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EFFECT OF MORINGA LEAVES (*MORINGA OLEIFERA* LAM.) EXTRACT ADDITION ON MAYONNAISE QUALITY

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Abstract

The effect of addition moringa leaves extract (MLX) on physical, chemical and sensory properties of mayonnaise was investigated. Mayonnaise samples were supplemented with 0.5, 1 and 1.5% of MLX. Results showed that supplementation of mayonnaise with MLX increased its content of protein, fiber and antioxidants. Protein content ranged from 4.10% in control to 4.59% in mayonnaise sample with 1.5% MLX. The total phenolic content of MLX was ranged from 65 to 67 mg/100g (as Gallic acid equivalent) while, the scavenging effects of 100µl of MLX were ranged from 79.51 to 88.57%. The TBA values increased for all the investigated samples gradually during storage period. The highest value for TBA was noticed in M1 (0.4060) after five weeks of cold storage while, the lowest value was observed with M2 (0.2039) at zero storage. The total polyphenols content and antioxidant activity increased in mayonnaise after added with moringa leaves extract. all the mayonnaise samples containing moringa leaves extract were generally acceptable for all tested parameters as non-scored below the minimum acceptable rating of 3 However, these mayonnaise meats were signficanty differ from content.

Key words: Moringa Leaves Extract,Mayonnaise,Antioxidant, Sensory evaluation.

Introduction

(*Moringa oleifera Lam*) Moringa is a kind of local medicinal Indian herb which has turn out to be familiar in the tropical and subtropical countries. The other expressions used for Moringa are Horseradish tree, Mulangay, Mlonge, Benzolive, Drumstick tree, Sajna, Kelor, Saijihan and Marango. *Moringa oleifera* is shown in scientific division to become from Kingdom: *Plantae*, Division: *Magnoliphyta*, Class: *Magnoliopsida*, Order: *Brassicales*, Family: *Moringaceae*, Genus: *Moringa*, Species: *M. oleifera* (Fahey, 2005).

Moringa commonly called drumstick, horse radish or miracle tree is indigenous to the Himalayas southern foothills and probably Africa and Middle East. Today, it is the most widely cultivated types in the genus and in many other places including central and southern America, Mexico and Malaya (Adedokun *et al.,* 2010).

Each part of *M. oleifera* is a storehouse of important nutrients and antinutrients. *M. oleifera* leaves are rich in minerals like calcium, potassium, zinc, magnesium, iron and copper (Kasolo *et al*., 2010). Vitamins such as vitamin A beta-carotene, vitamin B such as folic acid, pyridoxine and nicotinic acid, vitamin C, D and E also found in M. oleifera (Mbikay, 2012). Phytochemicals like tannins, sterols, terpenoids, flavonoids, saponins, anthraquinones, alkaloids and reducing sugar present along with anticancerous agents such as glucosinolates, isothiocyanates, glycoside compounds and glycerol-1-9-octadecanoate (Berkovich *et al*., 2013).

Mukunzi *et al.,* (2011) stated that the leaves, seeds and flowers of Moringa all have great nutritional and curative values. The seeds are eaten like peas or roasted like nuts whilst the flowers are eaten when cooked and taste such as mushrooms. Research found that ounce for ounce of moringa leaves contains seven times the vitamin C found in oranges, four times the vitamin A in carrots, four times the calcium found in milk, three times the potassium found in banana and two times the protein found in yoghurt.

Moringa is rich in phytosterols such as stigmasterol, sitosterol and kampesterol which are precursors for hormones. These compounds increase the estrogen production, which in turn stimulates the proliferation of the mammary gland ducts to produce milk. It is used to treat malnutrition in children younger than 3 years (Mutiara *et al*., 2013).

Moringa is considered one of the most beneficial trees, in the world, as almost each part of the moringa tree can be used for food, medication and industrial purposes (Khalafalla *et al*., 2010).

Moringa leaves have been reported to be a rich source of β-carotene, protein, vitamin C, calcium and potassium and act as a good source of natural antioxidants and thus enhance the shelf-life of fat containing foods due to the presence of diffrent types of antioxidant compounds like ascorbic acid, flavonoids, phenolics and carotinoids (Dillard and German, 2000).

