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Microbiological evaluation of yogurt stored in different types of containers over various time periods

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I. ABSTRACT

From February 22, 2025, until September 10, 2025, this study was carried out at the labs of the University of Tikrit's Department of Food Science, which is connected to the College of Agriculture, and the Department of Chemical Engineering. In order to investigate the impact of storage in plastic, glass, and aluminum containers on the microbiological content of yogurt samples held for 1, 14, and 21 days, milk samples were collected from the Shirqat district.

According to the study's findings, samples kept in glass containers had the lowest microbial concentration, at 15.53 log CFU/ml, while samples kept in plastic containers had the highest microbial content, at 17.11 log CFU/ml. Plastic was determined to be better in terms of microbiological counts during the 14-day storage period, which had the highest microbial count across all treatments in the statistical comparison of storage durations. Additionally, a statistically significant difference ($p<0.05$) was found across the treatments; the treatment kept in glass jars had the highest lactic acid bacteria count (9,089 log CFU), whereas the treatments kept in plastic and aluminum containers had lower counts.

Additionally, the results revealed that samples kept in aluminum containers had the highest concentration of coliform bacteria (5.97 log cfu/ml), whereas those kept in glass containers had the lowest level of coliform bacterial contamination. The numbers in the plastic-stored sample were in the middle of the two previously described samples.
The results showed no growth in any of the samples after 1 day of storage. On day 14, however, the samples kept in plastic exhibited the greatest levels of mold and yeast, with levels of 2.27 and 1.78 log cfu/ml, respectively, followed by those kept in aluminum. Day 21 has the most content when comparing the findings across storage periods.

***Keywords**: yogurt, fermentation, Microbiological, Bacterial Count , Lactic Acid Bacteria.*

II. Introduction

Lactic acid bacteria play a significant part in the fermentation of milk, which gives yogurt its gel-like consistency. Yogurt is a fermented dairy product. It is prepared from cow's milk or any other nutrient-rich milk, and when the economy improves and people's purchasing power rises, it becomes the product of choice for many consumers. However, stress and anxiety increase when people follow good diets and

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balanced nutrition. However, the yogurt market may encounter several problems, such as increasing flavor, appearance, texture, and taste, and lowering.

The microorganisms Lactobacillus bulgaricus and Streptococcus thermophiles are used to make yogurt, a fermented dairy product. In terms of health advantages and nutritional value, it is a nutritionally complete food since it is full of vital minerals like calcium, which helps build bones and teeth, crucial vitamins like B2 and B12, hydrolyzed proteins, and physiologically active proteins. It is really well-liked by customers all across the world. (2). People with lactose sensitivity benefit from some nutrients in milk because they aid the bacterial cultures used in yogurt fermentation in converting lactose into glucose and galactose during digestion (3). For thousands of years, people have included yogurt in their diets, making it one of the first known fermented foods. Yogurt is a basic meal in the family diet and is consumed widely throughout the world, especially in Middle Eastern nations. Its significance stems from the fact that, in addition to being a useful way of supplying the human body with beneficial microbes (probiotics), it is not just a traditional food but also a component of the culinary and social culture (4).

III. Methods

Microbial Tests of Yogurt

The decimal dilution method was used to determine the microbial counts of samples kept in glass, plastic, and aluminum containers at 0, 14, and 21 days of storage. To create the first dilution, 1 mL of yogurt was weighed, 9 mL of sterile physiological saline was added, and the mixture was thoroughly shaken. The pour plate method was used to inoculate the remaining decimal dilutions, which were manufactured in the same way. (5).

Total Bacterial Count

The pour plate method was used to determine the total microbial count of the samples. A sterile pipette was used to transfer 0.1 mL of the sixth dilution to a Petri dish, which was then filled with sterile Nutrient Agar medium after chilling to 45°C. To guarantee even distribution, the plates were gently rotated in a figure-8 motion both clockwise and counterclockwise before being allowed to solidify. The number of growing bacteria was counted after the plates were inverted and incubated for 48 hours at 37°C (6).

