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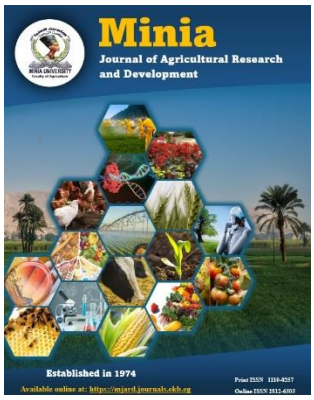

Chemical and Antioxidant Properties of Rayeb Milk Fortified with Thyme and Almond Oils

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ABSTRACT

The effect of fortification of Rayeb milk quality with thyme and almond oils was investigated. Control Rayeb milk was made using *Leuconostoc cremoris* and *Streptococcus lactis subsp. diaceteylactis* culture. Eight Rayeb milk treatments were made fortified with 0.1%, 0.2%, 0.3% and 0.4% thyme and almond oils. Changes in chemical, antioxidant, viability of bacteria and organoleptic properties of Rayeb milk were monitored during storage at 4°±1 for 7 days. The data indicated that essential oils had a slight effect on the total solids and fat %. The values of acidity showed significant (P< 0.05) increase and decrease in pH were noticed in Rayeb milk samples during storage at 4°±1 for 7 days. Total free fatty acids content increased as increasing essential oil ratios in all treated samples. All samples exhibited good radical scavenging activity with varied degrees, However the highest values were shown with almond oil samples on the first day. The greatest antioxidant capacity was found in Rayeb milk samples enhanced with essential oils, as indicated by a significant increase (P<0.05) in total flavonoids (TF), total phenolic and (DPPH) radical scavenging. Meanwhile, the addition of essential oils improved the viability of lactic acid bacteria (LAB). The treated samples fortified with 0.1% and 0.2% of essential oil and the control of Rayeb milk gained the highest score for organoleptic properties.

Keywords: : Rayeb milk and Essential oils

INTRODUCTION:

Fermented milk is representing one of the oldest methods of long-term food preservation. Traditional Egyptian fermented milk products were Rayeb milk and Laban khad **(Vasiljevic & shah, 2008; Ahmed et al., 2019).**

Consumption of fermented milk is also claimed to improve the digest-ability of milk constituents, useful to lactose intolerance, as well as being greatly beneficial in controlling all types of intestinal disorders **(Iannitti & Palmier, 2010).** Rayeb milk is a fermented milk popular among people of all ages in Egypt and other countries due to its great nutritional content and therapeutic characteristics **(Sayed, 2012 & Abou-Dobara et al., 2016).**

Rayeb milk is also known as Laban Matared, natural sour milk and gravity sour skimmed milk. Rayeb milk as fermented

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foods have the advantage of prolonged shelf-life due to organic acids such as lactic acid, acetic acid and other acids produced during fermentation which lowers the pH thus inhibiting the growth of spoilage microorganisms **(All & Dardir, 2009).**

Essential oils are volatile, natural, complex compounds, formed by aromatic plants as secondary metabolites. Essential oil has been known to have beneficial health effects. Antimicrobial and antioxidant activities, essential oils they have been explored as the most common biological activities, but some other activities as well as of essential oils, including antiviral, insecticidal, angiotensin-converting enzyme, amylase and glucosidase enzyme, and xanthine oxidase inhibitory activities **(Mutlu-Ingok et al., 2019).**

Almond oil is rich in phytosterols, vitamin (A) and (E). Phytosterols are believed to reduce blood cholesterol levels and to have anticancer immune- boosting properties **(Kahlaoui et al., 2019).**

Thyme is an excellent antiseptic and tonic. It's used as a respiratory remedy. The strong antiseptic and antifungal activities of thyme, essential oil, mainly due to the presence of biologically active compounds such as phenolic compounds, thymol, carvacrol and p-cymen. Also, thyme essential oil (TEO) is frequently utilized as an alternative medicine for several ailments, such as expectorant in the infection of the upper respiratory tract. It's also revealed that (TEO) acts as an anticancer agent by providing an antineoplastic effect **(Kowalczyk et al., 2020).**

The objective of this study was to utilize the extracts of essential oils (almond and thyme) with different ratios (0.1%, 0.2%, 0.3% and 0.4%) in developing a functional Rayeb milk with high acceptability.

MATERIALS AND METHODS

Materials:

Cow's milk:

Whole Fresh Cow's milk was obtained from the herd of the Animal Production Department, Faculty of Agriculture, Minia University.

Oils extracts:

Bitter almond oil and thyme oil were obtained from Faculty of Agriculture, Assiut University.

Starter culture:

Rayeb Milk starter culture consisted of *Streptococcus lactis subsp.diacetylactis* and *Leuconostoc Cremoris*. These bacteria were obtained from Cairo Microbiological Resource's Center (MIRCEN) Faculty of Agriculture, Ain Shams University.

Media:

All microbiological media including (MRS agar and MRS broth) were obtained from (Biolife Italiana, Milano, Italy).

Manufacture of Rayeb Milk:

Rayeb Milk was manufactured as described by **(Abd-El-Hamid et al., 2008).** Rayeb Milk treatments had been prepared from (5) treatments as follows: Milk containing 3% fat as a control(C), treatment Ⅰ (T_1) Cow milk +0.1% almond oil or thyme oil, treatment Ⅱ (T_2) Cow milk +0.2% almond oil or thyme oil, treatment Ⅲ (T_3) cow milk +0.3% almond oil or thyme oil and treatment Ⅳ (T_4) Cow milk +0.4% almond oil or thyme oil. The supplemented milk bases had been heated to 85°C for 15 min, cooled to 35±1°C Inoculated with 2-3% of starter culture (*Streptococcus lactis subsp. diacetylactis +Leuconostoc cremoris*), filled in plastic cups and incubated at 30°c until a uniform coagulation has been obtained. The

Rayeb Milk samples had been kept at 4°C ±1°C, and analysed when fresh, 3, 5, and 7 days of manufacturing. The results obtained in this study were the average of three replicates.