Moringa oleifera consists of anti-inflammatory, anti-spasmodic, anti-hypertensive, anti-tumor, anti-oxidant, anti-pyretic, anti-ulcer, anti-epileptic, diuretic, reduction of cholesterol, kidney, anti-diabetic, (Sharma *et al.,* 2012) and hepato protective activities (Huang *et al.,* 2012).

These nutrients are used to modify osmotics, activate enzymes, hormones and other organic molecules that increase life process development, function and maintenance (Anjorin *et al.,* 2010).

Mayonnaise

Before the beginning of the 19th century, the term mayonnaise was not used for a dressing. Mayonnaise is one of the most commonly eaten food products in Europe. It was originally France in existence. It was first manufactured commercially in the early 1900s, becoming popular in America from 1917 to 1927 and lately in Japan, where from 1987 to 1990 sales rose by 21 percent. Mayonnaise is relatively resistant to microbial spoilage due to its low pH and elevated fat content. (Depree and savage, 2001).

Mayonnaise is an oil-in-water emulsion including 70-80% fat. Oil in water emulsions consist of finely dispersed droplets of oil in a continuous phase of water or a dilute aqueous solution. Droplet size range is from less than 1μm to 20μm or more. This emulsion is formed by mixing the eggs, vinegar and spices and then slowly feeding the oil, resulting in a closed-packed foam of oil droplets or coarse emulsion. Dissimilarly, if the aqueous and oil stages are mixed at once the result is a water-in-oil emulsion, which viscosity is similar to the oil from which it was made (Depree and Savage, 2001).

The major role in mayonnaise production is composition ratio of oil phase and the addition of different emulsifier, stabilizer and thickener. Texture depends on oil, the more oil is used then the better texture is produced. Oil has important function in characteristic of rheology. Fat as one of the main ingredients, has positive effect on the rheological properties and sensory characteristic of final product. High fat intake as associated with increased risk of obesity, some types of cancer, cardiovascular diseases and hypertension. The production of low fat mayonnaise is normally associated with some technical problems such as poor texture, flavour, appearance stability and mouth feel (Amin *et al*., 2014).

Much attention has been concentrate on extracts from herbs and spices which have been utilized traditionally to improve the sensory characteristics and extend the shelf-life of foods (Botsoglou *et al*., 2003).

Thus, the aim of this paper is to study the chemical composition of moringa leaves and examine the effect of adding moringa leaves extract to Mayonnaise during Refrigerate Storage on its physical, Chemical and sensorial properties.

Materials and Methods

Materials

Moringa leaves powder (*Moringa oleifera lam*) was obtained from Agricultural Research Center, Giza, Egypt during the autumn season 2016.

Mayonnaise ingredients: Sun ûower oil, fresh egg yolks, freshly squeezed lemon juice, Vinegar (acetic acid) and salt (sodium chloride) were purchased from local super market Zagazig District, Sharkia Governorate, Egypt.

Methods

1. Preparation of extracts from moringa leaves: Moringa powder was extracted according to the method of Vongsak *et al*., (2013). About 50g of moringa leaves powder was mixed with 1 L of 70% Ethanol (1:20 W/V) for 72h. at room temperature (28±2°C) with occasional shaking. The mixture was centrifuged at 3000 X g for 10 min at 20°C then, it was filtered through whatman no. 1 filter paper. The ethanolic mixture was concentrated under vacuum at 45°C using a rotary evaporator (Buchi Waterbath B-480 with Buchi Rotavapor R-124, Germany) to obtain the crude extract. The extract was freeze dried by (Vacuum freeze dryer model:FDF 0350, Korea). The extract was stored in an air-tight container at -18°C until use.
2. Preparation of mayonnaise: A reference recipe was used throughout the study based on the following formulation: oil (500g), 2 eggs (120g), vinegar (30 g), salt (1g). Mayonnaise samples were prepared using a lab-scale mixer (Bimby TM31, Vorwerk, Wuppertal, Germany) in a two-steps stan- dardized process: eggs, vinegar and salt were preliminary mixed (100 rpm, 3 min) and then oil was slowly added under vigorous

mixing rate (from 3200 rpm up to 6000 rpm in 5 min).

