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Effect of Sage Extract on Antioxidant Activity and Sensory Properties of Refrigerated Yogurt

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Abstract: Sage extract was created by researchers using a water solvent at extraction levels of 3%, 5%, 7%, and 10% before being added to lab-made yogurt. These yogurt test tubes were kept at 4°C throughout the 14 days. A laboratory test was conducted to determine the antioxidant activity of the components of the bioactive extract all of which performed better than the control. The plant's chemical analysis revealed that the extract contains active ingredients detected by high-performance liquid chromatography with antioxidant properties comparable to those of BHT and synthetic ascorbic acid. Previous phytochemical studies confirmed that sage contains active compounds with antioxidant potential, suggesting its possible application as a natural alternative to synthetic antioxidants such as BHT and ascorbic acid, and even outperforming ascorbic acid in DPPH radical scavenging tests. The value of sage extract was 81.85±0. 38. After storage, yogurt samples showed a significant increase in titratable acidity and a decrease in pH they reached (4.28±0.06, 4.34±0.07, 4.41±0.07, 4.56±0.08, 4.71±0.1) respectively immediately after manufacturing and increased at the end of the storage period for all treatments. The DPPH radical scavenging test showed that the addition of stage extract significantly enhanced yogurts antioxidant activity. Yogurt with the different sage extracts had better sensory qualities than the control treatment; the 5% extract treatment was the best. The efficacy of sage extract as a natural preservative was demonstrated by the fortified yogurt's ability to maintain acceptable quality and storage conditions for 14 days.

Keywords: Sage, antioxidant, yogurt, phenolic, cow milk.

Introduction

Yogurt is made by fermenting milk with *Streptococcus thermophilus* and *Lactobacillus delbrueckii subsp. bulgaricus* (Salmazo *et al.,* 2023). Yoghurt's flavor and health benefits have led to its steady growth in the global market (Onyeaka *et al.,* 2023). According to Badoni and Alenisan *et al.*, (2017), the product contains high-quality proteins along with linoleic acid fatty acids, as well as minerals including calcium, phosphorus, magnesium, and zinc, as well as a variety of vitamins. Oxidative stress is brought on by the balance between reactive oxygen species and reactive nitrogen species as well as cellular antioxidants. An imbalance in reactive oxygen species and reactive nitrogen

species leads to the development of degenerative diseases such as cancer, cardiovascular problems, Alzheimer's disease, and arthritis (Muscolo *et al.,* 2024). Due to several studies confirming their effectiveness in both medical preventative and therapeutic treatment applications, scientific research on antioxidants is still ongoing. According to Parcheta *et al.* (2021), chemical antioxidants must interact with reactive molecules and disrupt their production process in order to break free radicals. By eliminating ROS, stopping radical reaction chains, and using a variety of techniques to prevent the generation of radicals, several antioxidant actions of distinct antioxidant substances can protect cells (El-ssayad *et al.,* 2025). / According to research, the application of antioxidants in food processing will improve the nutritional value and therapeutic qualities of functional food items. In order to ascertain if medicinal and aromatic plants are suitable as food preservation agents that extend storage times without compromising product quality, contemporary scientific teams study them (El-Sayed & Youssef, 2019). Professionals throughout Asia and Latin America have long used sage (*Salvia officinalis*), a perennial plant native to the Mediterranean and Middle East, for both culinary and medicinal uses. Sage has a wide range of medical applications, including the treatment of ulcers, convulsions, rheumatism, gout, infections, and elevated blood sugar (Zalyhina, 2022). Sage distilled leaf can retain relevant quantities of bioactive compounds that are not removed with water steam, including phenolic acids, flavonoids, and terpenes [Šojić *et al.,* 2018]. Some polyphenols present in sage by-products, such as rosmarinic, salvianic, and salvianolic acids, can act as radical scavengers and metal chelating agents [Sánchez-Vioque et al., (2018). Sage's varied phytochemical makeup and health-promoting properties make it a viable food system element, according to recent studies. Through free radical scavenging tests, this study will evaluate the antioxidant capabilities of sage extract while also investigating its impacts on the sensory aspects of yogurt as well as its physical and chemical characteristics during the course of storage.

Materials & Methods

Milk Collection

The Department of Animal Production's Animal Field at the University of Basrah's College of Agriculture provided the fresh cow's milk. The milk was promptly sent to the lab for further processing in a sanitary environment. The components of the cow's milk used in the study were estimated using a Milkoflash device manufactured by the German company Gerber.

Preparation of Aqueous Sage Extract

The researchers washed fresh sage leaves with distilled water and then allowed them to dry for several days under a standard laboratory airflow. After complete drying, the leaves were ground in an electric grinder and then sieved through a fine sieve to obtain a homogeneous powder. After completing the volume, 100 grams of the powder was extracted into 1,000 ml of distilled water and heated with continuous stirring for five minutes. Before passing it through Whatman No. 1 filter paper, the mixture was allowed to reach room temperature. The researchers divided the extract into small portions and stored at -18°C until use in yogurt enrichment processes. Jordán *et al., (*2013).

