10.21608/avmj.2025.383920.1704 Assiut University web-site: www.aun.edu.eg

EFFECT OF ADDING MINT, THYME, AND ERUCA SATIVA EXTRACTS ON SOME OF THE HEALTH PROPERTIES OF YOGURT

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Received: 11 November 2024; **Accepted:** 17 August 2025

ABSTRACT

Recently, there has been a noticeable increase in demand for healthy, value-added dairy products. This study aimed to evaluate the effect of adding extracts of certain medicinal plants (mint, thyme, and watercress) on some of the health, physicochemical, and sensory properties of yogurt. Yogurt was prepared from whole cow's milk and divided into four treatments: a control sample (Y) without additives, yogurt with mint extract (YM), yogurt with thyme extract (YT), and yogurt with watercress extract (YE). All samples were stored at 4°C for 20 days, and analyzed on days 1, 10, and 20. The acidity, content of phenolic compounds, antioxidant, viscosity and whey separation were measured, in addition to conducting the sensory evaluation of the final product. The results showed a decrease in pH values (increase in acidity) in the samples supplemented with plant extracts compared to the control sample during the storage period. The addition led to a significant increase in the total phenolic content and antioxidant activity, with the thyme sample (YT) recording the highest values, followed by the mint sample (YM). A decrease in viscosity and an increase in the amounts of separated whey was also observed in the fortified samples, especially at the beginning of storage. Sensory evaluation showed that the control sample received the highest ratings, followed by the mint sample (YM). In conclusion, the addition of mint, thyme, and watercress extracts improved the antioxidant value and phenolic compounds in yogurt, despite their effect on some physical and sensory properties, highlighting their potential for use in the development of functional dairy products.

Keywords: Yogurt, mint, thyme, *Eruca sativa*

INTRODUCTION

Many studies are interested in adding some plant substances to milk during the manufacturing of dairy products. Some of them, such as dried fruits or natural sweeteners, are added during the production of ice cream (Hasan *et al.,*2020; Saadi *et al.,* 2022a). Vegetable oils and cardamom are also added to the cheese industry (Saadi, 2018; Salih *et al.,* 2021). While some substances may be added in the manufacture of yogurt to improve its properties (ALKaisy *et al.,* 2023; Saadi *et al.,* 2022b; Al-Bedrani *et al.,* 2023).

Yogurt is a dairy product that is widely consumed around the world (Yu *et al.,* 2023). Many extracts of medicinal plants are used to produce healthy yogurt (Shori,

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2022; Ali *et al.,* 2021; Saberi *et al.,* 2023). Yogurt can also be considered a digestive improvement product (Shori, 2016). Nowadays, yogurt has been produced by adding natural plant-derived antioxidants or bioactive peptides derived from milk proteins during yogurt fermentation (Muniandy *et al.,* 2016; Mohammed *et al.,* 2025).

Mint, Thyme, and *Eruca sativa* are the most important medicinal plant species, and they have long been used in traditional medicine for the treatment of several diseases (Tariq *et al.,* 2022; Pakdemirli, 2020; Abdul and Razvi, 2019). The extracts of these plants are characterized by their antioxidant and antimicrobial properties (Padmiswari *et al.,* 2023; Mokhtari *et al.,* 2023; Awadelkareem *et al.,* 2022).

This study aimed to include mint, thyme, and *Eruca sativa* extract as antioxidants in manufacturing healthy yogurt and its effect on chemical, physical, and sensory properties.

MATERIALS AND METHODS

Materials: full-fat cow's milk was obtained from a cow breeder in the city of Mosul, Iraq. Medicinal plants were purchased from the local markets, and starter culture yogurt (*Lactobacillus bulgaricus* and *Streptococcus thermophilus*) was obtained from a dairy factory.

Methods:

Extract Marking: Mint and Eruca Sativa extract was prepared according to Panda *et al.* (2015). Thyme extract was prepared according to the method prescribed by Zakrzewski *et al. (*2022). Then the aqueous extracts were kept in bottles in the refrigerator at 4 °C.

Treatments: The study was divided into four treatments, the first included a control sample, which represents yogurt without any addition (Y), the second is yogurt with mint extract (YM), the third is yogurt with thyme extract (YT) and the fourth is yogurt with *Eruca sativa* extract (YE).