Chemical analysis.

pH Values and Titratable acidity:

pH value and titratable acidity of Rayeb Milk samples have been determined according to **Ling, (1963).**

Determination of total protein:

The **AOAC (2016)** describes the Kjeldahl methods that have been used to determine total nitrogen. Total nitrogen content was multiplied by factor 6.38 to determined total protein.

Fat determination:

The fat content of milk and Rayeb Milk was determined as described by **AOAC, (2016).**

Determination of Total solids:

Total solids had been determined as mentioned by **Ling, (1963).**

Total volatile free fatty acids (TVFFA):

The direct distillation method described by **Kosikowski, (1978)**

Determination of Antioxidant properties:

- Radical Scavenging method (DPPH):

DPPH radical scavenging method for water soluble extract. The 1,1-diphenyl-2-picrylhydrazed radical (DPPH) assay was carried out by modifying the method used by **Bhandari et al., (2010)** to investigate the antioxidant activity of water-soluble peptides.

Total Phenolic Content (TPC) :

The amount of total phenolic content can be determined by Folin-Ciocateu reagent method according to **(McDonald et al., 2001)**

Total Flavonoid Determination (TFC) :

The concentration of total flavonoid compounds in the extracts has been determined by the aluminium chloride colorimetric assay **Kim et al., (2003)**

Microbiological analyses

Lactic Acid Bacteria (LAB)

Counting LAB was used by the MRS agar (Biolife) as recommended by **Richardson, (1985).** The plates were incubated at 30°C for 72h for *Streptococcus lactis subsp. diacetylactis* and *Leuconostoc Cremoris*.

2- Yeast and mould counts:

The enumeration of yeasts and moulds was carried out as recommended by the **Richardson, (1985).**

Sensory Evaluation

Sensory evaluation of Rayeb Milk samples has been performed by panel of 10 trained panellists at the Faculty of Agriculture, Dairy Department, Minia University, Attributes evaluated had been appearance, aroma, taste, color as well as overall acceptability **(Giri, 2013).**

Statistical analyses

Data collected had been subjected to two-way Analysis of Variance (ANOVA) to determine and storage the overall effect of treatments, on physicochemical and quality attributes of samples. The differences had been separated using the least significant difference (LSD) **(Motulsky, 1999).**

RESULTSAND DISCUSSION

Chemical composition of Rayeb milk:

Data in **Table (1)** represent the chemical composition of the Rayeb milk samples being made from cow's milk (C) by starter bacteria (*Streptococcus lactis subsp. diacetylactis* and *leuconostoc cremoris*).

It could be concluded that the chemical composition was 4.6, 0.73%, 3.9% and 3.1% for pH, acidity, total protein and total fat, respectively, While, the average of total solids ranged from 9.5 to 10.7%. This result is similar to those obtained by **(Benkerroum & Tamime, 2004; Abd Elhamid et al., 2009 and Mohamed, 2010)** for traditional fermented milks.

Table (1). The chemical composition of Rayeb milk.

pH	Acidity	Fat	Protein	Moisture	Total solid
4.6	0.73%	3.1%	3.9%	89.7%	10.3%

Data presented in **Table (2)** show the effect of the addition of essential oils on the total solids of Rayeb milk at first day and during storage. Indicated that essential oils had a slight effect on the total solids and fat. Data showed that total solids ranged from 10.83±0.02, 11.03±0.05, 11.1±0.1 and 11.2±0.2 at first day to 10.5±0.1, 10.43±0.1, 10.66±0.1 and 10.96±0.05 at 7 days of storage of almond oil and from 10.4±0.1, 10.7±0.2, 11.26±0.1 and 11.3±0.2 at first day to 10.13±0.1, 10.5±0.1, 10.66±0.1 and 11.03±0.1at 7 days storage of thyme oil respectively. As expected, total solids increased by increasing plant essential oil ratios and decreased after 7 days storage. This decrease may be due to the fermentation by the starter or loss of some decomposed volatile compounds. The obtained results were in harmony with those reported by **(Essawy et al., 2005 & Mohamed et al., 2022).** In addition, interaction between lactose and some components of essential oil, which may be due to oxidation-reduction reactions, this may lead to loss of gaseous products from the system, and thus reduction in the total solids contents of the Rayeb milk.

These results are in agreement with the findings of **(Anjum & Zahoor, 2007).** Also, the results obtained in this study showed that slight increase in fat contents for each treatment as adding essential oil at first day. Fat content increased with increasing plant essential oils ranged from 3.41% for control, 3.6%, 3.7%, 3.8% and 3.9% for levels 0.1%, 0.2%, 0.3% and 0.4% plant essential oil respectively. The obtained results are consistent with the results of **(Zedan et al., 2003& Abd El-Hamid et al., 2008).**

pH and Titratable acidity:

Titratable acidity values of Rayeb milk manufactured with different ratios of essential oils and control are represented in **Table (3).** It was showed that the titratable acidity of Rayeb milk samples with almond oil were (0.61±0.01, 0.61±0.01, 0.61±0.01 and 0.62±0.02) samples The control samples showed less acidity as compared to all treated samples. The values of acidity showed significant increase ($P<0.05$) in all treated samples during storage for 7 days at 4ºc±1.The pH values of control samples were (4.56±0.1) on the first day, while decreased during storage for 7days till (3.94±0.03). The pH values of all treated samples at first day ranged from 3.7±0.2 to 3.82±0.02 with thyme oil and from 4.62±0.02 to 4.71±0.01 with almond oil. The pH decreased significantly ($P<0.05$) in all studied Rayeb milk samples. This decrease in pH could be due to the activity of starter bacteria which led to gradually hydrolyze Lactose into lactic acid during storage at 4°c ± 1. Similarities were observed by **(Panesar, (2011); Zedan et al., (2012), and Assem et al., (2013)** who reported that the decrease in pH was an increase in acidity due to the microorganism's activity.