Yogurt Preparation and Treatment Design

The milk was first heated to 90°C for 10 minutes before being cooled to 45°C to begin the procedure. Commercial starter cultures of *Streptococcus thermophilus* and *Lactobacillus delbrueckii subsp. bulgaricus* were introduced to the milk at a rate of 2% (v/v) during the manufacturing process. Within sterile containers, 40 mL sterile samples of inoculated milk were separated. Various amounts of sage extract were added to a solution according to the following treatment groups: **T1**: Control (milk + starter culture, no sage extract)

- **T2**: Milk + starter culture + 3% sage extract
- **T3**: Milk + starter culture + 5% sage extract
- **T4**: Milk + starter culture + 7% sage extract
- **T5**: Milk + starter culture + 10% sage extract

In the experimental setting, the samples were fermented for three hours at 37°C before being stored at 4°C for future assessment of antioxidant capability as well as physical and sensory quality features.

Estimation of Total Plate Count

The pour-plate method of (Neusely *et al.,* 2018) was followed, using Nutrient Agar, dissolving 28 $g.L^{-1}$, adjusting the pH to 7-7.2, and incubating at 32°C for 48 hours.

Estimation of Total Coliform Count: The pour-plate method of (Neusely *et al.,* 2018) was followed, using MacConkey Agar, dissolving 51.5 g/L, adjusting the pH to 7.2-7.4, and incubating at 37°C for 48 hours.

Estimation of Total Yeasts and Molds:

The pour-plate method of (Neusely *et al.,* 2018) was followed, using Potato Dextrose Agar, dissolving 42 g/L, and incubating at 22°C for 5 days.

Mannitol Salt Agar medium: The method of (Sperber and Tatini 1975) was followed, using Mannitol Salt Agar medium by dissolving 111 $g.L^{-1}$ of the medium to estimate the total number of Staphylococcus aureus bacteria.

Phytochemical Screening of Sage Extract

Standard qualitative techniques were used to evaluate the sage extract's primary bioactive compounds:

Glycosides: Found after Pratima *et al.* (2025) heated the extract in a boiling water bath for 10 minutes after combining equal amounts of the extract with Benedict's reagent; the presence of glycosides was confirmed by the production of a crimson precipitate.

Alkaloids: Identified using Mayer's and Dragendorff's reagents as per (Al-Daihan *et al.,* 2013). The appearance of an orange-red precipitate confirmed the presence of alkaloids.

Saponins: Determined Recognition of saponins occurred when the test tube extract received active shaking, which produced stable, persistent foam.

Coumarins: Assessed by the method of (Malik *et al.,* 1985) using UV light. A greenish-yellow fluorescence signified the presence of coumarins.

Phenols: Detected following (Samejo *et al.,* 2013) by adding hydrochloric acid to a mixture of 10% distilled water and 0.5 g of sage powder. A dark blue coloration indicated phenolic compounds.

Tannins: Identified using ferric chloride ($FeCl_3$) reagent as described by (*Yadav et*

al., 2025). A blue-black or greenish coloration indicated tannin presence.

Resins: Evaluated using the method of (Ehrnford *et al.,* 1980). Sage extract was mixed with 95% ethanol in a water bath, filtered after two minutes, and treated with distilled water and 4% hydrochloric acid. Turbidity confirmed the presence of resins.

Flavonoids: Detected according to (Samejo *et al.,* 2013) by mixing 0.5 mL of extract with 10 mL of ethanol, filtering the mixture, and adding drops of hydrochloric acid and magnesium. The appearance of a red color indicated flavonoids.

Analysis of extracts by GC-MS:

The sage precipitate's chemical composition was examined with a gas chromatograph-mass spectrometer (GC-MS). Injection volume: 1 µL, pressure: 11.933 psi, GC inlet line, temperature: 250 °C, auxiliary heaters: 300 °C, carrier gas: He 99.99%, GC dimensions: length 30 m × inner diameter 250 µm × film thickness 0.25 µm.

Determination of Total Phenolic Content

Folin-Ciocalteu was used to determine the total phenolic content (TPC) of the sage extract, with gallic acid as the reference material. A solution was prepared by combining 200 µL of Folin-Ciocalteu reagent, 100 µL of sage extract, and 1 mL of distilled water. Following ten minutes of incubation at room temperature, one milliliter of 10% sodium carbonate solution was added. For one hour, the mixture was allowed to stand at room temperature. The analysis was performed using a Beckman spectrophotometer set to 765 nm. The researchers carried out an experiment to measure the extract values in milligrams of gallic acid equivalents (GAE) per milliliter of solution.