Preparation of yogurt: Yogurt was prepared according to Shori *et al.* (2018), with some modifications. Briefly, 50 ml of extracts were added to 500 ml of pre-pasteurized whole cow's milk, the starter culture was added to the mixture and mixed well. Then the mixture is placed in the container and incubated at 43 °C until the curd formation is complete. Regular yogurt was prepared in the same way, with the addition of 50 ml of water to equal the final volume. All samples were stored in a 4 °C refrigerator for 20 days. All tests were conducted on the 1, 10 and 20 days.

Determination of pH and acidity: The pH and acidity of yogurt samples were measured according to Muniandy *et al.* (2017).

Rheological analysis: A Brookfield DVII + viscometer made by Brookfield Engineering Lab Inc. (Stoughton, Mass.), was used to assess yogurt's viscosity after 1, 10, and 20 days (Donkor *et al.,* 2007). Centrifugation was used to test the water retaining capacity (Parnell-Clunies *et al.,* 1986), and the material's cohesion, springiness, and hardness were assessed using a tissue analyzer (Joon *et al.,* 2017).

Determination of phenolic compounds: The total phenol content of the yogurt samples was determined by centrifugation procedure of 100 g of yogurt samples at 8000 rpm for 5 minutes at 4 °C, and under the same conditions, a mixture of 100 µL of yogurt extract with an equal volume of Folin-ciocalteu solution (1 mol/L) was prepared, and 300 µL of sodium carbonate solution (1 mol/L) was added to the mixture after incubation for 5 minutes. Then, 1 ml of distilled water was added to the solution obtained at room temperature. The absorbance was recorded at 760 nm

using a spectrometer (Ahmed *et al.,* 2021), and the results were reported as (µg) of gallic acid equivalent per (g) of the sample (mg GAE/100 G of the sample) (Kim *et al.,* 2019).

Determination of antioxidant activity: Following the procedure outlined by Demirci *et al.* (2017), the antioxidant activity of yogurt samples was assessed. This involved combining 100 µL of the extracted sample with 2 mL of diluted DPPH (IC50%), and then the mixture was allowed to sit at room temperature in the dark for 30 minutes. The absorbance was measured at 517 nm using an optical spectrophotometer, and the results were given as a percentage using the following equation:

$$Inhibition\ (\%) = Acontrol - Aextract / Acontrol \times 100$$

Viscosity: The method described by Donkor *et al.* (2007) was used to measure apparent viscosity, with a spindle used to number 4 and rotated at 10 rpm for 60 seconds; the results were recorded in the centipoise unit.

Whey separation: To determine the whey separation, the method described previously (Amatayakul, 2006) was used.

Sensory evaluation: After the experts have taken the approvals, the sensory evaluation of all yogurt treatments was evaluated by dairy experts, according to Ahmad (2015). The sensory evaluation is conducted on the first day of storage.

Statistical analysis: The SAS statistical analysis system was used to perform a statistical analysis of the collected data. To determine differences between averages, Duncan's multiple tests was used (Steel, 1997).

RESULTS

pH and acidity

Table (1) shows the pH and acidity values of the yogurt samples under study. It was noted that the pH values on the first day of storage decreased (increased acidity) by adding medicinal plant extracts. compared to the control sample (4.6). For the yogurt samples with added extracts (YM, YT, YE) the pH values were (4.5, 4.54 and 4.44), respectively.

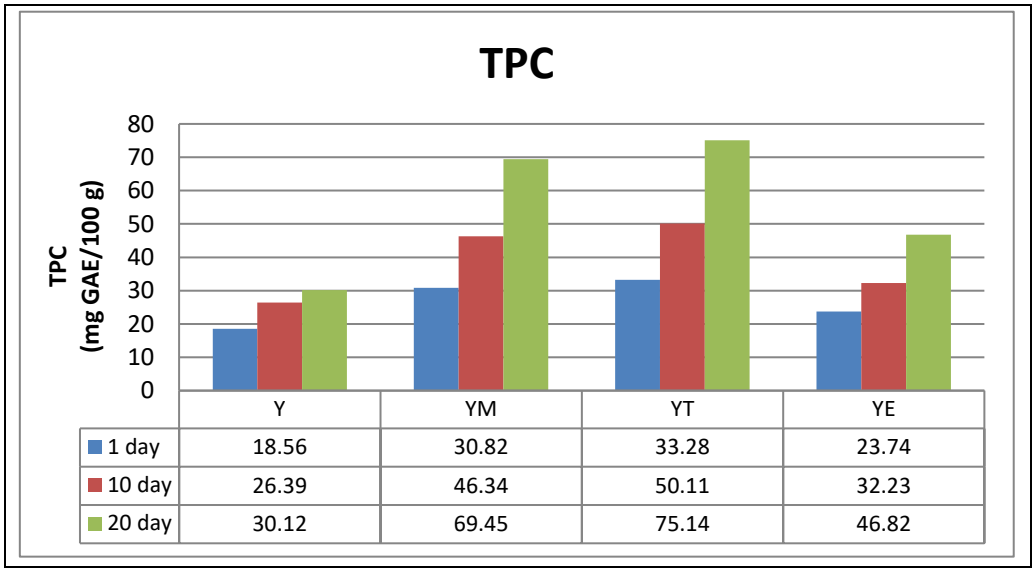
Table 1: pH and acidity values of yogurt samples during different storage periods

