No</th>
<th>Phenolic Compound</th>
<th>extract</th>
<th>Marjoram</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Salicylic</td>
<td>66.55</td>
<td>-</td>
<td>10</td>
<td>Catechol</td>
<td>23.86</td>
<td>10.90</td>
</tr>
<tr>
<td>2</td>
<td>P-OH Benzoic</td>
<td>-</td>
<td>55.24</td>
<td>11</td>
<td>P-coumaric</td>
<td>3.82</td>
<td>1.55</td>
</tr>
<tr>
<td>3</td>
<td>Caffeine</td>
<td>2.49</td>
<td>1.53</td>
<td>12</td>
<td>Gallic</td>
<td>0.000</td>
<td>1.06</td>
</tr>
<tr>
<td>4</td>
<td>Chlorogenic</td>
<td>11.27</td>
<td>5.59</td>
<td>13</td>
<td>Pyrogallol</td>
<td>43.24</td>
<td>19.70</td>
</tr>
<tr>
<td>5</td>
<td>Vanillic</td>
<td>16.94</td>
<td>5.42</td>
<td>14</td>
<td>Chlorogenic</td>
<td>3.18</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>Coumarin</td>
<td>19.83</td>
<td>33.45</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Ferulic</td>
<td>21.79</td>
<td>5.06</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Ellagic</td>
<td>157.98</td>
<td>62.20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Protocatechou</td>
<td>9.25</td>
<td>4.72</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 1: HPLC chromatogram of alcoholic (A) and water extract (B) of marjoram, the phenolic acids separated and identification as in table (1).

3. Proximate Chemical Composition of Cake Samples:

Different proximate compositions were found among butter cakes (Table 3). Total lipid, moisture and protein contents were found in the descending order of 1% > 2% > 3% > control whereas ash and carbohydrate contents showed ascending order of 1% < 2% < 3% < control. This may be referred to that 0–3% of cake flour in the butter cake formula was substituted with marjoram powder, the proximate composition, especially protein and ash contents was accordingly affected.

Different proximate compositions were found among cakes. Protein, total dietary fibre and ash contents were found in the descending order of (10%, 20%, and 30% replacement of cake flour with green tea powder) control whereas moisture, fat and carbohydrate contents showed no significant variation. The protein, fat, carbohydrate, total dietary fibre, and ash contents of green tea powder were 22.84, 1.13, 67.01, 32.54, and 4.62 g/100 g, respectively whereas those of cake flour were 7.87, 1.16, 79.04, 2.65, and 0.43 g/100 g, respectively. Because 0–30% of cake flour in the sponge cake formula was substituted with green tea powder (Lu et al., 2010).
The data were presented as mean ± S.D.

Table 5: Sensory evaluation of butter cakes prepared with marjoram powder replacement for cake flour.

<table>
<thead>
<tr>
<th>parameters</th>
<th>control</th>
<th>1%</th>
<th>2%</th>
<th>3%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crump color</td>
<td>8.50 ± 1.19</td>
<td>7.00 ± 2.00</td>
<td>8.51 ± 1.95</td>
<td>5.8 ± 2.29</td>
</tr>
<tr>
<td>Crump texture</td>
<td>8.75 ± 0.70</td>
<td>7.12 ± 1.24</td>
<td>7.12 ± 0.99</td>
<td>6.87 ± 0.83</td>
</tr>
<tr>
<td>Taste</td>
<td>8.1 ± 1.24</td>
<td>6.62 ± 1.40</td>
<td>6.87 ± 0.99</td>
<td>5.87 ± 2.73</td>
</tr>
<tr>
<td>Odor</td>
<td>8.37 ± 1.30</td>
<td>6.62 ± 1.59</td>
<td>7.00 ± 1.06</td>
<td>7.00 ± 1.6</td>
</tr>
<tr>
<td>Over Acceptability</td>
<td>8.56 ± 0.85</td>
<td>6.87 ± 1.35</td>
<td>6.68 ± 1.09</td>
<td>5.75 ± 1.58</td>
</tr>
</tbody>
</table>

The data were presented as mean ± S.D.