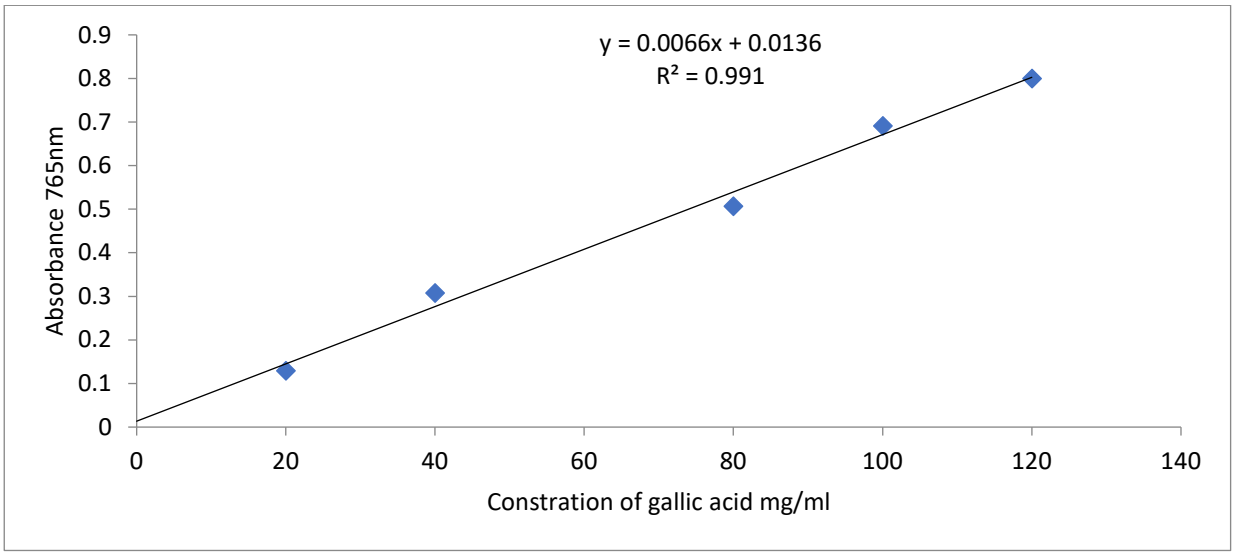

Fig. (1): Gallic acid concentration at 765 nm absorbance.

pH and acidity

The method described by Helrich (1990) was used to estimate the pH of yogurt. The acidity was measured. The pH was estimated by weighing 10 g of the sample and measuring with a pH meter, and estimate the pH using a pH meter.

Antioxidant activity

The ability of the solvents to chelate ferrous ions was evaluated using the method of Memarpoor-Yazdi *et al.,* (2013) with slight modification. In the chelation test, 200 µL of solvent solution (0.3 or 1 mg mL^{-1}) was mixed with 10 µL of ferric chloride (2 mM) and 600 µL of twice-distilled water. Next, 20 µL of ferrozine solution (5 mM) was added to the mixture and mixed vigorously for 2 minutes. The mixture was then kept at room temperature for 10 minutes. The color decrease resulting from Fe2+ chelation was recorded by measuring the absorbance at 562 nm:

$$Antioxidant\ Activity = 1- \frac{Sample\ absorbing\ reading}{The\ absorbing\ reading\ of\ control} X\ 100$$

DPPH free radical scavenging activity test

The following method was used to assess the free radical scavenging activity (DPPH) of sage extract in comparison to synthetic and natural antioxidants using the procedures outlined in AOAC (2016):

$$\text{AS\%} = 100\frac{1 - AC}{AD}$$

AC is the absorbance at 517 nm that contains the test sample including plant extracts or pure sample. AD is the absorbance at 517 nm of the control sample.

Sensory evaluation of yogurt

The Food Sciences Department panel comprised ten persons with dairy industry experience and completed the sensory evaluation of the yogurt product improved with sage extract. Yogurt samples were scored based on tissue, color, flavor, texture, and overall acceptability (Igbabul *et al.,* 2014).

Statistical analysis:

Data were analyzed using SPSS v.24. One-way and two-way ANOVA were applied, followed by Tukey's test to determine significant differences at $p<0.05$ (SPSS 2018). A two-way experiment used 5 treatments×3 storage periods (T1-T5 × 0, 7, and 14 days) in microbiological properties, pH, and acidity, Dpph and one-way experiment (4 treatments (BHT, Ascorbic Acid, Sage Extract)) was applied in the Antioxidant Effectiveness, total phenolic content, and sensory evaluation.

Results & Discussion

Chemical composition of milk:

The Chemical composition of cow's milk was investigated using data received from the College of Agriculture's Research Station and the morning milking station (Table1). After homogenizing the sample, Similar trends were reported by Mondini *et al.*, (2025), who observed comparable chemical composition in cow milk.