The prepared mayonnaise samples were divided into five samples and the moringa extract was added. Sample (1) was prepared as a control without adding any extract. Sample (2) was prepared by adding 0.01% BHT. The sample (3) was prepared by adding 0.5% moringa extract. A sample (4) was prepared with the addition of 1% moringa extract. A sample (5) was prepared with the addition of 1.5% of the leaves of the Moringa plant. Each sample was well mixed to be homogenous and packaged in sealed glass jars. Samples were stored in the refrigerator (1-4°C) until the analysis was performed.

Chemical composition

Moisture, ash, crude protein, crude lipids, crude fiber and ash of moringa leaves and mayonnaise samples were determined according to the methods recommended by A.O.A.C. (2005), while total carbohydrate content was calculated by difference. All analyses were conducted in central lab for soil, food and feed staff (CLSFF), Faculty of technology and development, Zagazig University.

Determination of total phenolic content (TPC)

The concentration of total phenols was measured by spectrophotometer (Jenway-UV-VIS Spectrophotometer) based on a colorimetric oxidation/reduction reaction, as described by Skerget *et al*., (2005) using Folin-Ciocalteu as oxidizing reagent (A.O.A.C., 2005). To 0.5 ml of diluted extract (10 mg in 10 ml solvent), 205 ml of Folin-Ciocalteu reagent (diluted 10 times with distilled water) and 2 ml of Na_2CO_3 (75 g/l) were added. The sample was incubated for 5 min at 50°C then cooled. For the control sample, 0.5 ml of distilled water was used. The absorbance was measured at 760 nm. Quantification of TPC was based on a Gallic acid standard curve generated by preparing 0, 5, 10, 15, 20, 30 ml/l. of Gallic acid equivalent (GAE) and calculated using the following linear equation based on the calibration curve:

$y = 0.015x + 0.0533$

$R^2 = 0.9966$

Where (y) is the absorbance

(x) is the concentration (mg GAE g^{-1} extract).

R2 = Correlation Coefficient.

Determination of antioxidants activity

Antioxidants activity was determined by DPPH (2.2-diphenyl-1picryl hydrazyle) method, scavenging effect (DPPH method) was adopted to assess antioxidative potential of the moringa extract as follows: The electron donating ability of the obtained extract was measured by bleaching of the purple coloured solution of DPPH according to the method of Hanato *et al*. (1988). One hundred µl of each extracts (10 mg extract/ 10 ml solvent) was added to 3 ml of 0.1 mM DPPH dissolved in ethyl acetate and ethanol according to the solvent used for extraction. After 30, 60, 90 and 120 min incubation period at room temperature, the absorbance was estimated against a control at 517 nm (Gulcin, 2012). Percentage of antioxidant activity of free radical DPPH was calculated as follows:

$$\text{Antioxidant activity (inhibition \%)} = \frac{A\ control - A\ sample}{A\ control} \times 100$$

Where: A control is the absorbance of the control reaction. A sample is the absorbance in the presence of plant extract. TBHQ was used as positive control.

Determination of thiobarbituric acid number (TBA)

Thiobarbituric acid value was measured according to the method described by Fernandez *et al*., (2005). About ten grams of sample was blended with 100 ml distilled water for 2 min. The pH of the sample was adjusted to 1.5 by adding few drops of 4N HCl and then transferred to a distillation tube. The mixture was distilled and 50 ml distillate was collected. Five ml of 0.02 M2-thiobarbituric acid in 90% acetic acid (TBA reagent) were added to a vial containing 5 ml of the distillate and mixed well. The vials were capped and heated in a boiling water bath for 30 min to develop the chromogen and cooled to room temperature. The absorbance was measured at 538 nm, against a blank, using JENWAY 6705 UV/VIS spectrophotometer. The TBA numbers were calculated as mg malondialdehyde/ kg sample according to the following equation:

TBA value (/kg) = absorbance at 538 nm × 7.8

Colour determination

Colour properties of low calorie mayonnaise were performed using Hunter Lab colour analyzer (Hunter Lab Colour Flex EZ, USA) according to Singh *et al.,* (2008). The L value (lightness index scale) ranges from 0 (black) to 100 (white), while a value indicates the redness (+a) or greenness (–a) and the b value refers to the yellowness (+b) or blue (–b).

