Original Research Article

Enhancing Yogurt Functionality through Enrichment with Cow and Soy Milk: Production and Quality Evaluation

Abstract

Yoghurt is a fermented dairy product produced from cow's milk. Soybeans are abundant, reasonably priced, and high in protein, so there has been some work done to use them to make more pleasant and acceptable food products.Although many people eat cow's milk yoghurt, others who are lactose intolerant or follow a plant-based diet could find it incompatible. However, in comparison to regular yoghurt, soy milk yoghurt does not always live up to customer expectations regarding flavor and texture, even though it is nutritionally sound. The difficult part of making yoghurt is creating a recipe that combines the health advantages of soy milk with the desired sensory attributes of cow milk yoghurt.

In the current investigation, soy milk was added to the milk of cows. The final soybean yoghurt was assessed about post-acidification modifications.The primary aim of this research is to improve the nutritional value and functioning of yoghurt by the addition of a blend of soy and cow's milk.

In keeping in mind yogurt is made out of cow milk and soy milk. Cow milk is rich in protein, calcium, vitamin D, and Potassium. Soy milk is rich in vitamins A, B, and proteins. The yogurt made out of this may have various health benefits. The study blended cow and soy milk in various proportions to create different yogurt formulations. The treatments were as follows: T1: Soy milk (200ml) without cow milk, T2: Cow milk (200ml) without soy milk, T3: [Cow milk (100ml) + Soy milk (100ml)], T4: [Cow milk (120ml) + Soy milk (80ml)], T5: [Cow milk (80ml) + Soy milk (120ml)], T6: [Cow milk (160ml) + Soy milk (40ml)], and T7: [Cow milk (40ml) + Soy milk (160ml)]. These formulations were tested to achieve a high-quality blended yogurt that is both nutritious and flavorful.Combining soy and cow's milk to enhance yoghurt is a viable way to satisfy the nutritional requirements of a wider range of customers, including those who have lactose intolerances or who choose plant-based diets. According to the study's findings, soy milk-enriched yoghurt is a competitive and enticing product on the market since it maintains the good aspects of regular yoghurt while also offering increased nutritional value. Optimising the ratio of cow to soy milk and gauging long-term customer acceptability are two potential areas for future study.

Keywords: Yogurt, cow milk, soy milk, enhancing.

1. Introduction

Milk is fermented with microorganisms to create yogurt, a dairy product. Although other bacteria can be added for varied flavors and health advantages, the most often utilized strains of bacteria are Lactobacillus bulgaricus and Streptococcus thermophilus. Lactose, or milk sugar, is fermented by these bacteria to produce lactic acid, which gives yogurt its thick consistency and tart taste. Yogurt can be eaten plain or flavored, and it's frequently used as a dessert, snack, or component of other recipes. It's also high in probiotics, good bacteria that help support intestinal health, protein, and calcium consumed (Penna, et al.,2015).

Yogurt is a probiotic. Probiotics reduce cell proliferation, It appears crucial to utilize probiotic microorganisms to cure and prevent intestinal dysbiosis, which raises the number of SCFAs in the colon (Kopec,.p and Slizewska,.k.,2020). S. thermophilus and L. bulgaricus interaction is one of the main factors that decide the fermentation process at the end of yogurt quality. This interaction accelerates the acidification, aroma volatiles, and non-metabolic volatiles in yogurt for good quality or organoleptic quality of yogurt (Yulianto, W. A., et al 2022). Yogurt eating has been linked to health advantages including antihypertension, anti-inflammatory, anti-oxidant, and anti-cancer (Gouda et al., 2021)

The process of lactic acid fermentation serves as the foundation for creating yogurt and other fermented beverages. Changes in milk proteins during and after fermentation and process parameters (temperature, duration, mechanical factors, such as stirring, pumping, and aeration) all affect the final gels' physical and structural characteristics (Tribby, D., & Teter, V. 2023).

To meet the rising demand for products without animal byproducts, unique plant-based foods, and beverages have been created and put on the market recently. Milk and dairy products have long been thought of as a category of food that contains vital nutrients for human nutrition that are rarely, and in the same proportions, found in other foods. However, those who have health issues caused by a diet high in cholesterol, lactose intolerance or malabsorption, or an allergy to milk proteins, should consume alternate products (Montemurro.M et al.,2021). Because milk contains proteins, carbs, minerals, and vitamins, it is commonly regarded as a healthy diet. Yoghurt has a similar nutritional profile to milk, from which it is formed (Rashwan. A. et al., 2023).