Table (1): Chemical composition of raw milk used in the study

Chemical Composition of Milk

Moisture %	Protein %	Fat %	Lactose %	Ash %
87.93	3.87	3.14	4.38	0.68

Microbial content

Table 2 shows total bacterial counts, coliform bacteria, Staphylococcus aureus, molds, and yeast in yogurt samples held at 5°C for 0, 7, and 14 days. The total bacterial count in the control samples grew from 6.16 CFU.g^{-1} yogurt at 0 days to 8.14 CFU.g^{-1} yogurt after 14 days, with all treated sample groups demonstrating a drop in total bacterial count relative to the control group by day 14. The control samples had higher coliform levels than the other yogurt treatments. As the storage days passed, it was obvious that the control group had the highest bacterial concentration, and as the sage extract concentration increased, the coliform content gradually dropped. There was no bacterial development of Staphylococcus aureus in the therapy groups at either 0 or 7 days. However, after 7 days of storage, S. aureus production increased to 2.37 CFU.g^{-1} in the control samples. However, the control group had a greater Staphylococcus aureus level (3.15 CFU.g^{-1}) than the mixed sage treatment groups. The reduction in fungal growth could be attributed to the phenolic compounds in sage, which possess strong antimicrobial properties. After 7 days, the control samples revealed fungal growth, and yeast and mold counts reached 2.21 CFU.g^{-1} after 14 days, but the treatment groups saw minimal levels of fungal growth, with T5 having the lowest level at 1.01 CFU.g^{-1} of any treatment. The result was similar to what Cedeño-Pinos *et al.,* (2023) found when they studied the effect of sage extract on microorganisms during the production of yogurt.

Table (2): Log of the total bacterial, coliform, Staphylococcus aureus, fungi, and molds in yogurt (mean ± standard deviation).

		Total count bacteria	Coliform	S. aureus	Yeasts and molds
T1	0	6.16±0.05	-	-	-
	7	7.12±0.03	2.26±0.06	2.37±0.03	1.58±0.02
	14	8.00±0.14	3.25±0.11	3.15±0.09	2.21±0.04
T2	0	6.16±0.05	-	-	-
	7	6.78±0.07	-	-	-
	14	6.84±0.08	2.22±0.05	1.18±0.03	1.07±0.01
T3	0	6.16±0.04	-	-	-
	7	6.72±0.07	-	-	-
	14	6.61±0.05	2.16±0.04	1.18±0.03	1.05±0.01
T4	0	6.16±0.04	-	-	-
	7	6.67±0.05	-	-	-
	14	6.59±0.03	2.14±0.04	1.14±0.03	1.03±0.01
T5	0	6.16±0.03	-	-	-
	7	6.63±0.04	-	-	-
	14	6.51±0.05	2.11±0.04	1.13±0.02	1.01±0.01

Active compounds in the Sage extract

Table 3 lists the biologically active compounds found in sage extract, including glycosides, alkaloids, saponins, coumarins, phenols, and resins, all of which were confirmed at high concentrations during qualitative tests based on the intensity of the color produced. Based on prior research, the findings were similar to

those of Ghorbang and Esmaeilizadeh (2017) and Levaya *et al., (*2025), as sage contains a wide range of phytochemicals, including phenols, as well as tannins and glycosides.

Table (3): Active compounds in sage extract

Active compound	Test Result
Glycoside	+
Alkaloid	+
Coumarins	+
Flavonoid	+
Saponins	+
Resins	+
Phenolic	+
Tannin	+

+ The presence of active compounds in sage extract
- The absence of active compounds in sage extract

The phenolic compounds in sage are displayed in the chromatogram in Figure 2. Eucalyptol (6.56 min), Thujone (8.08 min), Bornyl acetate (10.45 min), 4-Amino-3-hydroxybenzoic acid (11.36 min), Caryophylleneoxide (15.25 min), and Viridiflorol (15.41 min) were among the fifteen phenolic compounds that were discovered at 284 nm. 1-Naphthalenepropanol (21.15 minutes), 2-Pentadecanoic acid (18.43 minutes), n-Hexadecatrien-3-ol (19.59 minutes), 11-Octadecenoic acid (21.56 minutes), Oleic acid (22.06 minutes), Trimethylsilylestrone (24.03 minutes), Phenol (25 minutes), 5-Pregnen-3beta-ol-20-one (25.25 minutes), and 2-Phenanathrenol (26.55 minutes). Together with other significant ingredients including viridiflorol 5.1%, phenol 3.7%, and eucalyptol 3.2%, the sage extract also included 1-naphthalene propanol 20.9% and 4-amino-3-hydroxybenzoic acid 9.5%. A prior study [Alzawi *et al.,* 2022] that used high-performance liquid chromatography to identify the active chemicals in sage extracts of various species found that the acquired result was similar to what they found for 17–22 distinct compounds.