Table (2) The total Solids of Rayeb milk samples fortified with oils.

Oils ratio / Storage period (days)	Control	(0.1%)		(0.2%)		(0.3%)		(0.4%)	
		Almond oil	Thyme oil	Almond oil	Thyme oil	Almond oil	Thyme oil	Almond oil	Thyme oil
First day	$10.3^{nopq}\pm0.1$	$10.83^{ijkl}\pm0.02$	$10.4^{mnop}\pm0.1$	$11.03^{hi}\pm0.05$	$10.7^{jklm}\pm0.2$	$11.1^{ghi}\pm0.1$	$11.26^{fgh}\pm0.1$	$11.2^{fgh}\pm0.2$	$11.3^{efgh}\pm0.2$
3	$10.16^{opq}\pm0.1$	$10.63^{lmn}\pm0.02$	$10.3^{nopq}\pm0.1$	$10.83^{ijkl}\pm0.01$	$10.6^{lmn}\pm0.2$	$10.99^{hij}\pm0.005$	$11.1^{ghi}\pm0.1$	$11.16^{fghi}\pm0.1$	$11.2^{fgh}\pm0.1$
5	$10.1^{pq}\pm0.1$	$10.6^{lmn}\pm0.1$	$10.3^{nopq}\pm0.2$	$10.7^{jklm}\pm0.1$	$10.6^{lmn}\pm0.1$	$10.83^{ijkl}\pm0.1$	$11^{hij}\pm0.1$	$11.1^{ghi}\pm0.1$	$11.1^{ghi}\pm0.1$
7	$10.03^{q}\pm0.05$	$10.5^{lmno}\pm0.1$	$10.13^{pq}\pm0.1$	$10.43^{mnop}\pm0.1$	$10.5^{lmno}\pm0.1$	$10.66^{klm}\pm0.1$	$10.66^{klm}\pm0.1$	$10.96^{hijkl}\pm0.05$	$11.03^{hi}\pm0.1$

Table (3). The changes in pH and titratable acidity of Rayeb milk samples fortified with oils during storage at 4ºc±1 for 7 days.

Storage period (days)	Oil ratios	Control	(0.1%)		(0.2%)		(0.3%)		(0.4%)	
			Thyme oil	Almond oil	Thyme oil	Almond oil	Thyme oil	Almond oil	Thyme oil	Almond oil
First day	pH	4.56^{abc}±0.1	3.7^{ijkl} ±0.2	4.62^{ab} ±0.02	3.68^{ijklm}±0.01	4.62^{ab} ±0.02	3.77^{ij}±0.02	4.71^{a} ±0.01	3.82^{hi} ±0.02	4.71^{a} ±0.01
	Acidity	0.73^{defg} ±0.02	0.72^{efg}±0.01	0.61^{m} ±0.01	0.76^{def} ±0.01	0.61^{lm}±0.01	0.73^{defg}±0.02	0.61^{lm} ±0.01	0.77^{de}±0.02	0.62^{klm}±0.02
3	pH	4.24^{efg}±0.02	3.67^{ijklm}±0.02	4.24^{efg} ±0.01	3.67^{ijlkm}±0.02	4.34^{def} ±0.03	3.75^{ijk}±0.02	4.52^{bc} ±0.02	3.72^{ijkl} ±0.02	4.54^{abc} ±0.02
	Acidity	0.76^{def} ±0.02	0.73^{defg} ±0.02	0.64^{jklm}±0.02	0.78^{cd} ±0.01	0.67^{hijk}±0.02	0.74^{def}±0.02	0.62^{lm} ±0.01	0.77^{de} ±0.01	0.67^{hijk}±0.02
5	pH	4.14^{fg} ±0.02	3.6^{jklm}±0.2	4.22^{fg} ±0.02	3.63^{jklm}±0.01	4.32^{defg}±0.02	3.57^{klm}±0.02	4.51^{bc} ±0.01	3.57^{klm} ±0.02	4.45^{bcd} ±0.02
	Acidity	0.76^{def} ±0.02	0.76^{def} ±0.02	0.75^{def} ±0.02	0.82^{abc} ±0.02	0.68^{ghij} ±0.01	0.82^{bc} ±0.02	0.70^{fghi}±0.005	0.82^{abc} ±0.01	0.71^{fgh}±0.01
7	pH	3.94^{h} ±0.03	3.5^{m} ±0.3	4.12^{g} ±0.02	3.56^{klm}±0.02	4.23^{fg} ±0.02	3.56^{klm}±0.02	4.43^{cde}±0.02	3.53^{lm} ±0.02	4.32^{defg}±0.02
	Acidity	0.83^{abc} ±0.02	0.82^{abc} ±0.02	0.76^{def}±0.02	0.87^{a} ±0.02	0.73^{defg}±0.02	0.84^{ab} ±0.02	0.736^{def}±0.01	0.82^{abc}±0.01	0.73^{defg}±0.02

Phytochemical and antioxidant activity of essential oils Rayeb milk:

Total volatile free fatty acids (TVFFA):

Free fatty acids can influence the unique flavor of each fermented milk and act as precursors of aromatic compounds such as lactones, secondary alcohols and organic acid according to **(Smid & Kleerebezem, 2014).**

Data in **Fig ($1_{a\&b}$)** showed that there was a significant ($P \leq 0.05$) decrease in total free fatty acid content in control samples as compared to all treated samples on the first day. This finding was in agreement with what has been found by **(Atasoy & Türkoglu, 2009; Velez et al., (2010).** Who showed that heat treatment had a significant effect on cheese and fermented milk lipolysis and volatile compounds production.