Sensory evaluation

Sensory evaluation of mayonnaise: Sensory evaluation was conducted on the mayonnaise samples after one-day of the storage at room temperature. Initially, panelists were trained in 2 h. sessions prior to evaluation to be familiar with attributes and scaling procedures of mayonnaise samples under study. Sensory characteristics: appearance, colour, odour, texture, taste and overall acceptability were evaluated by 30 trained panelists on 9-point hedonic scale, 1 the least, the lowest, 9 the most,

Table 1: Chemical composition of mayonnaise and moringa leaves

Sample	Chemical composition of mayonnaise (%)					
	Moisture	**Crude Protein**	**Crude Fat**	**ASH**	**Crude Fiber**	**Carbohydrat**
M 1	44.047^{C}±6.083	4.100^{c} ±9.504	38.510^{d}±0.010	0.231^{d}±1.000	1.331^{b}±1.000	11.792^{b}±2.646
M 2	46.213^{a}±0.0153	4.910^{a} ±1.000	33.131^{e}±5.508	0.317^{c}±1.528	1.211^{c}±1.732	14.240^{a}±2.646
M 3	44.531^{b} ±1.000	3.410^{e}±0.010	42.271^{c}±1.001	0.171^{e}±1.000	1.451^{a}±1.000	8.180^{c}±1.000
M 4	42.360^{d} ±5.508	3.930^{d}±0.036	50.131^{b}±1.000	0.381^{a}±1.001	1.120^{d}±5.292	2.110^{d}±1.000
M 5	41.910^{e} ±0.0100	4.596^{b}±0.015	51.331^{a}±1.000	0.319^{b}±5.292	1.010^{e}±0.0100	0.851^{e}±1.528
Moringa leaves	5.90^{e}±0.01	22.16^{a}±0.01	10.70^{a}±0.06	11.77^{a}±0.01	9.91^{a}±0.01	39.56^{a}±0.03

*The results are presented as the mean value ± SE. Values expressed with different treatments are significantly different at P<0.05.
M 1: control (Mayonnaise free of moringa leaves extract) - M 2: Mayonnaise containing 0.01% BHT - M 3: Mayonnaise containing 0.5% moringa leaves extract - M 4: Mayonnaise containing 1% moringa leaves extract - M 5: Mayonnaise containing 1.5% moringa leaves extract.

the highest. All mayonnaise samples were coded with three-digit random numbers and presented to panelists on a tray in individual booths. Orders of serving were completely randomized. Water was provided between samples to cleanse the palate (Worrasinchai *et al*., 2006 and Yazici and Akgun, 2004).

Statistical analysis

The results were reported as mean ± standard deviation (SD) (n = 3) and were statistically investigated using one-way analysis of variance (ANOVA) with Duncan by SPSS for Windows 16.0. A statistical probability (p value) less than 0.05 indicated a statistically significant difference between groups (Steel and Torrie, 1980).

Results and Discussion

Chemical composition of mayonnaise samples and moringa leaves

The chemical composition of mayonnaise samples is presented in table 1. The moisture content of mayonnaise samples ranged between 41.910 and 44.047%. From the results it was noticed that, moisture content was decreased with the addition of moringa leaves extract. Protein content also was increased in mayonnaise samples fortified with MLX, it was ranged between 4.100% in control sample to 4.596% in M5 (mayonnaise with 1.5% MLX). Table 1, showed also that there is a gradual increase in ash and crude fiber content with the addition of MLX. These results are consistent with the findings of (Gaikwad *et al.,* 2017).