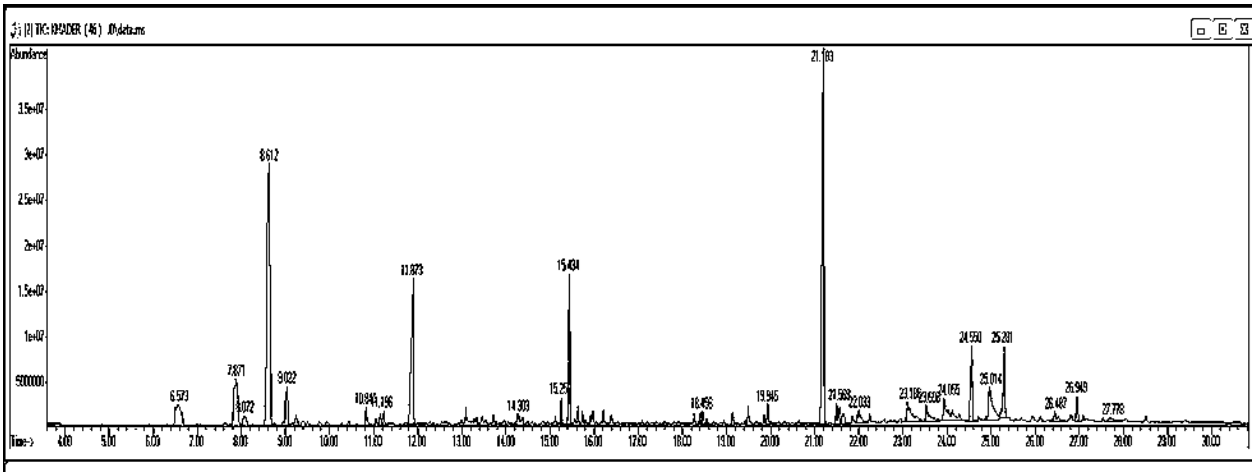

Fig .(2). HPLC profile of active compounds in sage extract

Table (4) Active comp**ounds in sage extract**

Peak	Chemical compound	Retention Time	Sage

number			Area%
1	Eucalyptol	6.56	3.2
2	Thujone	8.08	1
3	Bornyl acetate	10.45	0.7
4	4-Amino-3-hydroxybenzoic acid	11.36	9.5
5	Caryophylleneoxide	15.25	0.7
6	Viridiflorol	15.41	5.1
7	2-Pentadecanoic acid	18.43	1
8	n-Hexadecatrien-3-ol	19.59	0.9
9	1-Naphthalenepropanol	21.15	20.9
10	11-Octadecenoic acid	21.56	2
11	Oleic acid	22.06	2.1
12	Trimethylsilylestrone	24.03	3
13	Phenol	25	3.7
14	5-Pregnen-3beta-ol-20-one	25.25	3
15	2-Phenanathrenol	26.55	0.8

Oxidative activity of the sage extract

The sage extract's potent antioxidant qualities are demonstrated by the findings in Table 5. As demonstrated by their respective final lipid peroxidation inhibition rates of 88.21%, 92.32%, and 90.12%, the data showed no discernible difference in the antioxidant efficacy of sage extract, synthetic antioxidant BHT, and natural antioxidant ascorbic acid. According to Ngo *et al.*, (2010), the sage extract has a lot of hydrophobic amino acids that help stop the lipid matrix peroxide from being produced. Moreover, the inherent antioxidant properties of several amino acids, such as histidine, tyrosine, cysteine, and methionine, significantly strengthen the extract's effect (Lee *et al.,* 2025). Gong *et al*., (2025) state that the extract's bioactive peptides effectively inhibit lipid peroxidation in specific weight ranges between 3 and 5 kDa. The strong antioxidant properties of peptides containing two to ten amino acid residues may account for the extract's similar efficacy to that of traditional antioxidants (Fan *et al.,* 2012).

DPPH scavenging activity of sage extract

The considerable DPPH free radical scavenging activity displayed in Table 5 validates the strong anti-free radical qualities of sage extract. The extract's 81.85% radical scavenging performance was on par with that of ascorbic acid (76.69%) and BHT (83.44%). Sage has strong antioxidant properties because it contains phenolic compounds, namely flavonoids, tannins, and other related phytochemicals that have been shown to have the ability to scavenge radicals (Farnad *et al.,* 2014). According to the authors' research findings, phenolic-rich plant extracts exhibit comparable antioxidant capacities, as previously reported by Yüksel *et al.*, (2010). Sage's antioxidant capacity has been favorably correlated with its high levels of total phenolics, according to research in the literature (Ciobotaru *et al.,* 2025). Our investigation supports earlier findings by Mohamed Ahmed *et al.*, (2021) and Cho *et al.*, (2020) about the enhanced antioxidant qualities of yogurt that contains phenolic-rich extracts made from argel and olive leaves. Research supports sage extract's potential for application in the creation of functional foods as a natural antioxidant ag

