



Effect of Soy-whey Formulations and Medicinal Plant Additives on the Storage Stability and Viability of *Lactobacillus rhamnosus* GG

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ABSTRACT

Background: *Lactobacillus rhamnosus* GG bacteria is a type of probiotic belonging to the Lactobacillus family; a beneficial bacteria found in the intestines. This study aimed to prepare soymilk from soybean seeds and to produce fermented milk using the probiotic bacteria *L. Rhamnosus* GG, supplemented with whey and some medicinal plants and to study the storage qualities.

Methods: In This study Different lactic ferments were prepared, including: Treatment soybean and whey, in which soybean milk and whey were used in different percentage (30, 50 and 70%) and the probiotic bacteria starter *Lactobacillus rhamnosus* GG was added to this treatments, with the addition of some medicinal medicinal plants such as garlic, mint and paprika at a rate of 1%. Also, lactic fermentation treatments were prepared for soybean milk only and bacteria of the probiotic *Lactobacillus rhamnosus* GG were added, along with the same proportions of medicinal medicinal plants. In addition, a control treatment was prepared, in which whole cow's milk was used, to which bacteria of the probiotic Rhamnosus GG was added with garlic, mint and paprika.

Result: It was noted that the pH value of all fermented products of the soy milk industry at the age of 1 day ranged between 4.64-4.31, in the pH range of the product's fermented soymilk was 4.41 to 4.64. They have recorded between 4.55 and 4.59 and the pH In caws milk fermented products decreased in all treatments after 24 days to 3.89-4.29. The count of *Lactobacillus rhamnosus* GG bacteria was between 3.65 and 6.02×10^8 CFU/g after 14 days. The increase of the numbers increased significantly after the review of 7 days of store in the treatments of the fermented products from soybeans milk. Since the numbers were 5.03 to 5.12×10^9 CFU/g at 7 days, while they ranged from 3.65 to 3.74×10^8 CFU/g after 14 days. One of the treatments produced by whole soybeans milk in different proportions and the results of cow's milk were at least lower in terms of the counts of these bacteria compared to the treatments produced by soy milk only. Results of the sensory evaluation of fermented products showed that all the treatments were the same Good sensory qualities and acceptable.

Key words: Dairy fermented products, Garlic, *Lactobacillus rhamnosus* GG, Mint, Paprika, Probiotic, Soymilk, Viability, Whey.

INTRODUCTION

Soybeans (*Glycine max*) belong to the legume family. They are classified as oilseeds and have been used in China for 5,000 years as a food and medicine. Soybeans are an important global food and industrial crop. They differ from other legumes in that they contain all eight essential amino acids humans require to synthesize protein. Therefore, they are an excellent source of complete protein. Soybean seeds are used to produce many food products, including tofu, miso, soynuts, tempeh, soy sauce, natto, okara, soybean milk, edamame and soy sprouts. Soybean proteins have also been used as alternatives in the cheese and meat industries (Golbitz and Jordan, 2006). Soybean milk is obtained by hydrolyzing whole soybean seeds and contains all the components of the soybean kernel, except for the removal of some fiber during the processing process (Elhalis *et al.*, 2024).

Lactobacillus rhamnosus GG bacteria is a type of probiotic belonging to the Lactobacillus family; a beneficial bacteria found in the intestines. Several probiotic strains exist, including *Lactobacillus rhamnosus* GG, which is used to treat various digestive disorders such as diarrhea, irritable bowel syndrome and inflammatory bowel disease.

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It can ferment sugars into lactic acid in the absence of oxygen, these bacteria can grow between 15 and 40°C at a pH level between 4.5 and 6.4 and is widely used in the fermentation of foods such as fermented milk, cheese, pickles, olives and sauerkraut, as well as in the fermentation of meat and fish (Milani *et al.*, 2017).

The increasing knowledge of the consumer about the roles of the food system in health has led to an increase in the demand for food that contains probiotics, including many and varied foods, including the use of some dairy

products, including fermented milk, ice cream, powdered milk and cheese, which are foods that deliver bio-probiotics to the consumer. Its additions to such foods are important to ensure the preservation of food and dairy products with the desired flavor, texture and nutritional value (Dimitrellou *et al.*, 2019). In fact, it is not possible to guarantee the required level of living cells and biological probiotics in many commercial dairy products. Therefore, it leads to the failure of the basic condition for the successful delivery of these services (Abesinghe *et al.*, 2020).