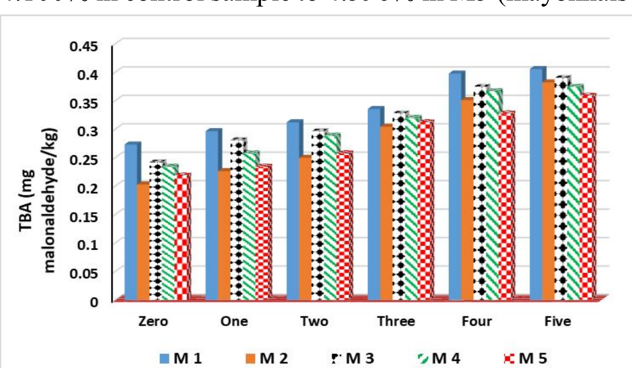

Fig. 1: Changes in TBA (mg malonaldehyde/kg) of mayonnaise during cold storage.

The chemical composition of moringa leaves is tabulated in table 1. From the results it could be noticed that the moisture, protein, fat, ash and fiber content was 5.99, 22.16, 10.70, 11.77 and 9.91%, respectively. These results are consistent with the findings of Satwase *et al.,* (2013), Mansour (2017) and Offor *et al.,* (2014).

Total phenolic compounds in moringa leaves (TPC)

Phenolic compounds and flavonoids are very important constituents due to antioxidant activity. Moringa leaves regarded as a promising rich source of phenolic compounds. The Polyphenols content of moringa leaves extract was determined. The total phenolic content was ranged from 65 to 67 mg/100g (as Gallic acid equivalent). This result is in agreement with those reported by Mansour (2017) who found total polyphenol content (65.5 mg/100g) was recorded for the oven dried samples at 70°C and Singh and Prasad (2013), found that the total polyphenol content of moringa leaves ranged from 23.57 to 155.15 mg/100g depending on the drying temperature, particle size and blanching process. El-Masry *et al.,* (2013) reported that total polyphenol contents were reduced as a result of drying process in comparison with fresh samples.

Antioxidant activity of moringa leaves extract

Table 2, showed that the antioxidants activity of moringa leaves extract. The antioxidants activity determind by DPPH of moringa leaves powder was ranged from 79.51 to 88.57% (zero time to 120 min.).

Table 2: Antioxidant activity of moringa leaves extract.

Sample	DPPH method (time, min)				
	zero	**30**	**60**	**90**	**120**
Moringa leaves extract	79.51%	87.10%	87.95%	88.33%	88.57%

Table 3: Changes in TBA (mg malonaldehyde/kg) of mayonnaise during cold storage

Sample	TBA (mg malonaldehyde/kg)					
	Storage time (Weak)					
	0	1	2	3	4	5
M1	0.273^{a}± 7.071	0.2957^{a}± 9.899	0.3170^{a}± 7.071	0.3353^{a}± 1.414	0.3929^{a}± 6.930	0.4060^{a}± 4.950
M2	0.2039^{e}± 1.555	0.2251^{e}± 1.555	0.2448^{c}± 6.788	0.3043^{e}± 1.414	0.3520^{d}± 1.414	0.3823^{bc}± 1.414
M3	0.2424^{b}± 8.485	0.2814^{b}± 8.485	0.2957^{b}± 9.899	0.3277^{b}± 7.071	0.3732^{b}± 1.697	0.3850^{b}± 7.071
M4	0.233^{c}± 1.414	0.2567^{c}± 9.899	0.2883^{b}± 4.243	0.3197^{c}± 1.414	0.3673^{b}± 9.899	0.3743^{c}± 1.414
M5	0.2177^{d}± 9.899	0.2335^{d}± 7.071	0.2567^{c}± 9.899	0.3125^{d}± 7.071	0.3273^{d}± 4.243	0.3584^{d}± 6.364

these result is agreement with that reported by Mansour (2017) who found that dried moringa leaves powder was 92.46%. Pakade *et al.,* (2013) found that the antioxidants activity of moringa was in the range from 59.8 to 40.4%. In view of the above, Moringa leaves can be considered a good source of natural antioxidants.