4. Physical Characteristics of Cake Samples:

Changes in cake characteristics with added marjoram powder are shown in Table 4. The weight and cake volume of cakes were significantly different. A significant increase in cake volume was noted with an increase in the marjoram powder level. The control sample had an average cake volume of 666 ml, increasing to 700, 680, and 677 ml for 1, 2, and 3% marjoram, respectively. These results were not agreement with Masood et al. (2002) who reported that a cake volume decreased with increasing apple pomace levels. Some investigations (Ngo and Taranto, 1986; Paton et al., 1981) found a good cake batter must retain sufficient viscosity to prevent the incorporated air bubbles from rising to the surface and being lost during initial heating. The cake setting must be timed so the air bubbles can be properly expanded by the carbon dioxide gas and water vapor before the cake sets. Thus, the resulting cake structure is highly aerated and has a more defined structure. In the study, the cake batter volume of 1, 2, and 3% marjoram were higher than that of the control but their specific volumes showed a reverse trend. Thus, the results of the cake specific volume in the study may be due to increased replacement of flour with cellulose, which has been reported to weaken the gluten matrix responsible for retaining gases in baked foods (Baldi et al., 1965; Donelson and Wilson, 1960).

Table 4: Physical characteristics of butter cakes prepared with marjoram powder replacement for cake flour.

<table>
<thead>
<tr>
<th>Marjoram Levels (%)</th>
<th>Moisture %</th>
<th>Total Lipid %</th>
<th>Total Protein %</th>
<th>Total Ash %</th>
<th>Total Carbohydrates %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>15.84</td>
<td>25.76</td>
<td>7.77</td>
<td>1.65</td>
<td>50.4</td>
</tr>
<tr>
<td>1</td>
<td>12.48</td>
<td>23.15</td>
<td>7.03</td>
<td>1.82</td>
<td>56.82</td>
</tr>
<tr>
<td>2</td>
<td>11.70</td>
<td>21.21</td>
<td>6.51</td>
<td>1.86</td>
<td>57.42</td>
</tr>
<tr>
<td>3</td>
<td>7.93</td>
<td>16.83</td>
<td>6.25</td>
<td>2.31</td>
<td>66.61</td>
</tr>
</tbody>
</table>

All color data were expressed by Hunter L, a, and b values corresponding to lightness, redness, and yellowness, respectively. The crust color of samples was affected by the replacement of cake flour with marjoram powder (Table 4). In general, as marjoram powder level increased, the crust color become darker as measured by the colorimeter. The crust of the control was lighter and more yellow than any of the other cakes. For crumb color, as the level of marjoram powder increased, the L, a and b values decreased, indicating that a darker, less redder, and less yellow crumb was obtained as a result of marjoram powder substitution. It was observed that baked cakes elaborated with marjoram powder were darker than the control. The color change of baked cakes might be related to the fact that marjoram pigments and polyphenols compounds underwent oxidation reaction, and sucrose also participated in caramelization during baking.

5. Sensory Evaluation of Cake Samples:

The present data given in Table (5) showed there were no significant differences among the samples with and without marjoram powder substitution for the liking scores of crump color & texture and over acceptability. While in taste and odor there were significant differences in control and other concentrations. These results were agreement with (Karaoglu and Kotancilar, 2011) who reported that there was no significant difference among the samples with and without cake preparation using tapioca starch substitution for the liking scores of appearance, color and odor exhibited. However, the mean scores of cakes evaluated in terms of softness and overall liking were higher with higher tapioca starch content in the cake and significantly different.

Table 5: Sensory evaluation of butter cakes prepared with marjoram powder replacement for cake flour.

The data were presented as mean ± S.D.
6. Moisture Content of Cake Samples During Storage:

Moisture content of cake substituted flour with different levels of marjoram storage at room temperature for 28 days are listed in Table (6). Moisture content of cake ranged between 36.14 to 28.48 % at zero time. During storage, the moisture content of all cake samples gradually decreased, it reached a values ranging 8.78 for control sample to 20.66 in cake substituted flour with 3 % marjoram after 28 days. The highest losses in moisture content of cake samples were observed for control cake sample and cake substituted flour with 1 % marjoram.

Table 6: Moisture content of cake substituted flour with marjoram storage at room temperature for 28 days.

<table>
<thead>
<tr>
<th>Storage periods (days)</th>
<th>Control (zero %)</th>
<th>Marjoram (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32.29</td>
<td>33.29</td>
</tr>
<tr>
<td>2</td>
<td>28.48</td>
<td>36.14</td>
</tr>
<tr>
<td>3</td>
<td>27.98</td>
<td>28.48</td>
</tr>
</tbody>
</table>

7. Acid Value (AV), Peroxide Value (PV), and Thiobarbituric Acid (TBA) of Cake Samples During Storage:

The primary products of lipid peroxidation are hydroperoxidations. Therefore, determining the concentration of peroxidase is one clear index of lipid peroxidation. Changes occurring in the AV, PV and TBA values of cake supplemented with marjoram during storage are given in Table (7).