	yogurts	1 day	10 day	20 day
pH	Y	4.6a	4.51a	4.39a
	YM	4.50b	4.40b	4.23bc
	YT	4.54b	4.42b	4.30b
	YE	4.44c	4.31c	4.19c
acidity	Y	0.86c	0.96c	1.07c
	YM	1.02b	1.11b	1.18bc
	YT	0.97b	1.06b	1.13b
	YE	1.09a	1.19a	1.21a

*Different letters within the same column indicates a significant difference.
(Y) yogurt without any addition , (YM) yogurt with mint extract, (YT) yogurt with thyme extract, (YE) yogurt with *Eruca sativa* extract.

Total phenolic content (TPC)

Figure (1) shows the total phenolic compounds in the yogurt samples. They were (18.56, 30.82, 33.28, 23.74 mg GAE/100 g) for Y, YM, YT, YE samples, respectively. The high content of phenolic compounds in yogurt samples with medicinal plant extracts is due to the inclusion of these plants on high percentages of phenolic compounds. We also noted that the content of phenolic compounds in yogurt increased with the progress of the storage period up to 20 days. The highest phenolic percentage in the yogurt sample was in the thyme samples, reaching (75.14 mg GAE/100 g).

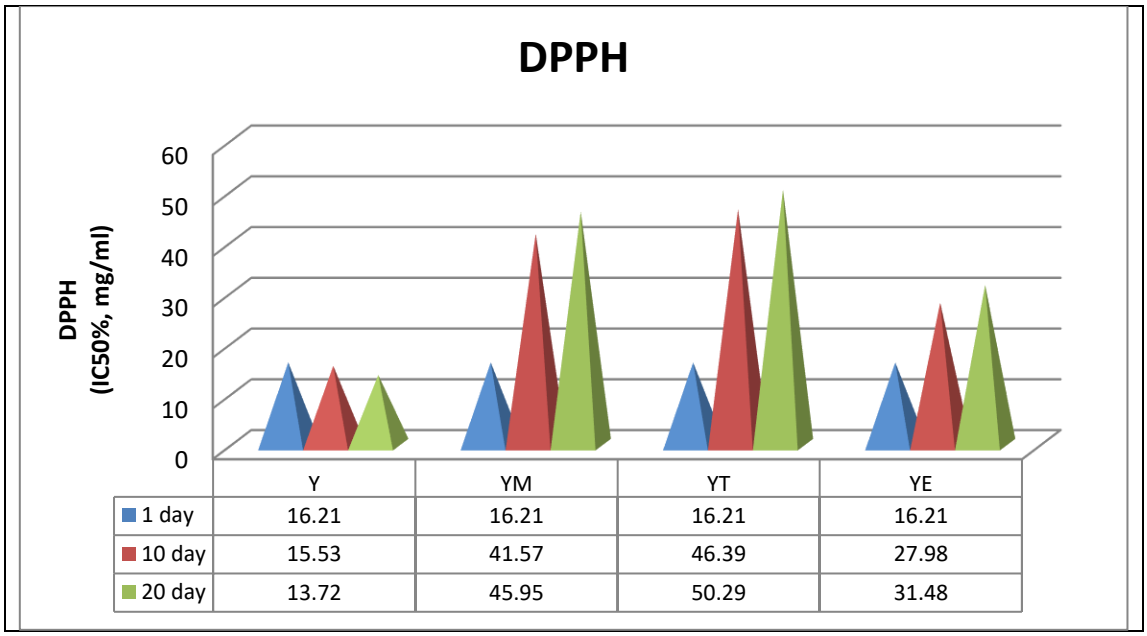


	Y	YM	YT	YE
1 day	18.56	30.82	33.28	23.74
10 day	26.39	46.34	50.11	32.23
20 day	30.12	69.45	75.14	46.82

Figure (1): Total phenolic content (TPC) of yogurt samples during the storage period. (Y) yogurt without any addition, (YM) yogurt with mint extract, (YT) yogurt with thyme extract, (YE)yogurt with *Eruca sativa* extract.