Xinhui *et al.* (2022) found that the combination of LAB and kombucha bacteria can significantly enrich the flavor and enhance the nutritional properties and antioxidant capacity of fermented soymilk and provide a new idea for the discussion and development of fermented soymilk and related fermented products based on medicinal plants. Because of the many health benefits of whole soymilk and the secondary product of cheese making and the beneficial bacteria, soymilk is the primary catalyst for beneficial bacteria. Therefore, this study aimed to prepare soymilk from soybean seeds and to produce fermented milk using the probiotic bacteria *L. Rhamnosus* GG, supplemented with whey and some medicinal plants and to study the storage qualities.

MATERIALS AND METHODS

Soybean seeds

The use of *Glycine max* L. seeds (Argentinian origin, class 74 Lee), which was obtained from Al-Sharjah markets in Baghdad has been used. Then, cleaning and eliminating impurities was done.

Extraction of soymilk

Soak 50 g of seeds in 500 ml of water, add 0.5 g of sodium bicarbonate per 100 ml of water, place in a container for 28 hours, then place in a water bath at 100°C for 15 minutes. Then, the pruning process was applied using an electric mixer for the seeds and added 4 parts of water to each part of the seeds to filter the solution after that and the Pasteurization process was used at 68°C for 30 minutes.

Medicinal plants additives

Garlic, paprika and mint in dried forms, which were obtained from local markets in Baghdad, have been used.

Preparation of treatments

The topic of preparation of treatments of lactic fermentation as in the following:

1. Soymilk (100%) was pasteurized at a temperature (85°C /15 min), after that cooled to 37°C and then added *Lactobacillus rhamnosus* GG bacteria as starter (5%), treated soymilk divided into 3 parts, add dried garlic to the first part by 0.5%, the second by adding paprika 0.5% and the third by adding mint also by 0.5%.
2. Whole Cow's milk and the treatments were prepared as mentioned in the section on preparation of soybeans milk treatments.

3. Soybeans milk treatments and 9 treatments have been prepared according to the different proportions of soybeans milk treatments: Soy milk: whey (30:70) and (50:50) and (30:70), then the whole treatments are divided into 3 types. Add 0.5% of garlic, paprika and dried mint each on one side and complete the manufacturing steps as mentioned with soy milk (100%). All treatments were stored at a temperature of 37°C for 3 hours, take them out later and keep them in the refrigerator at a temperature of 6°C for 24 days for the purpose of performing the required tests.

Chemical tests

The moisture content of 5 ml of soymilk and dried at a temperature of 105°C using an air oven until the weight is determined, the amount of alcohol nitrogen by the microcaldal method. The result is multiplied by the conversion factor of beans (5.7) to extract the total protein value. The determination of the fat percentage was done according to a method. The determination of pH using a pH-meter according to the method, measuring the total acidity of milk based on lactic acid by titration with 0.1% sodium hydroxide solution with the presence of phenolphthalein.

Activation of *Lactobacillus rhamnosus* GG bacteria: Empty the capsule of the commercially prepared *L- Rhamnosus* GG probiotic in 9 ml of MRS liquid culture medium (prepared by dissolving 28 g in 1000 ml of distilled water and autoclaving at 121°C for 15 minutes) and incubation at the temperature is 37°C for 24 hours and this process is repeated three times. Then, repeat all the steps mentioned with the use of prepared milk and adding 5% of the milk at the same temperature until coagulation and repeating the activation process three times to reach the desired action.

Microbiological analysis

The total number of *Lactobacillus rhamnosus* GG bacteria in various lactic acid fermentation treatments was determined using the standard plate counting method. One gram of each sample was taken and suspended in 9 mL of sterile peptone solution; the suspensions were then sequentially diluted 10-fold. The appropriate dilutions were transferred to Petri dishes after pouring a de Man Rogosa Sharpe (MRS) agar (prepared by dissolving 68.3 g in 1000 mL of distilled water and sterilizing with a steam sterilizer for 15 minutes at 121°C). The dishes were then incubated at 37°C for 48 hours, after which the colonies were counted according to the method described in Mathialagan *et al.* (2018).

Sensory evaluation

The sensory group of yogurt samples was conducted in the Food Science Department, College of Engineering Sciences, University of Baghdad, by a number of professors, with use of the evaluation template developed by Nelson and Trout (1964).