Table (5): Antioxidant activity of the sage extract (Mean ± standard deviation)

Treatments	Antioxidant Effectiveness	DPPH%
BHT	92.32±0.23[a]	83.44±0.11[a]
Ascorbic Acid	90.12±0.14[a]	76.69±0.12[a]
Sage Extract	88.21±0.30[a]	81.85±0.38[a]

Total phenols content in yogurt

The total phenolic content of yogurt samples containing aqueous sage extract progressively rose at the divided concentrations in comparison to the control sample, as shown by the results in Table 6. The plant material is frequently blamed for variations in the polyphenol composition of extracts produced under comparable extraction conditions. It has been proposed that the phenological stage and geographic location of the treated plants may affect the polyphenol concentration of sage extracts. While the baseline value for the control sample was 45.7 μg.ml^{-1}, phenolic levels rose proportionately to the extract concentrations when sage extract was added to yogurt. At 3%, phenols were 47.33 μg m^{l}-1, at 5%, 48.54 μg ml^{-1}, and at 7% and 10%, 54.90 μg ml$^{-1.}$

Considering that high-performance liquid chromatography (HPLC) analysis of sage reveals a range of bioactive components and phenolic compounds, Table 3 shows how sage raised the phenolic content of yogurt samples. These findings were comparable to those of Cedeño-Pinos *et al.*, (2023), who investigated the impact of sage phenol concentration on yogurt production. When de Elguea-Culebras *et al.*, (2022) investigated the impact of phenols originating from plants on the manufacturing of specific products, they verified this. Sage exhibits encouraging effectiveness as a natural ingredient for enhancing the functional qualities of dairy products, according to these study findings.

Table (6): Effect of adding different concentrations of sage extract on the total phenols

Treatment	Total Phenolic Content (μg/ml)
T1	45.70±2.34
T2	47.33±2.38
T3	48.54±2.41
T4	51.34±2.58
T5	54.90±2.62

The pH and acidity

Table 7 data demonstrates that as the sage extract concentration rose, so did the yogurt samples' pH levels. The sample with 10% sage extract had the highest pH value of 4.71, whereas the control sample had the lowest pH value of 4.28. According to Bakry *et al.* (2019), the results demonstrate that the phenolic chemicals in sage extract alter the pH of food matrices. From its initial measurement of 4.46 to the seventh day, when it reached 4.53, the average pH value of the stored product decreased, and by the fourteenth day, it had dropped to 4.35. According to Pramanik *et al.* (2025), lactic acid bacteria produce more lactic acid as a result of their proliferation and metabolic activity during storage. According to Celik *et al.* (2006), regular yogurt storage lowers pH and increases acidity because *Lactobacillus delbrueckii subsp. bulgaricus* and *Streptococcus thermophilus* keep growing and

exploit the nutrients at hand to produce organic acids.

Table (7): pH values of yogurt enriched with concentrations of sage extract during 14-day Storage.

Treatment	1 day	7 day	14 day
T1	4.28±0.06	4.22±0.06	4.09±0.05
T2	4.34±0.07	4.25±0.06	4.11±0.05
T3	4.41±0.07	4.54±0.08	4.42±0.07
T4	4.56±0.08	4.79±0.1	4.50±0.08
T5	4.71±0.1	4.88±0.11	4.67±0.9
average	4.46±0.07	4.53±0.08	4.35±0.07

Total Acidity

Total acidity levels were found to differ between the yogurt samples with sage extract added and the control yogurt samples, as shown in Table 8. The pH of the control sample was 1.01 at production and rose to 1.12 at the conclusion of the 14-day storage period as the storage time increased. The total acidity of the yogurt samples with added sage extract peaked on day 7 and then again on day 14, indicating a considerable rise in acidity over the storage period. which included 14 days. In addition to the availability of nutrients required for the growth of these bacteria, this study and Celik et al. (2006) discovered a significant increase in the acidity of yogurt due to the increased production of organic acids, represented by lactic acid, caused by the activity of bacteria during the storage period. This consequence of a rise in pH was also caused by the decrease in phenol concentration over the storage time.

Table (8): acidity values of yogurt enriched with concentrations of sage extract during 14 day storage.