Acid Value:

Value of the control and others concentrations samples at zero time were 2.56%, 2.02%, 1.74% and 1.69 ml equiv O2/Kg., after three weeks of storage they changed to 1.70%, 1.57%, 0.83%and 0.78 ml equiv. O2/kg respectively.

Wagdy and Taha (2012) reported that acid value (AV), IV, and PV of the control butter cake was fortified with jojoba hull at zero time were 0.71%, 37.60 g/100g, and 2.7 ml equiv O2/Kg., after three weeks of storage changed to 3.88%, 19.63 g/100g, and 15.37ml. equiv. O2/kg, respectively. The increase in AV when compared to control at zero time is explained by the hydrolysis of the oil to free fatty acids which will lead to further formation of aldehydes and ketones (Kun, 1988).

Peroxide Value (PV):

The effect of marjoram powder on the peroxide value (PV) in cakes stored at room temperatures for 28 days of storage period under room temperature was illustrated in Table (7). PV range of 10-20 mEq/kg indicate that food product is considered rancid but still acceptable, while more than 20 mEq/kg, the food product will considered already rancid and unacceptable to consume (Pearson, 1970). In present study, all samples were considered not rancid and still acceptable. Control exhibited the highest PV throughout the storage period, showing a high oxidation process. Among all samples, the cakes treated with marjoram showed the lowest PV throughout storage period than control sample. These results suggested that marjoram were effective in suppressing the oxidation of cakes. The anti-oxidative effect may have contributed to the oxidative stability of cakes with addition of natural antioxidants. When added into the cakes, antioxidants prevent the lipid peroxides formed during storage and delayed oxidation. This could be due to the slow permeation rate of antioxidant components into lipid layer of the cakes.

Table 7: Effects of marjoram powder on the acid value (AV), peroxide value (PV) and Thiobarbituric acid (TBA) in cakes stored at room temperatures for 28 days.

<table>
<thead>
<tr>
<th>Storage time (days)</th>
<th>Analysis Value</th>
<th>Control</th>
<th>Marjoram Levels (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AV</td>
<td>2.56</td>
<td>2.02</td>
</tr>
<tr>
<td></td>
<td>PV</td>
<td>13.73</td>
<td>12.47</td>
</tr>
<tr>
<td></td>
<td>TBA</td>
<td>0.527</td>
<td>0.517</td>
</tr>
<tr>
<td>7</td>
<td>AV</td>
<td>2.53</td>
<td>1.76</td>
</tr>
<tr>
<td></td>
<td>PV</td>
<td>15.79</td>
<td>6.39</td>
</tr>
<tr>
<td></td>
<td>TBA</td>
<td>0.693</td>
<td>0.446</td>
</tr>
<tr>
<td>14</td>
<td>AV</td>
<td>1.75</td>
<td>1.69</td>
</tr>
<tr>
<td></td>
<td>PV</td>
<td>16.41</td>
<td>16.24</td>
</tr>
<tr>
<td></td>
<td>TBA</td>
<td>0.769</td>
<td>0.536</td>
</tr>
<tr>
<td>21</td>
<td>AV</td>
<td>1.70</td>
<td>1.57</td>
</tr>
<tr>
<td></td>
<td>PV</td>
<td>16.27</td>
<td>9.89</td>
</tr>
<tr>
<td></td>
<td>TBA</td>
<td>0.969</td>
<td>0.799</td>
</tr>
</tbody>
</table>

Thiobarbituric Acid Value (TBA):

Table (7) showed that TBA value for control sample is higher than other sample that has been tested. Marjoram powder reduced TBA values compared to the control sample throughout the storage. TBA value less than 0.576 mg /
kg-1 sample are considered not rancid, whereas values of 0.65 – 1.44 mg / kg-1 sample are regarded as rancid but still acceptable and values greater than 1.5 mg / kg-1 sample are said to be rancid and unacceptable (Ke et al., 1984). At the end of storage (14, 21 days), control sample was rancid but still acceptable. The TBA value for control sample showed the highest value compared to other sample studied. All treated samples resulted in lower TBA values when compared to the control, which indicates that the natural antioxidants incorporated into cakes exhibited antioxidant properties and preventing lipid oxidation in cakes.

**Conclusion:**

This study concluded that a different level of marjoram provides antioxidant benefits to cakes during room temperature storage. Between these three levels, 3 % marjoram demonstrated the most potent effect in terms of antioxidative activity which comparable to that of control. Therefore, it is suggested that marjoram could be used to extend the shelf life of cakes for effectiveness as natural antioxidant agent.

**REFERENCES**