Data showed that total free fatty acids increased as increasing oil ratios for all treated samples at first day. The highest content of free fatty was found in samples supplemented with almond oil, especially with 0.4% at first day.

Data in **Fig ($1_{a\&b}$)** showed that during storage significant effect ($P \leq 0.05$) of essential oils especially almond oil on the production of total free fatty acids. The statistical analysis showed also significant ($P \leq 0.05$) differences between treated samples at first day and during storage for 7days at $4^{o}c \pm 1$.

Also, **Fig ($1_{a\&b}$)** revealed that the essential oils could have a significant effect on total free fatty acid production in all treated samples. This was in agreement with the results obtained by **(Bendimerad et al., 2012).**

Total phenolic content (TPC):

The total phenolic content of Rayeb milk samples is shown in **Fig ($2_{a\&b}$)**. The highest total phenolic content was obtained from treated samples with almond oil at first day. The values ranged from 211.05±0.02, 213.83±0.02, 222.21±0.01 to 242.24±0.02 mg/100g. Meanwhile, the control samples had the lowest values of total phenolic content (121.63±0.02 mg/100g) at first day, while during storage total phenolic content for all samples gradually decreased till the 7day. These results revealed that the fortified oil developed significantly ($P<0.05$) higher concentrations of phenolic compounds than control.

These results are in agreement with those reported by **Uguru et al., (2023).** Who found that (TPC) of samples fortified oil (thyme and almond) had significantly ($P<0.05$) higher concentration than control.

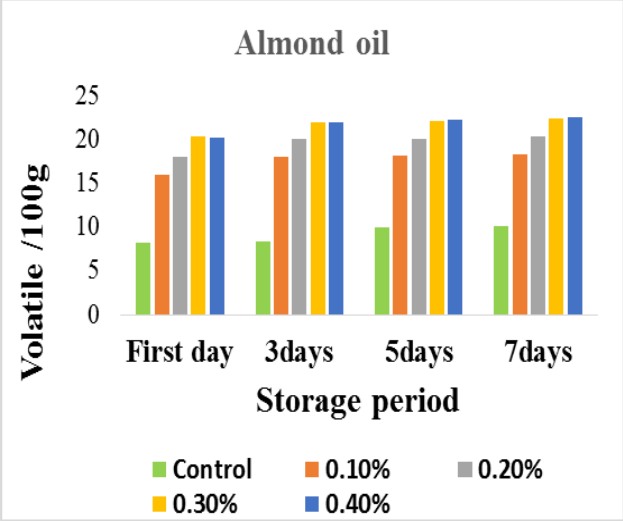

Fig (1_a). Concentration of Total volatile free fatty acids in Rayeb milk samples fortified with almond oil during storage at 4°c±1

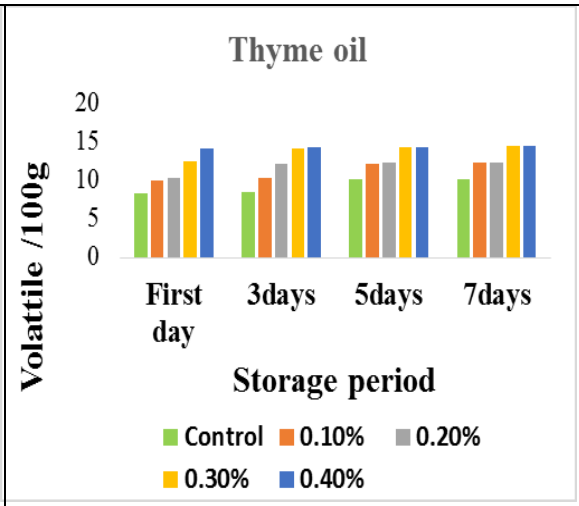

Fig (1_b). Concentration of Total volatile free fatty acids in Rayeb milk samples fortified with thyme oil during storage at 4°c±1.

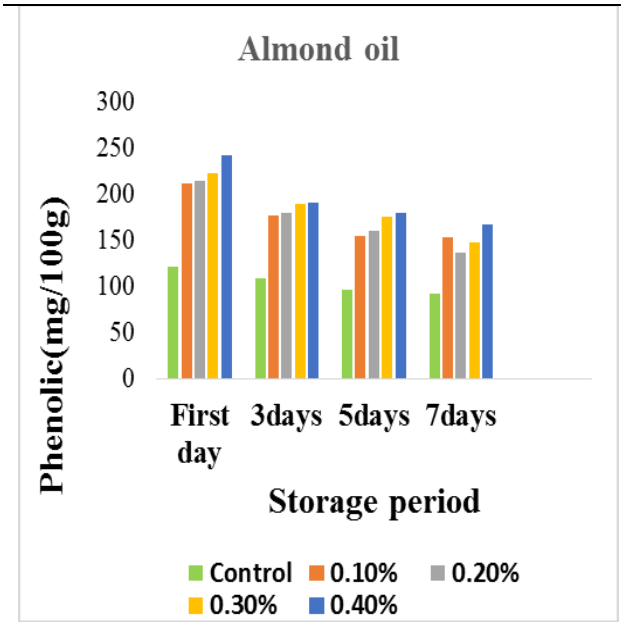

Fig (2_a). Concentration of Total phenolic content (mg/100g) in Rayeb milk samples fortified with almond oil.