Treatment	1 day	7 day	14 day
T1	**1.01±0.021**	**1.04±0.022**	**1.12±0.026**
T2	**0.94±0.016**	**0.98±0.018**	**1.08±0.024**
T3	**0.91±0.013**	**0.96±0.017**	**1.00±0.02**
T4	**0.90±0.013**	**0.95±0.016**	**0.98±0.018**
T5	**0.83±0.01**	**0.90±**	**0.99±0.019**
average	**0.91±0.013**	**0.96±0.016**	**1±0.02**

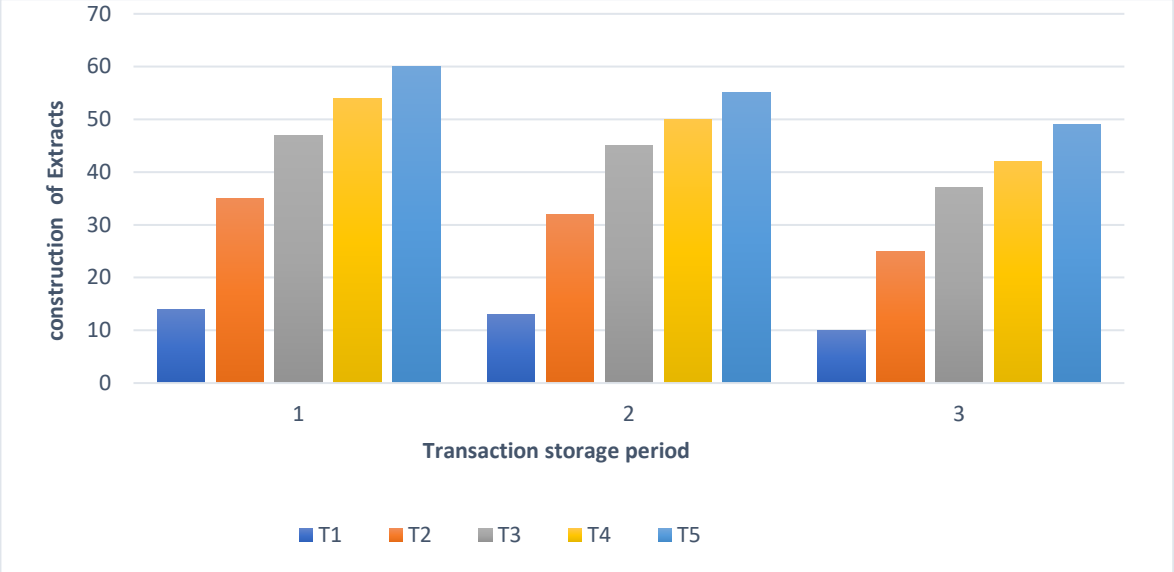

Fig. (3): The relation between concentration of extract (%) and time of storage period (day)

DPPH scavenging activity

Yoghurt's DPPH capacity to scavenge radicals was enhanced by sage extract treatment, as demonstrated by the results in Figure 3. While the control yoghurt retained the lowest scavenging effect with a value of 14%, the yoghurt fortified with 10% sage extract had the highest antioxidant activity throughout the first day of storage, achieving a scavenging rate of 60%. According to Amrani *et al.* (2019), the phenolic chemicals in sage extract have the ability to scavenge free radicals, which results in radical termination. The DPPH-transposed antioxidant activity dropped from 60% to 32%, 45%, 50%, and 55% in yoghurt with varying sage extract concentrations ranging from 3% to 10%. Antioxidant values decreased further among the various treatments to 25%, 37%, 42%, and 49%, according to measurements taken on day 14. Phenolic molecules appear to be degraded by the extended cold storage time, which lowers the samples' antioxidant activity. The results of a 14-day yogurt storage trial showed that enriched basil seeds initially reduced free radical scavenging activity, which is similar to what Kabir *et al.* (2021) found.

Sensory evaluation

According to Table 9 findings, the addition of sage extract to yogurt considerably changed its texture, consistency, color, and flavor. The fortified yogurt samples had higher sensory acceptance ratings than the control group. When comparing the sage-fortified yogurt to the control sample, consistency ratings revealed better results. The dosage of sage extract enhanced the yogurt's color and flavor ratings. According to a sensory review by a panel of specialists from the Department of Food Sciences, College of Agriculture, University of Basrah, treatment T3 fared better than the other treatments and the control group. The results of the study were comparable to those of Habib *et al.* (2019), who investigated the impact of adding sage extract to processed yogurt. The extract improved the sample's resistance to oxidation, resulting in superior results than the control sample. Evaluations of yogurt color, flavor, and general satisfaction on the fourteenth day of refrigeration revealed that the control sample significantly declined in comparison to the samples that received sage

concentrate. Compound deterioration during cold storage, which lowers antioxidant activity, is the cause of this quality decline. Yogurt's capacity to scavenge free radicals is greatly impacted by storage duration, which results in notable alterations to its sensory qualities. Thus, according to this study, sage extract may be a rich source of antioxidant components and may also increase the health advantages of yogurt that is made organically.

Table (9): The effect of adding different concentrations of sage extract on the sensory properties of yogurt.