Statistical analysis

The Statistical Analysis System, User's Guide. Statistical program was used to detect the effect of different groups in

study parameters. Least significant difference-LSD was used to significant compare between means in this study (SAS, 2018).

RESULTS AND DISCUSSION

PH and acidity

All treatments in Table 1 show a clear decrease in the pH value and a corresponding increase in the total acidity percentage when moving from (1) day to (24) day of storage at 6°C. This effect is expected and common in fermented food products, especially those containing Lactic Acid Bacteria (LAB) such as *Lactobacillus rhamnosus* GG (Miller, 2021). *L. rhamnosus* GG bacteria continue their metabolic activity, albeit at a slower pace, during the cold storage period. The continued drop in pH (to about pH 4.08-4.30 in most treatments on day 24) is considered a positive indicator of high viability and the preservation of a sufficient count of probiotic colonies (*L. rhamnosus* GG) throughout

the storage period, which is vital for ensuring the product's health benefits.

Chemical structure

The results in Table 2 illustrate the changes in the fundamental chemical composition (Total Solids, Protein and Fat) of fermented products based on soy milk, cow's milk, or soy-whey blends, fortified with the probiotic *Lactobacillus rhamnosus* GG (R. GG) and medicinal plants (Garlic, Mint, Paprika), after 1 and 24 days of refrigerated storage. Decline in Total Solids (TS) and Protein a general and consistent trend across all treatments is a clear decrease in the content of total solids (TS) and protein from Day 1 to Day 24 of storage at 6°C. This is due to Lipolysis, the breakdown of fats (triglycerides) into free fatty acids by enzymes produced by the lactic acid bacteria (Brown, 2017; Vachhani *et al.*, 2023). These free fatty acids are crucial for the development of the final product's flavor and aroma (Miller, 2021).

Table 1: Effect of the storage period at 6°C on the pH and acidity of the therapeutic fermented product treatments by *Lactobacillus rhamnosus* GG and fortified with medicinal plants after 1- and 24-days storage period at 6°C.

Treatments	Trials	Storage period (day)	
		1	24
Soy+ R. GG + garlic	pH	4.64	4.14
	acidity %	1.85	2.30
Soy+ R. GG + mint	pH	4.44	4.24
	acidity %	1.77	2.20
Soy+ R. GG + paprika	pH	4.41	4.24
	acidity %	1.76	2.19
Milk + R. GG + garlic	pH	4.56	4.28
	acidity %	1.87	2.30
Milk + R. GG + mint	pH	4.59	4.29
	acidity %	1.76	2.19
Milk + R. GG + paprika	pH	4.55	4.25
	acidity %	1.82	2.30
Soy 30 + whey 70+ R. GG + garlic	pH	4.44	4.24
	acidity %	1.78	2.25
Soy 30 + whey 70+ R. GG + mint	pH	4.32	3.89
	acidity %	1.47	1.97
Soy 30 + whey 70+ R. GG + paprika	pH	4.31	4.10
	acidity %	1.72	2.21
Soy 50 + whey 50+ R. GG + garlic	pH	4.47	4.27
	acidity %	1.41	1.91
Soy 50 + whey 50+ R. GG + mint	pH	4.43	4.15
	acidity %	1.76	2.20
Soy 50 + whey 50+ R. GG + paprika	pH	4.42	4.08
	acidity %	1.70	2.20
Soy 70 + whey 30+ R. GG + garlic	pH	4.58	3.92
	acidity %	1.83	2.30
Soy 70 + whey 30+ R. GG + mint	pH	4.50	4.30
	acidity %	1.78	2.23
Soy 70 + whey 30+ R. GG + paprika	pH	4.32	4.16
	acidity %	1.72	2.21

This stability is likely due to the higher buffering Capacity of cow's milk proteins and the complex composition provided by whey, which may moderate the rate of microbial activity compared to a pure soy base. while, for effects of mint the mint extract treatment in the pure soy base (Soy + R. GG + mint) resulted in one of the most significant overall chemical declines (e.g., TS from 15.35% to 12.91%). This suggests that the bioactive compounds in mint (such as phenolics or essential oils) may be acting as prebiotics that strongly promote the metabolic and enzymatic activities of *L. rhamnosus* GG, accelerating the consumption of total solids (Chen and Li, 2022; Honkar and Hembade, 2026).