Estimation Lactic Acid Bacteria (LAB)

After the medium was prepared and sterilized beforehand, 1 mL of the yogurt from the sixth dilution was put into a Petri dish and spread using the pour and spread technique on MRS agar (de Man, Rogosa, and Sharpe) to determine the total count of lactic acid bacteria (LAB). The sample was added to the plates after they had cooled without solidifying. To guarantee thorough mixing of the sample and medium, the plate was rotated in a circular motion both clockwise and counterclockwise after pouring. After then, the plates were allowed to harden. For a whole day, the plates were kept in an incubator at 37°C. Bacterial colonies were enumerated right away following the incubation period (7).

Estimation of Yeasts and Molds

The pour plate method on Malt agar was used to calculate the total number of yeasts and molds. After seven days of incubation at 25°C, the colonies on the inoculation plates were counted.

Estimation of Coliform Bacteria

The pour plate method on MacConkey agar was used to calculate the total coliform count in the samples. The developed colonies were counted after the plates were incubated for 48 hours at 37°C.

Statistical Analysis

The Complete Randomized Design (CRD) was used to examine the experimental findings. The statistical software package's General Linear Model (GLM) was utilized for analysis of variance (ANOVA) (8), and Duncan's test was employed for mean separation (9).

IV. Results

Total Bacterial Count in Yogurt Stored in Different Packaging Types During a Specific Storage Period

The results shown in **Table (4-1)** indicate significant differences (p≤0.05)(p \leq 0.05)(p≤0.05) in the **total bacterial count** (log CFU/mL)\left(\log \text{CFU}/\text{mL}\right)(logCFU/mL) of yogurt depending on the **type of packaging used**. The **plastic packages** recorded the highest mean value (17.11±1.20)(17.11 \pm 1.20)(17.11±1.20), followed by **aluminum packages** with a value of (16.29±0.99)(16.29 \pm 0.99)(16.29±0.99), while **glass packages** recorded the lowest value (15.53±0.89)(15.53 \pm 0.89)(15.53±0.89).

The table also shows a significant effect of **storage time** on the total bacterial count. At **day 1**, the value was (12.49±0.05)(12.49 \pm 0.05)(12.49±0.05), and it increased clearly by **day 14** to reach (18.98±0.47)(18.98 \pm 0.47)(18.98±0.47). In contrast, the count decreased relatively by **day 21**, recording (17.50±0.48)(17.50 \pm 0.48)(17.50±0.48).

Moreover, the results indicate that the interaction between packaging type and storage duration had significant effects on the total bacterial count. The samples stored in **plastic packages** recorded values of (12.47±0.13)(12.47 \pm 0.13)(12.47±0.13) on **day 1**, increased to (20.36±0.29)(20.36 \pm 0.29)(20.36±0.29) on **day 14**, and then decreased to (18.51±0.54)(18.51 \pm 0.54)(18.51±0.54) on **day 21**. For **aluminum packages**, the values were (12.54±0.05)(12.54 \pm 0.05)(12.54±0.05) on day 1, increased to (18.81±0.88)(18.81 \pm 0.88)(18.81±0.88) on day 14, and reached (17.52±0.19)(17.52 \pm 0.19)(17.52±0.19) on day 21. Meanwhile, the **glass packages** recorded values of (12.34±0.03)(12.34 \pm 0.03)(12.34±0.03) on day 1, increased to (17.78±0.28)(17.78 \pm 0.28)(17.78±0.28) on day 14, and then reached (16.48±1.18)(16.48 \pm 1.18)(16.48±1.18) on day 21.