Protein, polysaccharides, and lipids are all part of the complex gel system that makes up yogurt. It is made from milk through fermentation, one of the earliest processes used by humans to turn milk into goods with a long shelf life. Yogurt is a well-balanced diet that contains 0–3.5% fat, 5–6% protein, 4.6–5.2% lactose, and minerals such as calcium (Ca; 0.12–0.14%), phosphorus (P; 0.09–0.11%), sodium (Na), potassium (K), magnesium (Mg), iron (Fe), copper (Cu), and zinc (Zn). Additionally, this dish gives consumers a variety of vitamins, such as vitamins A, B6, B12, and C (Dan. T et al.,2023). Fermentation is a metabolic process that converts carbohydrates, such as sugars and starches, into alcohol or organic acids using microorganisms like bacteria, yeast, or fungi. In the case of probiotic fermentation, the microorganisms involved are typically beneficial bacteria that confer health benefits when consumed (Tsafrakidou et al., 2020).

There is a substantial study vacuum concerning the combination of both forms of milk in yoghurt manufacture, despite the fact that many studies have examined the functional qualities and health advantages of yoghurt prepared from either cow's milk or soy milk alone. Combining soy with cow's milk can have synergistic effects on yoghurt that may improve its texture and sensory qualities, increase microbial activity, and improve its nutritional profile. The ideal ratios, the circumstances of fermentation, and the effect on customer acceptability, however, are yet unexplored fields. By methodically examining the enrichment of yoghurt with both cow and soy milk and evaluating the ensuing changes in its functional qualities, this study aims to close this gap.

This study attempts to investigate how adding different amounts of soy and cow milk to yoghurt affects its qualitative characteristics and manufacturing process. The objective of this study is to offer insights into the viability of manufacturing a functional yoghurt with improved health benefits and consumer appeal by analysing the physicochemical qualities, sensory attributes, and nutritional content of the enriched yoghurt. Knowing how soy and cow's milk work together to produce yogurt might help create a unique functional food product that appeals to a wide range of current customers' dietary demands and tastes.

Typical cow milk yoghurt is healthful, but it lacks the benefits of soy milk, such a greater protein content and micronutrients derived from plants. Customers are becoming more and more in need of dairy alternatives that meet dietary needs including lactose intolerance and vegetarianism. Creating a yoghurt that combines the benefits of soy and cow milk while maintaining the desirable texture is the aim of this research.

1.1 Review of Literature:

Yogurt is a versatile dairy product enjoyed by many for its creamy texture and tangy taste. Its nutritive advantages and mouthwatering flavor are the main reasons for its appeal. Protein, calcium, and probiotics—beneficial microorganisms that support gut health—are all found in abundance in yogurt (Shah, N. P.2017). Yogurt comes in a variety of forms: Greek yogurt, normal yogurt, Icelandic yogurt (Skyr), and plant-based substitutes including almond or coconut yogurt. To accommodate a range of dietary requirements and tastes, each variety has a slightly distinct taste and texture (Ankiewicz, W. et al.,2023).

Yogurt flavors vary widely; you may get plain yogurt, fruit-flavored yogurt, or decadent dessert-inspired yogurts like chocolate or caramel (Aryana, K.et al.,2021). Some love pre-flavored yogurts for their convenience, while others like the simplicity of plain yogurt, which can be personalized with toppings like honey, oats, or fresh fruit (Albala, K. 2023).

Yogurt's texture varies depending on the fat level and straining method; it might be creamy and smooth or thicker and more substantial (Lange, I.,et al., 2020). Regular yogurt tends to be smoother and lighter in texture, but Greek yogurt is renowned for its thick and creamy consistency .

2. Materials:

Cow milk: The complex biological fluid known as cow milk is highly nutritious. Its makeup changes somewhat based on breed, nutrition, and stage of lactation.

Soy milk: Soy milk, often referred to as soybean milk or soymilk, is a plant-based beverage made by pulverizing and soaking soybeans, then straining the resulting mixture to remove the liquid. For people who are allergic to dairy, lactose intolerant, or who live a vegan lifestyle, it is a well-liked substitute for dairy milk.

2.1 Method:

Raw cow milk and soy milk

Milk Heating

Cooling

Inoculation

Mixing

Fermentation

Cooling and Storage

Chart 1: Flow chart showing fermentation process

Raw cow milk and soy milk:

Several things need to be taken into account while making yoghurt by combining soy and cow's milk to have the right texture, flavour, and nutritional makeup. Verify that the soy milk is free of thickeners or stabilizers that may interfere with the fermentation process and the finished texture. Cow milk contributes to a smoother, creamier texture due to its higher fat content.