Microbiological analysis

Table 3 presents the viable cell count (CFU/g) of the probiotic strain *Lactobacillus rhamnosus* GG (R. GG) in various fermented products (Soy, Milk and Soy-Whey blends) fortified with medicinal plants (Garlic, Mint, Paprika) over a 24-day refrigerated storage period at 6°C. The results demonstrate two clear phases for probiotic survival across

all formulations: Initial Stability/Slight Increase (Day 1 to Day 7): Most treatments show stable or slightly increased *Lactobacillus rhamnosus* GG bacteria counts during the first week. This indicates that the refrigeration temperature (6°C) was not immediately lethal, allowing the bacteria to potentially undergo a slow adaptation phase or complete their delayed post-fermentation growth cycle due to nutrient availability, a gradual and expected decline in the viable count is observed after Day 7 storage period, reaching the lowest levels by Day 21.

The survival rate of (R. GG) is significantly influenced by the fermentation medium, Formulations based on Cow's Milk (Milk + R. GG + Garlic) generally exhibit the highest survival rates and best stability, maintaining counts often above 5.98×10^8 CFU/g until Day 14. This high stability is due to the high buffering capacity of milk proteins (casein), which effectively slow down the drop in pH thereby protecting the probiotic cells from acid stress. for the Soy-Whey Blends, The treatment (Soy 30 + Whey 70) also show excellent viability, often comparable to cow milk,

Table 2: Chemical composition of the therapeutic fermented product treatments by *Lactobacillus rhamnosus* GG and fortified with medicinal plants after 1- and 24-days storage period at 6°C.

Treatments	Storage period	Total solid%	Protein %	Fat %
Soy + R. GG + garlic	1	15.47	3.76	2.98
	24	13.91	3.35	2.66
Soy + R. GG + mint	1	15.35	3.73	2.95
	24	12.91	3.30	2.45
Soy + R. GG + paprika	1	15.32	3.70	2.91
	24	13.90	3.30	2.66
Milk + R. GG + garlic	1	14.85	3.60	2.85
	24	14.22	3.43	2.75
Milk + R. GG + mint	1	14.82	3.69	2.80
	24	14.20	3.41	2.70
Milk + R. GG + paprika	1	15.63	3.80	3.01
	24	14.25	3.60	2.66
Soy 30 + whey 70+ R. GG + garlic	1	14.44	3.49	2.74
	24	13.79	3.32	2.63
Soy 30 + whey 70+ R. GG + mint	1	14.85	3.60	2.85
	24	14.22	3.43	2.72
Soy 30 + whey 70+ R. GG + paprika	1	14.47	3.50	2.78
	24	13.13	3.15	2.50
Soy 50 + whey 50+ R. GG + garlic	1	14.45	3.49	2.77
	24	13.79	3.32	2.63
Soy 50 + whey 50+ R. GG + mint	1	14.94	3.86	2.87
	24	14.32	3.46	2.74
Soy 50 + whey 50+ R. GG + paprika	1	14.77	3.59	2.84
	24	13.92	3.36	2.66
Soy 70 + whey 30+ R. GG + garlic	1	15.63	3.71	2.94
	24	13.72	3.30	2.62
Soy 70 + whey 30+ R. GG + mint	1	15.40	3.64	2.89
	24	13.22	3.17	2.52
Soy 70 + whey 30+ R. GG + paprika	1	15.42	3.50	2.77
	24	14.41	3.48	2.66

demonstrating that the addition of whey protein significantly enhances the protective environment for the probiotic compared to pure plant-based systems, while just Soy treatments show slightly more variance, but still meet the minimum required level, indicating that (GG) is well-adapted to the soy matrix and can effectively utilize its nutrients and oligosaccharides.

Abdulkarem and Hasan (2022) found that a decrease in the number of microorganisms and significantly in soft cheese added to it with different concentrations (5, 10 and 15) of raw bacteriocin for *Lactobacillus bulgaricus* kg⁻¹ stock compared to the control treatment when the cheese was stored for 21 days. Usually, the function of bio-enhancing bacteria, especially *L. rhamnosus* GG, is to convert the lactose sugar present in milk or products to lactic acid and this conversion leads to a decrease in pH and an increase in corrective acidity. However, cold storage of soft cheese with bio-enhanced bacteria at a temperature of 6°C helps in reducing the vitality and growth of bio-enhanced bacteria

and lactose metabolism (Wahhab and Al-Mosowy, 2024; Hasan *et al.*, 2023). Meybodi *et al.* (2020) mentioned several factors that control the viability of bacteria in fermented dairy products, namely acidity, strain used, development conditions, incubation temperature, coagulation time and storage temperature.