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Table (1) Total bacterial count (log CFU/mL) in yogurt stored in different containers over a specified period of time

Type of effect			Characteristics
			Total bacterial count (log cfu/ml)
T	Plastic		17.11 ± 1.20 a
	Aluminum		16.29 ± 0.99 ab
	Glass		15.53 ± 0.89 b
Significant Levels			
Duration	1		12.49 ± 0.05 c
	14		18.98 ± 0.47 a
	21		17.50 ± 0.48 b
Significant Levels			
Interference	Plastic	1	12.47 ± 0.13 d
		14	20.36 ± 0.29 a
		21	18.51 ± 0.54 b
	Aluminum	1	12.54 ± 0.05 d
		14	18.81 ± 0.88 ab
		21	17.52 ± 0.19 bc
	Glass	1	12.34 ± 0.03 d
		14	17.78 ± 0.28 bc
		21	16.48 ± 1.18 c

*Lowercase letters within the same column indicate statistically significant differences (P < 0.05) between the effects of the treatments

*Different lowercase letters within the same column indicate statistically significant differences (P ≥ 0.05) between the effects of the treatments

Total Count of Lactic Acid Bacteria (LAB) in Yogurt Stored in Different Packaging Types Over a Specific Storage Period

The results in Table (2) indicate a significant effect (P≤0.05) of the type of packaging material, storage duration, and the interaction between them on the total number of lactic acid bacteria. Glass containers significantly outperformed others, recording the highest average (9.89 ± 0.72 log CFU/ml), followed by plastic containers (9.07 ± 0.53 log CFU/ml), while aluminum containers recorded the lowest values (8.41 ± 0.37 log CFU/ml). Regarding the effect of storage duration, the results showed a significant increase in bacterial counts on day 14 (10.92 ± 0.36 log CFU/ml) compared to day 21 (9.19 ± 0.33 log CFU/ml), while the lowest values were recorded on day 1 (7.26 ± 0.02) log CFU/ml. The interaction effect between container type and storage duration, the highest significant value was recorded when glass containers were used and on day 14 (12.17 ± 0.20 log CFU/ml), indicating that these conditions were most favorable for bacterial growth. The lowest values were recorded on day 1 in most treatments, particularly in

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aluminum containers (7.22 ± 0.04 log CFU/ml) and plastic containers (7.29 ± 0.05 log CFU/ml). A significant decrease was also observed on day 21, especially in aluminum containers (8.26 ± 0.13 log CFU/ml).

Table (2) Total count of lactic acid bacteria (log10CFU/mL\log \text{CFU}/\text{mL}logCFU/mL) in yogurt stored in different packages during a specified time period.

Type of effect			Characteristics
			Total count of lactic acid bacteria (log cfu ⁄ml)
T		Plastic	9.07 ± 0.53 b
		Aluminum	8.41 ± 0.37 c
		Glass	9.89 ± 0.72 a
Significant Levels			
Duration		1	7.26 ± 0.02 c
		14	10.92 ± 0.36 a
		21	9.19 ± 0.33 b
* Significant Levels			
Interference	Plastic	14	7.29 ± 0.05 f
		21	10.84 ± 0.20 b
		1	9.08 ± 0.50 d
		14	7.22 ± 0.04 f
		21	9.74 ± 0.16 c
	Aluminum	1	8.26 ± 0.13 e
	Glass	14	7.28 ± 0.04 f
		21	12.17 ± 0.20 a
		1	10.23 ± 0.20 bc
* Significant Levels			

*Lowercase letters within the same column indicate statistically significant differences (P < 0.05) between the effects of the treatments

*Different lowercase letters within the same column indicate statistically significant differences (P ≥ 0.05) between the effects of the treatments

Coliform bacteria counts in yogurt stored in different containers over a specific time period

The results in Table (3) indicate a significant effect (p ≥ 0.05) of both the type of packaging and the storage period, as well as the interaction between them, on coliform bacteria counts in yogurt. A clear difference was observed in the recorded values according to the type of packaging. Aluminum containers recorded the highest average coliform bacteria count (5.97 log CFU/ml), followed by plastic containers (5.60 log CFU/ml), while glass containers recorded the lowest values (5.20 log CFU/ml. Regarding the effect of storage period, the results showed a significant increase in coliform bacteria counts on day 14 (6.10 ± 0.21) compared to day 1 (5.11 ± 0.05), followed by a relative decrease on day 21 (5.56 ± 0.12). Regarding the interaction between packaging type and storage duration, the results showed that the

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highest value was recorded in aluminum containers on day 14 (6.85 ± 0.10), while the lowest value was in glass containers on day 1 (5.03 ± 0.03).