Changes in (TBA) Thio barbituric Acid of mayonnaise during cold storage

Data in table 3, showed that TBA values of the mayonnaise samples M (1:5) showed no great differences between all prepared samples at zero time. Also, from the previous results, it could be observed that the higher value TBA was M1 (0.4060) at storage 5 week. While, other values range from 0.2039 to 0.3850.

The TBA values increased from 0.551±0.02 to 1.284±0.05, 0.744±0.02, 0.962±0.01, 0.915±0.01 and 0.775±0.07 mg malonaldehyde/Kg oil for the control and samples treated with BHA (200 μg/g), SEE (100 μg/g), SEE (200 μg/g) and SEE (400 μg/g), respectively, by the end of the storage period. the lowest TBA values were recorded in mayonnaise samples treated with sage ethanolic extract (400 μg/g) (Rasmy *et al.,* 2012).

Abu-Salem and Abou-Arab, (2008) reported that rhe numbers of TBA after 20 weeks were 0.56 and 0.65 (mg malonaldehyde/kg) in unpasteurized mayonnaise made from ostrich eggs and chicken eggs, respectively. A significant ($P < 0.05$) decrease in TBA was detected at every storage period due to pasteurization compared with unpasteurized mayonnaise manufactured either from ostrich or chicken eggs. TBA in pasteurized mayonnaise made from ostrich eggs was 0.49 mg/kg and from chicken eggs was 0.60 mg/kg after storage for 20 weeks. Results also indicated that mayonnaise from ostrich eggs contained a lower TBA value than that detected in mayonnaise made from chicken eggs. The TBA test determines the amount of malonaldehyde, a major secondary byproduct of lipid oxidation in a sample (Botsoglou *et al.,* 1994).

Table 4: Color evaluation of mayonnaise.

Sample		L*	a*	b*
M1	Zero time	86.723^{a}	- 1.733^{a}	13.893^{g}
	After 15 days	87.927^{a}	- 2.133^{bc}	14.347^{f}
M2	0	88.277^{a}	- 2.206^{cd}	15.083^{e}
	15	88.167^{a}	- 1.980^{b}	15.573^{d}
M3	0	86.307^{a}	- 2.250^{cd}	15.600^{d}
	15	85.277^{a}	- 2.200^{cd}	15.197^{e}
M4	0	72.543^{b}	- 2.350^{de}	16.200^{c}
	15	82.927^{ab}	- 2.350^{de}	16.140^{c}
M5	0	83.073^{ab}	- 2.516^{e}	17.197^{a}
	15	81.110^{ab}	- 2.500^{e}	16.667^{b}

(L*):- Lightness (a*):- Redness (b*):- yellowness

Color evaluation of mayonnaise

Color analysis of food product is an important parameter defining consumer's choice and acceptability and controlling the first impression of the food product. All treatments with moringa leaves extract significantly affected the lightness (L*), redness (a*) and yellowness (b*) of mayonnaise color (Table 4). The L* value decreased with the increase in the levels of moringa leaves extract in M3 (zero time and after 15 dayes), M4 (zero time) and M5 (zero time and after 15 dayes) and increase in M2 (zero time and after 15 dayes) and M4 (zero time) compared to control M1. The change in a* value, which indicates the redness was no great differences between all prepared samples with added moringa leaves extract Whether it is zero time or after 15 days. The change in b* value, which indicates the yellowness, gradually increased with the increase in moringa leaves extract.

Changes in total phenolic compounds and antioxidant activity of mayonnaise

The polyphenols content of mayonnaise was presented in (Table 5). The total polyphenol content in M1 was 45 mg/100g. Polyphenols content were increase with the addition of moringa leaves extract where M2,

Table 5: Changes in total phenolic compounds and antioxidant activity of mayonnaise.

	Polyphenols content (mg/100g)	DPPH
M1	45 ± 0.023	29.8 ± 0.033
M2	81.4 ± 0.01	60.4 ± 0.017
M3	87.9 ± 0.03	68.7 ± 0.054
M4	90.4 ± 0.056	70.2 ± 0.023
M5	97.8 ± 0.049	78.9 ± 0.041

Table 6: Sensory evaluation of mayonnaise.