Fermented products: (based on soy milk, cow's milk, or soy-whey blends)

Sensory analysis

The results of the sensory evaluation of the sensory properties of the fermented products showed that all the products had very good sensory qualities and the results were close to each other due to the variation of the degrees given to the quality of flavor between 39 and 45 degrees. However, the value of the quality is between 20-30 degrees from 30 degree and while reading the results, it finds that the highest degree of flavor quality was obtained by the fermented dairy treatment, which includes 50% soybeans

Table 3: Viability (log CFU/g) of *L. rhamnosus* GG in the therapeutic fermented product treatments during the 21 day storage period at a temperature of 6°C.

Treatments	Storage period (day)			
	1	7	14	21
Soy+ probiotic + garlic	3.53 × 10 ⁹	5.03 × 10 ⁹	3.65 × 10 ⁸	0.93 × 10 ⁸
	3.62 × 10 ⁹	5.12 × 10 ⁹	3.74 × 10 ⁸	1.02 × 10 ⁸
Soy+ probiotic + mint	3.60 × 10 ⁸	5.10 × 10 ⁸	3.72 × 10 ⁸	1.01 × 10 ⁷
	4.81 × 10 ⁸	9.31 × 10 ⁸	5.93 × 10 ⁸	3.23 × 10 ⁷
Soy+ probiotic + paprika	4.50 × 10 ⁸	4.00 × 10 ⁸	5.90 × 10 ⁸	3.21 × 10 ⁷
	4.70 × 10 ⁸	4.30 × 10 ⁸	5.91 × 10 ⁸	3.15 × 10 ⁷
Milk + probiotic + garlic	5.98 × 10 ⁸	6.70 × 10 ⁸	4.32 × 10 ⁸	2.62 × 10 ⁷
	8.00 × 10 ⁸	9.40 × 10 ⁸	6.02 × 10 ⁸	4.32 × 10 ⁷
Milk + probiotic + mint	7.90 × 10 ⁸	9.40 × 10 ⁸	6.02 × 10 ⁸	4.33 × 10 ⁷
	5.00 × 10 ⁸	6.50 × 10 ⁸	5.12 × 10 ⁸	2.40 × 10 ⁷
Milk + probiotic + paprika	5.27 × 10 ⁸	6.77 × 10 ⁸	5.39 × 10 ⁸	2.67 × 10 ⁸
	5.32 × 10 ⁸	7.82 × 10 ⁸	5.44 × 10 ⁸	2.72 × 10 ⁷
Soy 30 + whey 70+ probiotic + garlic	5.60 × 10 ⁸	7.10 × 10 ⁸	5.72 × 10 ⁸	3.00 × 10 ⁷
	5.80 × 10 ⁸	7.30 × 10 ⁸	5.91 × 10 ⁸	3.22 × 10 ⁷
Soy 30 + whey 70+ probiotic + mint	5.85 × 10 ⁸	7.35 × 10 ⁸	6.00 × 10 ⁸	3.30 × 10 ⁷
	3.53 × 10 ⁹	5.03 × 10 ⁹	3.65 × 10 ⁸	0.93 × 10 ⁸
Soy 30 + whey 70+ probiotic + paprika	3.62 × 10 ⁹	5.12 × 10 ⁹	3.74 × 10 ⁸	1.02 × 10 ⁸
	3.60 × 10 ⁸	5.10 × 10 ⁸	3.72 × 10 ⁸	1.01 × 10 ⁷
Soy 50 + whey 50+ probiotic + garlic	4.81 × 10 ⁸	9.31 × 10 ⁸	5.93 × 10 ⁸	3.23 × 10 ⁷
	4.50 × 10 ⁸	4.00 × 10 ⁸	5.90 × 10 ⁸	3.21 × 10 ⁷
Soy 50 + whey 50+ probiotic + mint	4.70 × 10 ⁸	4.30 × 10 ⁸	5.91 × 10 ⁸	3.15 × 10 ⁷
	5.98 × 10 ⁸	6.70 × 10 ⁸	4.32 × 10 ⁸	2.62 × 10 ⁷
Soy 50 + whey 50+ probiotic + paprika	8.00 × 10 ⁸	9.40 × 10 ⁸	6.02 × 10 ⁸	4.32 × 10 ⁷
	7.90 × 10 ⁸	9.40 × 10 ⁸	6.02 × 10 ⁸	4.33 × 10 ⁷
Soy 70 + whey 50+ probiotic + garlic	5.00 × 10 ⁸	6.50 × 10 ⁸	5.12 × 10 ⁸	2.40 × 10 ⁷
	5.27 × 10 ⁸	6.77 × 10 ⁸	5.39 × 10 ⁸	2.67 × 10 ⁸
Soy 70 + whey 50+ probiotic + mint	5.32 × 10 ⁸	7.82 × 10 ⁸	5.44 × 10 ⁸	2.72 × 10 ⁷
	5.60 × 10 ⁸	7.10 × 10 ⁸	5.72 × 10 ⁸	3.00 × 10 ⁷
Soy 70 + whey 50+ probiotic + paprika	5.80 × 10 ⁸	7.30 × 10 ⁸	5.91 × 10 ⁸	3.22 × 10 ⁷
	5.85 × 10 ⁸	7.35 × 10 ⁸	6.00 × 10 ⁸	3.30 × 10 ⁷