Table (3) Coliform bacteria count (ml/log cfu) in yogurt stored in different containers over a specific time period.

Type of effect			Characteristics
			Coliform bacteria count (ml/log cfu)
T		Plastic	5.60 ± 0.14 b
		Aluminum	5.97 ± 0.24 a
		Glass	5.20 ± 0.08 c
*			
Duration		1	5.11 ± 0.05 c
		14	6.10 ± 0.21 a
		21	5.56 ± 0.12 b
*			
Interference	Plastic	14	5.10 ± 0.10 d
		21	5.98 ± 0.11 b
		1	5.73 ± 0.06 b
		14	5.20 ± 0.10 cd
		21	6.85 ± 0.10 a
	Aluminum	1	5.87 ± 0.07 b
	Glass	14	5.03 ± 0.03 d
		21	5.46 ± 0.10 c
		1	5.10 ± 0.10 d
* Significant Levels			

*Lowercase letters within the same column indicate statistically significant differences ($P < 0.05$) between the effects of the treatments

*Different lowercase letters within the same column indicate statistically significant differences ($P \geq 0.05$) between the effects of the treatments

Yeast and mold counts in yogurt stored in different containers over a specified period

The results in Table 4 showed a significant effect ($P \leq 0.05$) of both the type of packaging material and the storage duration, as well as their interaction, on the counts of yeast and mold in yogurt, with values varying depending on the type of container and the storage period.

Regarding the effect of packaging material type, plastic containers recorded the highest value of (2.27 ± 0.57 log cfu/ml), followed by aluminum containers with a value of (1.78 ± 0.56 log cfu/ml), while glass containers recorded the lowest value of (0.33 ± 0.33 log cfu/ml). This is attributed to the fact that plastic containers have higher oxygen permeability compared to glass, creating a suitable environment for the growth of yeasts and molds, whereas glass is an insulating and inert material that reduces the chances of fungal contamination.

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As for the storage period, the results showed that yeast and mold counts were negligible on the first day, at (0.00 ± 0.00 log cfu/ml), then increased significantly by day 14 to reach (1.79 ± 0.57 log cfu/ml), and continued to rise by day 21, reaching (2.60 ± 0.50 log cfu/ml). This is attributed to the ability of yeasts and molds to grow under acidic conditions, in addition to the fact that the long storage period provides sufficient time for their proliferation, especially in the presence of oxygen.

As for the interaction effect between packaging type and storage duration, the results showed that the values were negligible on the first day for all treatments (0.00 ± 0.00 log cfu/ml), indicating good manufacturing quality and low initial contamination. By day 14, plastic containers recorded 3.26 ± 0.14 log cfu/ml and aluminum containers 2.10 ± 1.05 log cfu/ml, while values remained negligible in glass containers.

(0.00 ± 0.00 log cfu/ml) On day 21, plastic containers recorded (3.55 ± 0.07 log cfu/ml), aluminum containers (3.25 ± 0.13 log cfu/ml), while glass containers recorded a lower value of (1.00 ± 1.00 log cfu/ml).