Antioxidant Activity

Figure (2) shows the percentage of antioxidants in different yogurt samples. The results of the antioxidant activity are associated with the total phenol content. All extracts groups demonstrated a higher percentage of antioxidants, compared to the control sample, and the yogurt with the thyme extract (YT) have the highest percentage (47.92) followed by mint yogurt (YM) (43.84), and then the yogurt with *Eruca sativa* extract (YE) (29.62) on the first day of storage. The levels of antioxidants for all groups decreased on the tenth day of storage. However, it increased on the last day of storage, and for all transactions.



	Y	YM	YT	YE
1 day	16.21	16.21	16.21	16.21
10 day	15.53	41.57	46.39	27.98
20 day	13.72	45.95	50.29	31.48

Figure (2): Antioxidant Activity (DPPH) of yogurt samples during storage period. (Y) yogurt without any addition, (YM) yogurt with mint extract, (YT) yogurt with thyme extract, (YE)yogurt with *Eruca sativa* extract.

Viscosity

Table (2) shows the results of the viscosity (Sentepoise) for different yogurt groups during the storage period. We note the existence of a moral difference (P≥0.05) for the added plant extracts, where the viscosity of samples (YM) (YT) (YT) decreased, compared to the control sample.

Table 2: Viscosity of yogurt samples during storage period

	yogurts	1 day	10 day	20 day
Viscosity (Centipoise)	Y	1330a	1420a	1570a
	YM	1110b	1265b	1380b
	YT	1125b	1240b	1345b
	YE	1120b	1250b	1360b

*Different letters within the same column indicate a significant difference.
(Y) yogurt without any addition, (YM) yogurt with mint extract, (YT) yogurt with thyme extract, (YE)yogurt with *Eruca sativa* extract.

Whey separation

Table (3) shows the amount of whey separation (ML/100GM) for different yogurt groups during the storage period, where a moral difference (P≥0.05) for the control sample compared to the groups with plant extracts, where the amount of the whey separated increased in YM YT YE groups, compared to the control sample. While on the 20th day of storage, the whey separated gradually decreased for all transactions compared to the first day of storage.

Table 3: Whey separation of yogurt samples during storage period

	yogurts	1 day	10 days	20 days
Whey Separation (ml/100gm)	Y	6.6a	5.4a	4.3a
	YM	8.8b	6.3b	5.1b
	YT	8.5b	6.6b	5b
	YE	8.6b	6.2b	5.4b

*Different letters within the same column indicate a significant difference.
(Y) yogurt without any addition, (YM) yogurt with mint extract, (YT) yogurt with thyme extract, (YE)yogurt with *Eruca sativa* extract.

Sensory evaluation

Table (4) shows the values of the sensory assessment for the different yogurt samples on the first day of manufacturing. We noted the existence of a disparity in the valuesobtained. In general, the best treatment is the control sample, then (YM), (YE), and the last was (YT).

Table 4: Sensory evaluation of yogurt samples during storage period

Sensory evaluation	Y	YM	YT	YE
Taste(10)	10 a	9.5ab	8b	9ab
Color(10)	9a	8b	7.5c	8b
Flavor (10)	9.5a	9ab	8b	7.5c
Aroma(10)	10a	9ab	8.5b	8b
Texture(10)	9a	8.5b	8.5b	8.5b
Overall preference(10)	9a	8.5ab	7.5c	8b

*Different letters within the same row indicate a significant difference. (1-2 Very bad, 3-4 bad, 5-6 acceptable, 7-8 good, 9-10 very good).(Y) yogurt without any addition, (YM) yogurt with mint extract, (YT) yogurt with thyme extract, (YE) yogurt with *Eruca sativa* extract.

DISCUSSION

The decrease in pH values and increased acidity is due to the high acidity of plant extracts (Saad *et al.,* 2021; Veloso *et al.,* 2020). The decrease in pH and the increased acidity with storage continued until day 20, might be due to the continued decomposition of lactose and the production of lactic acid (Saadi *et al.,* 2022).