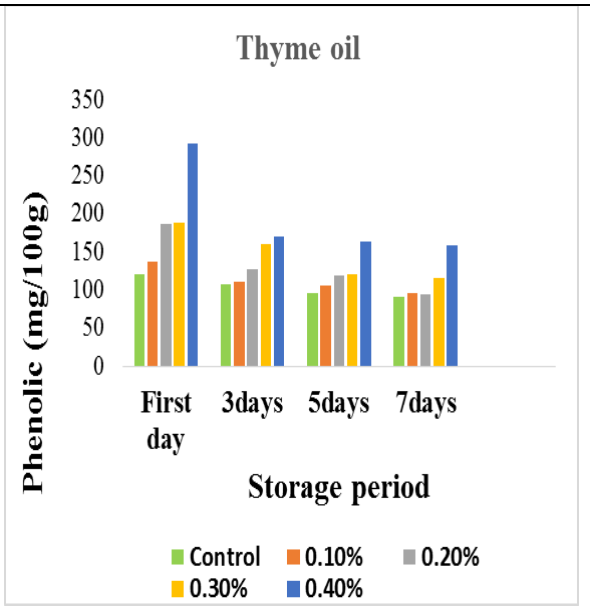

Fig (2_b). Concentration of Total phenolic content (mg/100g) in Rayeb milk samples fortified with thyme oil.

Total flavonoids content (TFC):

The total flavonoids of all Rayeb milk samples are shown in **Fig ($3_{a\&b}$),** they were 25.36 mg/100g for control, 24.62±0.01, 32.32±0.02, 44.62±0.01 and 40.74±0.02 mg/100g for thyme samples and 36.92±0.01, 55.35±0.02, 56.13±0.02 and 68.44±0.02 mg/100g for almond samples at first day.

During storage at 4°c±1 data showed that (TFC) decreased significantly till 7days storage, while control sample showed gradual increase in (TFC) during storage. These results are in agreement with those reported by **(Shori, 2022).** Who found that a significant reduction in (TFC) was observed for all herbal yoghurt samples at the end of storage.

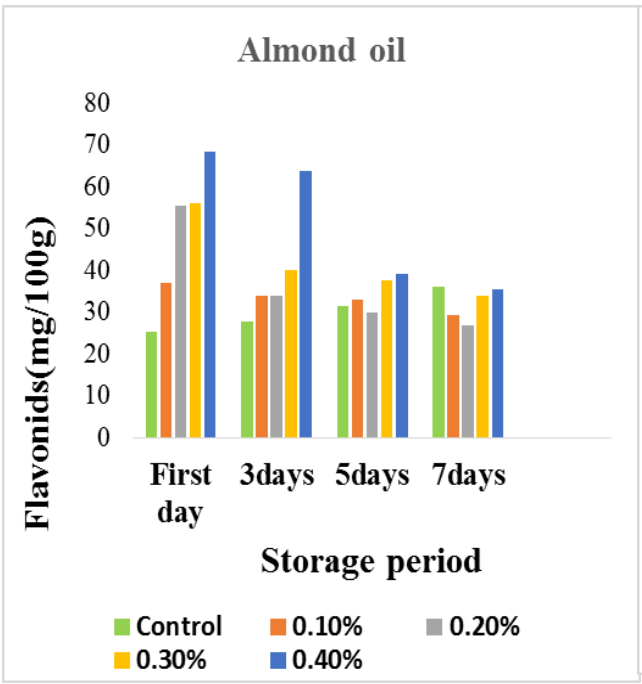

Fig (3_a). Concentration of Total flavonoids content (mg/100g) in Rayeb milk samples fortified with almond oil.

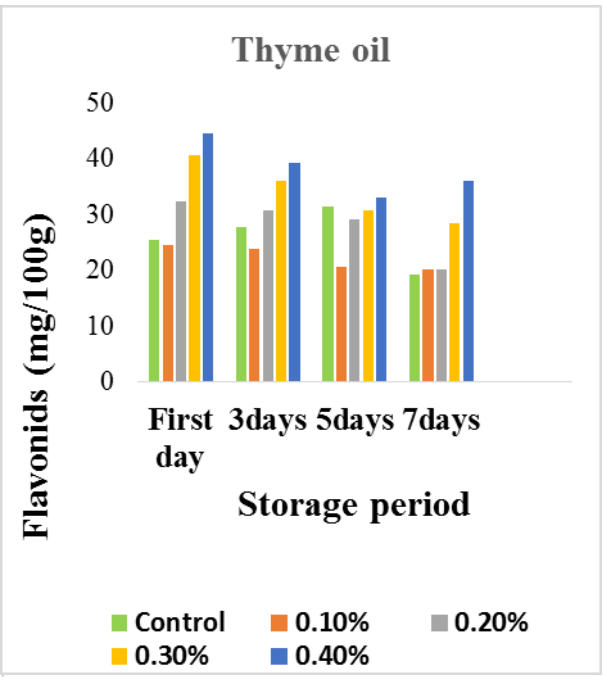

Fig (3_b). Concentration of Total flavonoids content (mg/100g) in Rayeb milk samples fortified with thyme oil.