Mayonnaise samples	Sensory evaluation				
	Color	Appearance	Flavor	Texture	Taste
M1	$8.4667^{a} \pm 0.8338$	$8.3333^{a} \pm 0.6172$	$8.2000^{a} \pm 0.9411$	$8.2000^{a} \pm 0.6761$	$8.3333^{a} \pm 0.7237$
M2	$8.1333^{ab} \pm 0.7432$	$7.9333^{a} \pm 0.9612$	$7.2667^{b} \pm 1.1629$	$7.5333^{abc} \pm 1.1872$	$7.4667^{b} \pm 1.1255$
M3	$7.7333^{bc} \pm 1.0998$	$7.7333^{ab} \pm 0.9612$	$7.0667^{b} \pm 1.7512$	$7.9333^{ab} \pm 1.3345$	$7.5333^{ab} \pm 1.2459$
M4	$7.6667^{bc} \pm 0.6172$	$7.2667^{b} \pm 0.8837$	$7.1333^{b} \pm 1.1872$	$7.3333^{bc} \pm 0.8997$	$7.2667^{b} \pm 1.3870$
M5	$7.4000^{c} \pm 1.4041$	$7.2000^{b} \pm 1.5213$	$6.8667^{b} \pm 1.4573$	$6.9333^{c} \pm 1.0998$	$6.9667^{b} \pm 1.6308$

M3, M4 and M5 were 81.4, 87.9, 90.4 and 97.8 mg/100g, respectively.

Also table 5, showed that the antioxidants activity of mayonnaise. The antioxidants activity was 29.8, 60.4, 68.7, 70.2 and 78.9 in M1, M2, M3, M4 and M5, respectively.

Polyphenols and antioxidants are increased by increasing addition of moringa leaves.

Sensory evaluation of mayonnaise

Results of sensory evaluation indicated that all Data in table 6, showed the sensory evaluation. The results of sensory tasting showed that the taste was acceptable with good score for all mayonnaise samples and they were less score in M5. Flavor score was found to be the highest in M1 compared to other studied mayonnaise samples, while M5 was of worst score and M2, M3 and M4 were approximated score. The highest color score was for M1 then M2, followed by M3, meanwhile the M4 and M5 showed a relative low score. However, all the investigated samples (including the control) realized good color scores. About texture, M1 was found to be of highest texture score, while M5 was of lowest score. Mayonnaise containing increase moringa leaves extract give less score of the sensory evaluation.

Rasmy *et al.,* (2012) showed that the consistency, color and odor of mayonnaise samples treated either with BHA or sage ethanolic extract at different concentrations did not differ significantly comparing with the control ones (P#0.05) during storage for four months. However, mayonnaise samples containing 400 µg/g of sage ethanolic extract recorded significant higher scores in color and odor (7.25, 7.00, 7.25 and 7.00, respectively, P#0.05) during the third and fourth month of storage than that of the control ones. In addition, samples containing s age ethanolic extract (400 µg/g) recorded significant higher scores (7.00, 6.75, 7.00, 6.75, 7.75, 7.50, 7.00 and 6.75, P#0.05) in taste and overall acceptability, respectively, compared to the control samples during the storage period. Mayonnaise samples containing 400 µg/g of sage ethanolic extract were superior in taste and overall acceptability compared to the control ones and also were equivalent to the samples containing BHA (200 µg/g) during the storage period.

Conclusion

This investigation shows the potential value of moringa leaves extract as a good natural source of nutritive components, total phenolic compounds and antioxidants, such as phenolic compounds. Based on its total phenolic compounds and antioxidant, moringa leaves extract could be very suitable as a natural additive or substituted material in the production of many foodstuffs. The information obtained in the present investigation is useful for characterizing moringa leaves extract and for the industrial utilization in mayonnaise. The addition of different concentration of moringa leaves extract improved the quality criteria of mayonnaise and increased the values of total phenolic compound, antioxidant activity and of mayonnaise after added moringa leaves extract. Notice the increase of TBA of mayonnaise during cold storage.

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