It is possible that plant-specific phyto-chemical substances, including phenolic compounds and flavonoids, are responsible for the observed increase in phenolic compounds in yogurt treated with plant extracts (Akan *et al.,* 2021; Saadi *et al.,* 2024). Whereas the high total phenolic compounds TPC in the control yogurt during storage can be associated with the degradation of milk protein (Marand *et al.,*

2020). It may be also due to microbial activity on phenolic acids, which leads to the production of phenolic compounds (Kumar and Goel, 2019).

The level of antioxidants for all groups decreased on the tenth day of storage. However, it increased on the last day of storage. . The reason may be related to the high concentrations of certain materials from the vehicles during the storage or may return to the interactions that occur between some ingredients in the yogurt stored with oxygen or other components in the sample (Anese *et al.,* 2003). In addition, (Sawicki and Wiczkowski 2018) found that the more storage time with the presence of water activity leads to an increase in antioxidant activity.

The viscosity of (YM) (YT) (YT) samples decreased because plant extracts contain moisture. The viscosity increased on the 20th day for all samples, compared to the first day of storage, due to the increased loss of moisture with storing (Coggins *et al,*2010)

The amount of separated whey of (YM (YT) (YE) samples increased, compared to the control sample. The reason is that plant extracts contain a higher humidity, which raised the moisture content of the yogurt. While on the 20th day of the storage, the whey separated gradually decreased for all transactions compared to the first day of storage, which could be attributed to the increased loss of moisture with storing (El-Sattar *et al.,* 2017).

The sensory properties of food products determine the extent to which consumers admit food, and therefore, consumers' decisions are related to some food properties, such as appearance, color, consistency, smell, and flavor (Pereira *et al.,* 2021). The existence of a disparity in the values obtained might be because the consumers get used to the natural form without unusual additives. However, modern trends towards consuming dairy products are supported by medical evidence that helps increase the demand for healthy dairy consumption.

CONCLUSION

The use of medicinal plant extracts led to a slight increase in acidity, phenolic compounds, antioxidants, the quantity of the separate whey, while the viscosity decreased. The addition of mint to yogurt gave the best values regarding the sensory assessment.

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تأثير إضافة مستخلصات النعناع والزعتر والجرجير على بعض خصائص الزبادي الصحية

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شهد الطلب على منتجات الألبان الصحية ذات القيمة المضافة زيادة ملحوظة في الآونة الأخيرة. هدفت هذه الدراسة إلى تقييم تأثير إضافة مستخلصات بعض النباتات الطبية (النعناع والزعتر والجرجير) على بعض الخصائص الصحية والفيزيائية والكيميائية والحسية للزبادي. تم تحضير الزبادي من حليب البقر كامل الدسم وتقسيمه إلى أربع معاملات: عينة ضابطة (Y) بدون إضافات، وزبادي مع مستخلص النعناع (YM)، وزبادي مع مستخلص الزعتر (YT)، وزبادي مع مستخلص الجرجير (YE). تم تخزين جميع العينات عند ٤ درجات مئوية لمدة ٢٠ يومًا، وتم تحليلها في الأيام ١ و١٠ و٢٠. تم قياس الحموضة ومحتوى المركبات الفينولية ومضادات الأكسدة واللزوجة ومصل اللبن، بالإضافة إلى إجراء التقييم الحسي للمنتج النهائي. أظهرت النتائج انخفاضًا في قيم الرقم الهيدروجيني (زيادة في الحموضة) في العينات المضافة بالمستخلصات النباتية مقارنة بالعينة الضابطة خلال فترة التخزين. أدت الإضافة إلى زيادة ملحوظة في إجمالي محتوى الفينول ونشاط مضادات الأكسدة، حيث سجلت عينة الزعتر (YT) أعلى القيم، تليها عينة النعناع (YM). كما لوحظ انخفاض في اللزوجة وزيادة في كميات مصل اللبن المنفصل في العينات المدعمة، وخاصة في بداية التخزين. أظهر التقييم الحسي أن العينة الضابطة حصلت على أعلى التقييمات، تليها عينة النعناع (YM). ختامًا، حسّنت إضافة مستخلصات النعناع والزعتر والجرجير قيمة مضادات الأكسدة والمركبات الفينولية في الزبادي، على الرغم من تأثيرها على بعض الخصائص الفيزيائية والحسية، مما يُبرز إمكاناتها في تطوير منتجات ألبان وظيفية ذات قيمة أعلى.

الكلمات المفتاحية: زبادي، نعناع، زعتر، جرجير