Radical Scavenging Activity (DPPH):

DPPH is one of the stable free radicals which is of violet color, accepts an electron or hydrogen atom from the antioxidant compounds and is converted into a colorless or somewhat yellow diamagnetic DPPH molecule **(Rehman et al., 2013).** As shown in **Fig ($4_{a\&b}$)** all tested samples exhibited good radical scavenging activity with varied degrees.

A significant difference ($P<0.05$) recorded between DPPH activation. The highest values were shown with treated samples with almond oil on the first day. The values ranged from 68.7±0.2, 69.86±0.2, 71.5±0.2 to 75.3±0.2% for 0.1, 0.2, 0.3 and 0.4% oil ratios respectively. Thus, almond oil had high potential (DPPH) radical scavenging activity. According to reports by **Viuda Martos et al., (2010)** phenolic groups in rosemary and almond oils contribute to their antioxidant action.

Results in **Fig ($4_{a\&b}$)** also showed that radical scavenging activity decreased gradually for samples with almond and thyme treated during storage at 4ºc±1 for 7days. However, radical scavenging activity increased for control during storage till 7days.

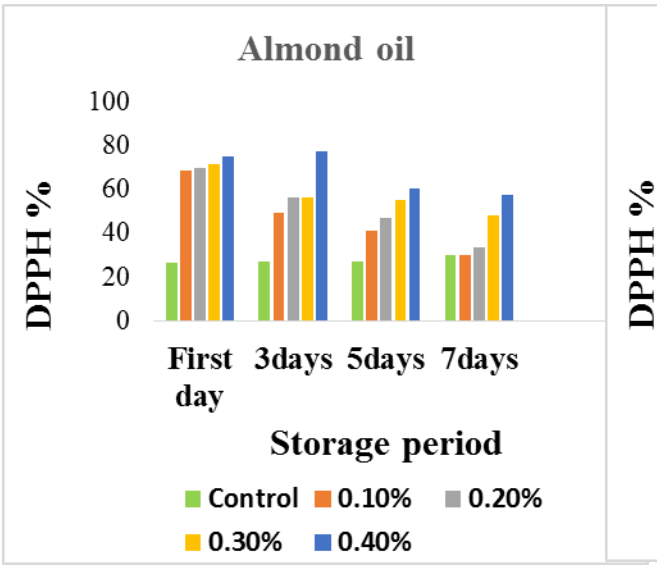

Fig (4_a). Radical Scavenging activity (DPPH) of Rayeb milk samples fortified with almond oil during storage at 4ºc±1 for 7 days.

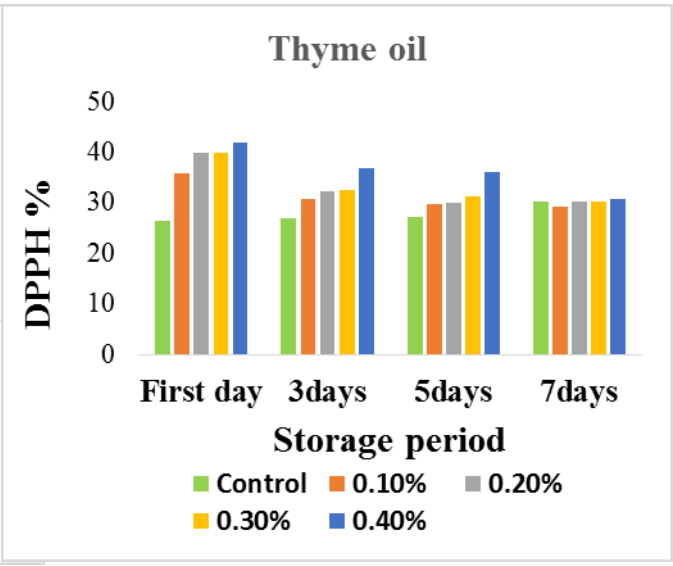

Fig (4_b). Radical Scavenging activity (DPPH) of Rayeb milk samples fortified with thyme oil during storage at 4ºc±1 for 7 days.

Viability of bacteria:

Total viable counts of starter bacteria had been determined at the end of acidification and during storage period at 4ºc±1 in Rayeb milk. The results revealed that essential oils did not affect the growth of starter cultures. Lactic acid bacteria were gram positive fermentative bacteria which were resistant to essential oils.

Table (4) indicated that there had been differences among the viable counts of the starter bacteria in all treated samples in comparison with control.

The results revealed that the control samples had the lowest count at first day and during storage for 7days. While the highest count was found in treated samples with thyme oils with all ratios at first day and during storage till 7day. It could be seen that the starter bacteria count of all treated samples increased considerably as compared with control samples with increasing storage period. The health benefits of Rayeb milk are associated with the starter bacteria in it. Therefore, these results can be revealed that the plant essential oils had improved the viability of LAB. These results are in agreement with those by **Singh et al., (2008) and Singh et al., (2010).**

Also, the yeast and mould were not detected in all Rayeb milk samples at first and during storage. This might be due to the hygienic conditions where the manufacturing procedures took place. Similar results have been reported by **(Taha et al., 2007 & Salma, 2018).** The results obtained in this study provide evidence for the presence of antimicrobial compounds in plant essential oils.

Sensory evaluation:

The effect of fortification with essential oils on the organoleptic properties of Rayeb milk are presented in **Table ($5_{a\&b}$)**. The majority of consumers don't prefer Rayeb milk with 0.3% and 0.4% thyme oils especially during storage at 4ºc±1. This could be due to high ratios of thyme oil which failed to improve body, flavor and texture of Rayeb milk. Meanwhile, these samples showed the highest values of antioxidants. The control and all treated samples with concentrations of 0.1% and 0.2% of Rayeb milk gained the highest score either when fresh or throughout the storage periods for 7 days at 4ºc±1 as compared to other concentration 0.3% and 0.4%.