*Lowercase letters within the same column indicate statistically significant differences (P < 0.05) between the effects of the treatments

*Different lowercase letters within the same column indicate statistically significant differences (P ≥ 0.05) between the effects of the treatments

Table (4) Yeast and mold counts (log cfu/ml) in yogurt stored in different containers over a specified period of time

Type of effect			Characteristics
			Yeast and mold counts log cfu ⁄ml))
T		Plastic	2.27 ± 0.57 a
		Aluminum	1.78 ± 0.56 a
		Glass	0.33 ± 0.33 b
* Significant Levels			
Duration		1	0.00 ± 0.00 b
		14	1.79 ± 0.57 a
		21	2.60 ± 0.50 a
* Significant Levels			
Interference	Plastic	14	0.00 ± 0.00 c
		21	3.26 ± 0.14 a
		1	3.55 ± 0.07 a
		14	0.00 ± 0.00 c
		21	2.10 ± 1.05 ab
	Aluminum	1	3.25 ± 0.13 a
	Glass	14	0.00 ± 0.00 c
		21	0.00 ± 0.00 c
		1	1.00 ± 1.00 bc
* Significant Levels			

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V. Discussion

Glass containers are more chemically inert and less permeable to gases than plastic materials, which helps minimize microbiological alterations within the food product during storage. This variation may be explained by the varied physical and chemical properties of packing materials. On the other hand, some kinds of plastic might provide a greater level of oxygen permeability, creating an environment that is comparatively conducive to the growth of microbes in fermented dairy products. These findings are in line with those of Anwar et al. (10), who discovered that the type of packaging material greatly influences the microbial counts in yogurt; samples kept in plastic containers had higher bacterial counts than those in glass containers because of variations in the barrier qualities against moisture and oxygen. According to Rasul et al. (11) The stability of microorganisms in fermented dairy products during storage is directly impacted by various packing materials.
This shift could be explained by the lactic acid bacteria's ongoing activity during the initial days of storage, since they continue to proliferate and expand by using the medium's nutrients, raising the overall bacterial population. However, the continuous fermentation process raises acidity and lowers pH, which may eventually restrict bacterial development and result in fewer germs in the later phases of storage. These findings align with those published by Zhang et al. (12) They clarified that the lactic acid bacteria's ongoing metabolic activity causes the total bacterial count in yogurt to rise during the first few days of storage before progressively declining as acidity rises and fermentation products build up. Additionally, Abdulrhman and Thalij (13) observed that bacterial counts in chilled yogurt can rise during storage before starting to fall because of unfavorable environmental conditions.

These findings suggest that the type of packing used has a significant impact on the effect of storage duration on bacterial counts, as glass containers maintained a relatively lower level of bacteria while plastic containers exhibited a bigger increase in bacterial counts compared to other containers. This could be explained by variations in the packing materials' capacity to stop the spread of light, oxygen, and other environmental elements that could have an impact on the product's microbial population. These findings align with a recent study that was published in the journal Frontiers in Nutrition. (14) Because the characteristics of packaging materials can greatly affect the growth of microbial populations during storage, this study showed that the interaction between the type of packaging material and the storage period is one of the key factors determining the stability of microbial populations in fermented foods.

This benefit of glass containers is explained by their chemical inertness, minimal reactivity with product components, and efficiency as a barrier against moisture and oxygen penetration, which keeps the atmosphere conducive to lactic acid bacteria growth. On the other hand, ion migration or interactions with acidity in metal containers may result in minor environmental changes that could restrict the survival of bacteria. The stability of microorganisms is directly impacted by the type of packaging, according to Ayyash et al. (15) and Ranadheera et al. (16), since low-permeability materials like glass retain more beneficial bacteria than other materials.

This can be explained by the fact that lactic acid bacteria continue to grow in the early stages of storage because lactose and nutrients are readily available, as well as because the initial pH is favorable. However, as organic acids like lactic acid accumulate and the pH drops, cellular stress and self-inhibition of growth result. These findings corroborate those of Sarkar (17) and Shori (18), who found that when acidity increases, lactic acid bacteria numbers peak halfway during storage and subsequently start to fall.

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According to Zhang et al. (19), bacterial viability decreases during refrigerated storage when pH drops to low values.