Table 4: Sensory evaluation of *Rhamnosus* GG bio-enriched fermented milk products and different flavors during the storage period of 24 days at a temperature of 6°C.

Treatments	Trials				
	Flavor (15°)	Texture (30°)	Acidity (10°)	External and color (10°)	Packaging with cover (10°)
Soy+ probiotic + garlic	39	23	10	10	5
Soy+ probiotic + mint	39	23	10	10	5
Soy+ probiotic + paprika	38	23	9	10	5
Milk + probiotic + garlic	45	28	10	10	5
Milk + probiotic + mint	44	28	10	10	5
Milk + probiotic + paprika	45	28	10	10	5
Soy 30 + whey 70+ probiotic + garlic	45	20	10	10	5
Soy 30 + whey 70+ probiotic + mint	43	20	10	10	5
Soy 30 + whey 70+ probiotic + paprika	45	20	10	10	5
Soy 50 + whey 50+ probiotic + garlic	44	28	10	10	5
Soy 50 + whey 50+ probiotic + mint	43	28	10	10	5
Soy 50 + whey 50+ probiotic + paprika	41	27	10	10	5
Soy 70 + whey 50+ probiotic + garlic	44	30	10	10	5
Soy 70 + whey 50+ probiotic + mint	43	28	10	10	5
Soy 70 + whey 50+ probiotic + paprika	45	25	10	10	5

milk and 50% whey milk. It is enhanced with probiotic *Rhamnosus* GG with the flavor of paprika. As well as, the treatment of fermented dairy products, which include soybeans milk by 30% and whey by 70%, *Rhamnosus* GG with the flavor of paprika also, which was similar to the degree obtained by the treatment of the positive control, which is 45 degrees. However, the highest degree of texture is achieved by the treatment of soybeans with a ratio of 70% and 30% of the whey with the flavor of garlic, which is 30 degrees and also similar to what was obtained with the treatment of control. Meanwhile, the degrees given for the attributes of packaging, cover, color, external appearance and acidity were the same in all treatments. They were 5, 10 and 10, of which 5, 10 and 10 degrees were used and there was no significant difference between them at the probability level ($p>0.05$) (Table 4).

CONCLUSION

The results confirm the success of all fermentation treatments in maintaining the therapeutic minimum for the probiotic, with *L. rhamnosus* GG counting in all formulations remaining well above 10^7 CFU/g (or equivalent in log form) until day 21 and continuing above the minimum required (10^6 CFU/g) until the end of the storage period. This indicates that the blending of the soy/whey matrices and the use of medicinal plants provide an excellent protective environment for the survival of this probiotic and the results of the sensory evaluation of fermented products showed that all the treatments were the same from good sensory qualities and acceptable.

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Disclaimers

The authors have responsible for the accuracy and completeness of information that provided, but do not accept any liability for any direct, or indirect losses resulting from the use of this content.