From the foregoing results, it could be concluded that fortification of Rayeb milk with thyme and almond oils up to 0.2% can be used in the manufacture this product without objectionable effect on the organoleptic properties.

Table (4). Change in viable lactic acid bacteria (*Streptococcus lactis subsp. diacetylactis + Leuconostoc Cremoris)* in Rayeb milk samples fortified with oils during storage at 4ºc±1 for 7days.

Oils ratio	Control	(0.1%)		(0.2%)		(0.3%)		(0.4%)	
Storage period (days)		Thyme oil	Almond oil	Thyme oil	Almond oil	Thyme oil	Almond oil	Thyme oil	Almond oil
First day	11.03^{r} ±0.05	11.73^{nop}±0.02	11.6^{opq} ±0.1	12.03^{mn}±0.05	12.23^{klm}±0.1	12.1^{lmn} ±0.1	12.26^{jklm}±0.2	12.33^{ijklm}±0.05	12.5^{ijkl} ±0.1
3	12.06^{lmn} ±0.05	12.3^{ijklm}±0.2	12.3^{ijklm}±0.1	12.5^{ijkl}±0.1	12.73^{i}±0.02	12.7^{ij} ±0.1	13.12^{gk}±0.01	13.03^{h}±0.05	13.2^{efgh} ±0.1
5	12.6^{ijk} ±0.1	13.07^{h}±0.06	12.6^{ijk}±0.1	13.51^{defg}±0.005	13.16^{fgh}±0.1	13.66^{d} ±0.02	13.62^{d}±0.01	14.1^{c}±0.1	14.03^{c} ±0.05
7	13.2^{efgh} ±0.1	13.74^{d}±0.02	13.4^{defgh}±0.1	14.1^{c} ±0.1	13.56^{def} ±0.1	14.21^{c} ±0.5	14.1^{c} ±0.1	15.1^{a} ±0.1	14.6^{b} ±0.1

Table (5_a). Sensory properties of Rayeb milk fortified with almond oil during storage at 4ºc±1.

Oils ratio	Days	Taste	Texture	Color	Appearance	Acceptability
control	**First**	5^{a} ±0.05	5^{a} ±0.05	5^{a} ±0.1	5^{a} ±0.1	4.99^{a} ±0.005
	3	4.49^{bc}±0.005	5^{a} ±0.05	5^{a} ±0.1	5^{a} ±0.1	4.54^{bc}±0.01
	5	4.46^{bc}±0.05	4.53^{b} ±0.05	5^{a} ±0.05	5^{a} ±0.05	4.49^{bc}±0.01
	7	4.29^{cd} ±0.005	4.23^{cd} ±0.05	5^{a} ±0.05	5^{a} ±0.05	4.46^{bc} ±0.05
0.1%	**first**	5^{a} ±0.05	5^{a} ±0.1	5^{a} ±0.05	5^{a} ±0.05	4.93^{a} ±0.1
	3	4.49^{bc} ±0.01	5^{a} ±0.05	5^{a} ±0.05	5^{a} ±0.05	4.63^{b} ±0.2
	5	4.46^{bc} ±0.05	4.53^{b} ±0.05	5^{a} ±0.05	5^{a} ±0.05	4.56^{bc} ±0.05
	7	4.29^{cd} ±0.01	4.53^{b} ±0.05	5^{a} ±0.05	5^{a} ±0.05	4.49^{bc} ±0.01
0.2%	**first**	5^{a} ±0.05	5^{a} ±0.1	5^{a} ±0.1	5^{a} ±0.1	4.93^{a} ±0.1
	3	4.46^{bc} ±0.05	4.99^{a} ±0.005	5^{a} ±0.05	5^{a} ±0.05	4.63^{b} ±0.2
	5	4.37^{cd} ±0.1	4.99^{a} ±0.005	4.96^{a} ±0.1	4.96^{a} ±0.1	4.56^{bc} ±0.05
	7	4.26^{cd} ±0.05	4.53^{b} ±0.05	4.73^{ab} ±0.4	4.73^{ab} ±0.4	4.49^{bc} ±0.01
0.3%	**first**	4.52^{ab} ±0.02	4.96^{a} ±0.05	5^{a} ±0.1	5^{a} ±0.1	4.56^{bc} ±0.05
	3	4.32^{cd} ±0.2	4.53^{b} ±0.05	4.63^{bc} ±0.05	4.53^{b} ±0.05	4.46^{bc} ±0.05
	5	4.16^{cd} ±0.2	4.33^{c} ±0.05	4.56^{bc} ±0.05	4.5^{b} ±0.1	4.17^{d} ±0.05
	7	4.03^{de} ±0.05	4.13^{de} ±0.05	4.46^{bc} ±0.05	4.46^{b} ±0.05	4.03^{d} ±0.05
0.4%	**first**	4.46^{bc} ±0.05	4.53^{b} ±0.05	4.99^{a} ±0.005	4.99^{a} ±0.005	4.49^{bc} ±0.01
	3	4.33^{cd} ±0.3	4.53^{b} ±0.05	4.56^{bc} ±0.05	4.53^{b} ±0.05	4.36^{c} ±0.05
	5	3.79^{e} ±0.1	4.03^{e} ±0.05	4.43^{bc} ±0.05	4.5^{b} ±0.1	4.03^{d} ±0.05
	7	3.46^{f} ±0.05	3.83^{f} ±0.05	4.36^{c} ±0.05	4.46^{b} ±0.05	3.46^{e} ±0.05

Table (5_b). Sensory properties of Rayeb milk fortified with thyme oil during storage at 4°c±1.