Overall, the findings show that sustaining large quantities of lactic acid bacteria requires choosing the right container material and managing storage conditions since glass offers a more stable environment than plastic and aluminum. Furthermore, since these bacteria are linked to the synthesis of bioactive chemicals and better digestion, a drop in bacterial counts at the end of the storage period may have a detrimental impact on the functional and nutritional qualities of yogurt. The vitality of lactic acid bacteria is a key predictor of the quality of fermented products, according to García-Burgos et al. (20). This is in line with their findings.

These findings can be explained by the fact that, in contrast to plastic and aluminum, which may permit oxygen penetration or surface reactions that lead to increased bacterial growth, glass is a chemically inert substance that is impermeable to gases and moisture, lowering the possibility of contamination and microbial growth. Additionally, certain kinds of plastic may get tiny scratches that encourage the growth of microbes. These results are in line with those of Sharma et al. (21), who discovered that there were fewer contaminating bacteria in yogurt kept in glass containers as opposed to plastic ones.

The accumulation of organic acids (like lactic acid) produced by lactic acid bacteria, which inhibits the growth of coliform bacteria over time, may be the cause of the subsequent decrease. This behavior can be explained by the fact that the increase in the early days of storage is due to the presence of conditions favorable for bacterial growth, such as humidity and temperature.

This result is in line with the findings of Aryana & Olson (22), who observed that the number of unwanted bacteria may rise at the start of storage before declining as a result of a pH reduction. Additionally, Oliveira et al. (23) verified that the growing acidity of yogurt restricts coliform bacteria's ability to survive during storage.

This implies that as the duration of storage rises, the impact of the packaging material becomes more noticeable because more permeable materials are more likely to become contaminated or to harbor bacteria. Additionally, glass containers' ability to preserve dairy products was demonstrated by the comparatively steady bacterial counts they maintained during the storage time. These findings suggest that the impact of the packaging material rises with longer storage times, since glass containers restrict fungal growth while other materials let it over time.

These findings are in line with those of Rashwan et al. (25), who verified that glass containers lower fungal growth and enhance the microbial stability of yogurt, and Akkerman et al. (24), who observed that storage duration and container type interactively influence the growth of microorganisms. The amount of yeast and mold in yogurt varies according to the type of container and the length of storage, as well as how these factors interact.

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VI. Conclusion

1. The samples kept in glass jars had the most lactic acid bacteria, whereas the yogurt samples kept in plastic containers had the fewest.
2. Over the course of the storage period, the quantity of coliform bacteria in yogurt kept in metal containers considerably increased in comparison to the other samples.
3. The findings indicated that while no mold or yeast growth was seen on the first day of storage, their presence was noted on the 21st day.

VII. Reference

1-Yu, Z., & Bradley, R. L. (2023). Sensory evaluation of yogurt: Current perspectives and future challenges. Journal of Dairy Science, 106(5), 3456–3470.

2-Shishir, M. R. I., Saifullah, M., Hashim, S. B., Aalim, H., Bilal, M., Khan, S., ... & Zou, X. (2024). Micro and nano-encapsulated natural products in yogurt: An emerging trend to achieve multifunctional benefits in product quality and human health. Food Hydrocolloids, 154, 110124.

3- Pei, R., Martin, D. A., DiMarco, D. M., & Bolling, B. W. (2017). Evidence for the effects of yogurt on gut health and obesity. Critical reviews in food science and nutrition, 57(8), 1569-1583.

4- Pena, F. L., Souza, M. C., Valle, M. C. P., Bezerra, R. M., Rostagno, M. A., & Antunes, A. E. (2021). Probiotic fermented milk with high content of polyphenols: study of viability and bioaccessibility after simulated digestion. International Journal of Dairy Technology, 74(1), 170-180.