Conflict of interest

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REFERENCES

- Abdulkarem, K.A. and Hasan, S.K. (2022). Effect of addition of raw bacteriocin produced by *Lactobacillus delbrueckii* Sub-Sp. *bulgaricus* on soft cheese. *Iraqi Journal of Market Research and Consumer Protection*. **14(2)**: 90-102.
- Abesinghe, A.M.N.L., Priyashantha, H., Prasanna, P.H.P., Kurukulasuriya, M.S., Ranadheera, C.S. and Vidanarachchi, J.K. (2020). Inclusion of probiotics into fermented buffalo (*Bubalus bubalis*) milk: An overview of challenges and opportunities. *Fermentation*. **6(4)**: 121.
- Brown, R.T. (2017). Lipolysis and free fatty acid formation by lactic acid bacteria in fermented products. *European Journal of Lipid Science and Technology*. **119(9)**: 1700147.
- Chen, X. and Li, Y. (2022). Phenolic compounds from mint as prebiotic promoters for *L. rhamnosus*. *Food Chemistry*. **365**: 130545.
- Dimitrellou, D., Kandyli, P. and Kourkoutas, Y. (2019). Assessment of freeze-dried immobilized *Lactobacillus casei* as probiotic adjunct culture in yogurts. *Foods*. **8(9)**: 374.
- Elhalis, H., Chin, X.H. and Chow, Y. (2024). Soybean fermentation: Microbial ecology and starter culture technology. *Critical Reviews in Food Science and Nutrition*. **64(21)**: 7648-7670.

- Golbitz, P. and Jordan, J. (2006). Soyfoods: Market and Products. Soy Applications in Food. New York: CRC. pp. 1-21.
- Hasan, M., Meena, L.N., Krishnan, V., Rudra, G.S. and Dahuja, A. (2023). Impact of storage on probiotic viability, nutritional and sensory quality of fermented soymilk produced from different soybean varieties. *Legume Research*. **46(6)**: 721-727. doi: 10.18805/LR-5051.
- Honkar, A.S. and Hembade, A.S. (2026). Effect on physic-chemical quality of soymilk blended channa based sweetmeat by using natural coagulant. *Asian Journal of Dairy and Food Research*. **45(2)**: 215-218. doi: 10.18805/ajdfr.DR-1886.
- Mathialagan, M., Edward, Y.S.J.T., David, P., Senthilkumar, M., Srinivasan, M. and Mohankumar, S. (2018). Isolation, characterization and identification of probiotic lactic acid bacteria (LAB) from honey bees. *International Journal of Current Microbiology and Applied Sciences*. **7(4)**: 894-906.
- Meybodi, N.M., Mortazavian, A.M., Arab, M. and Nematollahi, A. (2020). Probiotic viability in yoghurt: A review of influential factors. *International Dairy Journal*. **109**: 104793.
- Milani, C., Duranti, S., Bottacini, F., Casey, E., Turrone, F., Mahony, J. and Ventura, M. (2017). The first microbial colonizers of the human gut: composition, activities and health implications of the infant gut microbiota. *Microbiology and Molecular Biology Reviews*. **81(4)**: 10-1128.
- Miller, C.K. (2021). Post-acidification and physicochemical changes in refrigerated fermented foods. *Food Control*. **130**: 108345.
- Nelson, J.A. and Trout, G.M. (1964). Judging Dairy Products. 4th Edn., IV EA. Olsen Publishing Co., Wilwaukee. pp. 357.
- SAS. (2018). Statistical Analysis System, User's Guide. Statistical. Version 9. 6th ed. SAS. Inst. Inc. Cary. N.C. USA.
- Vachhani, M.N., Ahuja, K.K., Thesiya, A.J., Hazra, T. and Ramani, V.M. (2023). Formulation, characterization and storage stability of prickly pear (*Opuntia ficus*) fruit and milk based fermented beverage. *Asian Journal of Dairy and Food Research*. **42(4)**: 535-540. doi: 10.18805/ajdfr.DR-2113.
- Wahhab, H.S. and Al-Mosowy, A.J. (2024). Effect of postbiotics and killed cells of *Lactobacillus acidophilus* bacteria on improving the storage properties of soft cheese. *In IOP Conference Series: Earth and Environmental Science*. IOP Publishing. **1371(6)**: 062023.
- Xinhui, P., Yi, L., Kunyu, R., Yanwei, L., Mengmeng, W., Aihua, Y., Tian, T., Peilong, L., Zhaoxian, H., Huan, W. and Lianzhou, J. (2022). Fermentation performance, nutrient composition and flavor volatiles in soy milk after mixed culture fermentation. *Process Biochemistry*. **121**: 286-297.