Oils ratio	Days	Taste	Texture	Color	Appearance	Acceptability
control	**First**	5^{a} ±0.05	5^{a} ±0.05	5^{a} ±0.1	5^{a} ±0.1	4.99^{a} ±0.005
	3	4.49^{c}±0.005	5^{a} ±0.05	5^{a} ±0.1	5^{a} ±0.1	4.63^{b} ±0.2
	5	4.46^{c}±0.05	4.53^{b} ±0.05	5^{a} ±0.05	5^{a} ±0.05	4.49^{b} ±0.01
	7	4.29^{cd} ±0.005	4.23^{c} ±0.05	5^{a} ±0.05	4.56^{bc} ±0.2	4.46^{bc} ±0.05
0.1%	**first**	5^{a} ±0.05	5^{a} ±0.1	5^{a} ±0.05	5^{a} ±0.05	4.93^{a} ±0.1
	3	4.49^{c} ±0.01	4.99^{a} ±0.005	5^{a} ±0.05	5^{a} ±0.05	4.54^{bc} ±0.01
	5	4.46^{c} ±0.05	4.99^{a} ±0.005	5^{a} ±0.05	4.73^{ab} ±0.4	4.56^{bc} ±0.05
	7	4.29^{cd} ±0.01	4.53^{b} ±0.05	5^{a} ±0.05	4.46^{c} ±0.05	4.49^{bc} ±0.01
0.2%	**first**	4.82^{b} ±0.3	4.96^{a} ±0.05	5^{a} ±0.1	5^{a} ±0.05	4.93^{a} ±0.1
	3	4.46^{c} ±0.05	4.53^{b} ±0.05	5^{a} ±0.05	5^{a} ±0.1	4.53^{b} ±0.05
	5	4.13^{de} ±0.05	4.53^{b} ±0.05	4.96^{ab} ±0.1	4.73^{ab} ±0.4	4.06^{d} ±0.05
	7	4.03^{e} ±0.05	4.46^{b} ±0.05	4.73^{bc} ±0.4	4.6^{abc} ±0.1	3.76^{e} ±0.05
0.3%	**first**	4.06^{e} ±0.05	4.53^{b} ±0.05	4.54^{c} ±0.005	4.63^{ab} ±0.2	4.16^{cd} ±0.05
	3	3.76^{f} ±0.05	4.26^{c} ±0.05	4.54^{c} ±0.01	4.49^{c} ±0.01	4.03^{d} ±0.05
	5	3.26^{g} ±0.05	4.03^{d} ±0.05	4.53^{c} ±0.05	4.46^{c} ±0.05	3.56^{f} ±0.05
	7	2.99^{hi} ±0.05	4.03^{d} ±0.05	4.46^{c} ±0.05	4.26^{cd} ±0.05	3.16^{g} ±0.05
0.4%	**first**	4.03^{e} ±0.05	4.53^{b} ±0.05	4.54^{c} ±0.005	4.46^{c} ±0.05	4.03^{d} ±0.05
	3	3.76^{f} ±0.05	4.06^{d} ±0.05	4.53^{c} ±0.05	4.26^{cd} ±0.05	3.76^{e} ±0.05
	5	3.06^{h} ±0.05	3.86^{e} ±0.05	4.5^{c} ±0.1	4.06^{cde} ±0.05	3.06^{g} ±0.05
	7	2.86^{i} ±0.05	3.76^{f} ±0.05	4.49^{c} ±0.005	3.96^{de} ±0.05	2.86^{h} ±0.05

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الملخص العربي

الخواص الكيميائية ومضادات الاكسدة للبن الرايب المحتوى على زيت الزعتر واللوز

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يهدف البحث الي دراسة تأثير اضافة زيت الزعتر واللوز علي جودة اللبن الرايب، استخدمت في هذه الدراسة بادئ مكون من (*Streptococcus lactis subsp. diacetylactis* and *Leuconostoc Cremoris*) الى اللبن الرايب الكنترول وايضا مع نسب من الزيوت تتراوح من ٠.١- ٠.٢-٠.٣ الى ٠.٤% كلا من زيت الزعتر واللوز. تم تقدير التغيرات الكيميائية ومضادات الاكسدة والنمو البكتيري والخواص الحسية لعينات البن الرايب (الكنترول والعينات المعاملة) على درجة حرارة ٤ درجة مئوي لمدة ٧ ايام. اوضحت النتائج ان اضافة الزيوت لها تأثير منخفض على محتوي الجوامد الصلبة الكلية والدهن. اظهرت قيم الحموضة زيادة معنوية بينما انخفضت قيم الpH خلال فترة التخزين.

اظهرت النتائج انه بزيادة نسب الاضافة لهذه الزيوت زاد المحتوي من الاحماض الدهنية الحرة لجمع المعاملات. اظهرت جميع المعاملات درجة عالية من النشاط المضاد للأكسدة بدرجات مختلفة طبقا لاختلاف نسب اضافة الزيوت وهذا واضح بصورة معنوية في ارتفاع كلا من مركبات الفلافونيدات والمركبات الفينولية ومضادات الاكسدة. اظهرت المعاملات المحتوية على ٠.١ و٠.٢ % من الزيوت والكنترول اعلى درجات من المحكمين في تقييم الخواص الحسية. وبالتالي فان هذه الدراسة توصي بامكانية استخدام الزيوت المشار اليها حتي ٠.٢% في صناعة اللبن الرايب بدون الاعتراض في اختبارات الخصائص الحسية.