5-5- Al-Sabaawi, Anas Saad, Khazal Shaban Al-Dally, and Adeba Younis Al-Nomaan. "Isolating and Identifying the Bacteria Pseudomonas fluorescens from Cheese and Studying its Effect on some Chemical Properties of Soft Cheese Contaminated with It." *IOP Conference Series: Earth and Environmental Science*. Vol. 1371. No. 6. IOP Publishing, 2024.

6- Wehr, H. M., and Frank, J. F. (Eds.). (2004). Standard methods for the examination of dairy products. Ignatius Press.

7- Fu, J., Shen, W., Bao, J., and Chen, Q. (2000). The decontamination effects of gamma irradiation on the edible gelatin. Radiation Physics and Chemistry, 57(3-6): 345-348.

8- SAS (2001). Version, Statistical Analysis System, SAS Institute Inc., Cary

9- Duncan, D. B. (1955). Multiple range and multiple F tests. biometrics, 11(1), 1-42.

10- Anwar, A., Faiz, M. A., Badar, I. H., Jaspal, M. H., & Hou, J. (2025). Influence of fermentation time and storage conditions on the physicochemical properties of different yogurt varieties using starter cultures and probiotic Lactobacillus rhamnosus GG. Processes, 13(3), 759.

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11- Rasul, S., et al. (2022). Roles of different packaging materials on the quality and shelf life of yogurt. Food Science and Technology.

12- Zhang, Y., et al. (2024). Influence of fermentation time and storage conditions on probiotic yogurt properties. Processes, 12, 759.

13-Abdulrhman, W. I., & Thalij, K. M. (2023). Determination of microbial contamination of yogurt during storage. EC Microbiology.

14- Frontiers in Nutrition. (2024). Effect of packaging materials and storage conditions on microbial stability of fermented foods.

15-Ayyash, M., Abu-Jdayil, B., & Itsaranuwat, P. (2020). Impact of storage conditions on probiotic viability in fermented dairy products. LWT - Food Science and Technology, 124, 109196.

16- Ranadheera, R. D. C. S., Evans, C. A., Adams, M. C., & Baines, S. K. (2024). Effect of bioprotective cultures on physicochemical properties of yogurt. Fermentation, 10(11), 585.

17- Sarkar, S. (2019). Microbiological considerations of yogurt. International Journal of Dairy Technology, 72(3), 327–339.

18- Shori, A. B. (2021). Influence of storage conditions on yogurt quality. Journal of Food Science and Technology, 58(6), 2050–2060.

19- Zhang, J., Liu, M., & Wang, Z. (2023). Categorizing food contaminants: From classical classification to integrated risk-based models. Critical Reviews in Food Science and Nutrition, 63(18), 2542–2559.

20- García-Burgos, M., Moreno-Fernández, J., & Alférez, M. J. M. (2020). New perspectives in fermented dairy products. Nutrients, 12(6), 1712.

21- Sharma, P., Bakshi, P., Kaur, R., Sharma, A., Bhardwaj, R., El-Sheikh, M. A., ... & Ahmad, P. (2023). Inoculation of plant-growth-promoting rhizobacteria and earthworms in the rhizosphere reinstates photosynthetic attributes and secondary metabolites in Brassica juncea L. under chromium toxicity. Plant and Soil, 483(1), 573-587.

22 Aryana, K. J., & Olson, D. W. (2021). A 100-Year Review: Yogurt and other cultured dairy products. Journal of Dairy Science, 104(7), 7067–7087.

23 Oliveira, M. M., et al. (2022). Microbial dynamics in fermented dairy products during storage. Food Research International, 154, 110995.

24- Akkerman, M., Logtenberg, M. J., Ananta, E., & van Impe, J. F. (2020). Effect of storage conditions and packaging on microbial growth in food products. International Journal of Food Microbiology, 328, 108–145.

25-Rashwan, A. K., Shaheen, M. S., & Abd El-Salam, M. H. (2023). Impact of packaging materials on the quality and shelf life of yogurt. Journal of Dairy Science, 106(4), 2450–2460.