Treatment	Period of stage	Tissue	Texture	Color	Flavor	Overall acceptability
T1	0	7.5±0.12	15±0.21	8±0.13	25±0.32	16±0.22
	7	6.5±0.06	14.5±0.2	7.5±	24.5±0.31	15.5±0.21
	14	6±0.05	14±0.2	7±0.1	24±0.31	15±0.21
T2	0	8.5±0.15	17.5±0.25	9±	27±0.33	18±0.26
	7	8±0.13	17.5±0.25	8±0.13	27±0.33	17.5±0.25
	14	7±0.1	17±0.24	7.5±0.12	25±0.32	17±0.25
T3	0	8.5±0.15	18.55±0.27	8.5±0.14	27.5±0.33	18.5±0.27
	7	8.5±0.15	18±0.26	8±0.13	27±0.33	18±0.26
	14	8±0.13	17.5±0.25	7.5±0.12	26±0.32	17.5±0.25
T4	0	8.5±0.14	18.5±0.27	8±0.13	27±0.33	18±0.26
	7	8±0.13	17.5±0.25	7.5±0.12	27±0.33	17.5±0.25
	14	7±0.1	17±0.25	7±0.1	25±0.32	17±0.25
T5	0	8.5±0.14	18±0.26	8±0.12	26±0.32	17.5±0.25
	7	7.5±0.12	18±0.26	7.5±0.12	25±0.32	17±0.25
	14	7±0.1	17±0.25	7±0.1	24.5±0.31	17±0.25

Conclusion

The numerous antioxidants found in sage contribute to the efficient elimination of free radicals, while also improving the texture and flavor of yogurt due to its antioxidant phenolic compounds. Incorporating sage extract into yogurt at varying concentrations has significantly enhanced its antioxidant capacity, microbiological stability, and sensory acceptability in terms of color, flavor, texture, and overall palatability. This highlights its potential as a natural preservative in the dairy industry.

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Contributions of Authors

E.K.N.: Collection of specimens, Suggestion the proposal of the article.

W.A.S.: Laboratory techniques, Suggestion the proposal of the article.

Z.A.A. : Suggestion the proposal of the article, Collection of specimens .

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Conflict of interest

The authors declare that they have no conflict of interests.

Ethical Approval

All ethical guidelines related to the dairy industry issued by national and international organizations were applied in this report.

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تأثير مستخلص المريمية كمضاد للأكسدة وتحسين الخواص الحسية للزبادي المبرد

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المستخلص: تم الحصول على مستخلص المريمية من قبل الباحثين باستخدام المذيب المائي بمستويات استخلاص 3٪ و 5٪ و 7٪ و 10٪ قبل إضافته إلى اللبن الرائب المصنع في المختبر. تم حفظ اللبن الرائب بالتبريد عند 4 درجات مئوية طوال فترة الخزن والبالغة اربعة عشر يومًا. تم إجراء اختبار لتحديد النشاط المضاد للأكسدة للمكونات التي يتكون منها المستخلص النشط بيولوجيًا والتي كان أداؤها جميعًا أفضل من مجموعة االمقارنة. كشف التحليل الكيميائي للنبات أن المستخلص يحتوي على مكونات فعالة تم الكشف عنها بواسطة كروماتوغرافيا السائل عالية الأداء ولها خصائص مضادة للأكسدة مماثلة لتلك الموجودة في BHT وحامض الأسكوربيك الصناعي. تفوق مستخلص المريمية على حامض الأسكوربيك في الاختبارات التي تقيس قدرته على التقاط جذور DPPH اذ بلغت قيمته لمستخلص الميريمية 81.85±0.38. كما زادت الحموضة الكلية وقيم الرقم الهيدروجيني لعينات اللبن الرائب بشكل ملحوظ وانخفضت بعد التخزين اذ بلغت (4.28±0.06 , 4.34±0.07, 4.41±0.07, 4.56±0.08, 4.71±0.1) على التوالي بعد التصنيع مباشرة وارتفعت في نهاية فترة الخزن لجميع المعاملات. أظهر اختبار التقاط الجذور DPPH أن خصائص مضادات الأكسدة في اللبن الرائب قد تعززت بشكل كبير بإضافة مستخلص المريمية. كما أظهر اللبن الرائب المُضاف إليه مستخلصات المريمية المختلفة خصائص حسية أفضل من مجموعة السيطرة، وكانت المعالجة بمستخلص 5% هي الأفضل. وقد أثبتت قدرة اللبن الرائب المُدعّم على الحفاظ على جودة وظروف تخزين مقبولة لمدة 14 يومًا كما اثبت فعالية مستخلص المريمية كمادة حافظة طبيعية.

الكلمات المفتاحية: المريمية، مضادات الأكسدة، الزبادي، الفينول، حليب البقر