Heating of milk:

One important stage in making yoghurt is heating the milk. It's hot enough to make the milk 180°F (82°C). This is usually kept up for thirty minutes, while other techniques could recommend a little bit less time. Lactoglobulin, the main protein found in whey, is denatured by heat, which aids in the formation of a stable gel during fermentation of the milk proteins (casein). Lowering the number of unwanted bacteria that could compete with the yoghurt culture, guarantees a more regulated and predictable fermentation process(Dash.et al., 2022)

Cooling of milk:

To guarantee the ideal conditions for the yoghurt cultures to flourish, chilling milk after heating it for yoghurt manufacturing is an essential step. Steer clear of abrupt temperature changes. The final texture of the yoghurt and the milk proteins might be impacted by abrupt temperature fluctuations (Khan, I. T., Nadeem. et al.,2020).

Yogurt inoculation:

The process of inoculating milk to produce yoghurt entails the introduction of certain bacterial cultures. A tiny quantity of a live bacterial starting culture should be added. Lactobacillus bulgaricus and Streptococcus thermophilus are the most often utilized microbes. A freeze-dried bacterial culture or a commercial yoghurt containing live cultures can be used as the starter(Sharma, A. et al., 2019).

Mixing:

To ensure that the starting cultures are evenly distributed throughout the milk throughout the yogurt-making process, mixing is an essential step following inoculation. To guarantee that all of the bacteria are incorporated into the milk, it must be well stirred after adding the starting culture. Large-scale manufacturing can use mechanical mixers, or small batches can be done manually with a sterile whisk or spoon. The idea is to create a homogenous mixture in which every bacterium has equal access to the nutrients in the milk.

It is essential to keep the area hygienic during the mixing procedure. To avoid the introduction of undesirable bacteria that may contaminate the yoghurt or stop the growth of the starter cultures, sterilized tools and containers should be used, and the procedure should be carried out in a clean environment.

Gently mixing is important. An excessive amount of air may be included in the mixture by vigorous mixing, which might alter the yogurt's texture. The culture is dispersed uniformly without absorbing air when it is gently mixed.

Fermentation:

Through the metabolic process of fermentation, microbes like bacteria transform carbohydrates (such as sugars) into organic acids, gases, or alcohol. Lactic acid bacteria (LAB) are the main microorganisms that cause fermentation during the making of yoghurt.

Throughout four to six hours, the infected milk is maintained at a steady 43°C (110°F). Lactic acid is created when lactose is broken down by the lactic acid bacteria during this time.

Yoghurt gets its texture and tart taste from the coagulation of milk proteins, mostly casein, which results from the creation of lactic acid, which lowers the pH of the milk. Yoghurt usually finishes with a pH of 4.5 to 4.7. The yoghurt retains its tangy flavour and is helped to maintain this acidic environment (Li, C., et al., 2017).

Cooling and storage:

The yogurt's fermentation is stopped by cooling it after the appropriate acidity and texture are reached. For texture preservation and longer shelf life, quickly cool food to 7°C (45°F) or below. Transfer the yoghurt to the fridge when it has firmed up (make sure it's still consistent). Let it cool completely, at least for two hours, before serving.

PROCEDURE:

The yoghurt was made by heating soy and cow milk in varied proportions in a sterilized utensil to 180°F (82°C), which helped to denature the proteins and thicken the mixture. When the milk reached a temperature of around 110°F (43°C), it was heated. The beginning culture was well mixed and swirled for uniform culture dispersion at such temperature. To get the required tartness and consistency, transfer the mixture into jars or a container and incubate it at a constant warm temperature of around 110°F for 4 to 12 hours. Chill the yoghurt to solidify and preserve it once it has been incubated.

2.2 Treatment details: Cow milk and soy milk were blended together with different formulations this process is done to achieve a high quality blended yogurth both in taste and in nutrition

Table 1: proportion of the cow milk and Soy milk

Treatments	Cow milk(ml)	Soy milk(ml)
T1	-	200
T2	200	-
T3	100	100
T4	120	80
T5	80	120
T6	160	40
T7	40	160

2.3 Sensory Analysis:

Sensory evaluation of samples of yogurt made from cow milk and soy milk was carried out by a panel of 20 semi-trained judges. The panelist was given samples and asked to evaluate the samples for colour, texture, taste, aroma, and overall acceptability by using a 9-point hedonic scale (Annexure I) for each attribute in each product (Amerine et al., 1965).

3. Result and Discussion

The table below presents data on the sensory assessment of yoghurt and demonstrates the noteworthy impact of various treatments on the sensory characteristics of yoghurt with varying concentrations. For each yoghurt, the average overall acceptability (OAA) score varied from 7.65 to 8.20, with T_2 scoring the highest at 8.30 and T_6 is scoring the lowest at 7.65.

The colour scores fall between 7.64 and 8.57. The colour grade for treatment T_5 is the highest. T_2 and T_6 are just behind. The lowest colour rating is T_7. The scores for texture vary from 7.66 to 7.97. The texture ratings of treatments T_2 and T_4 are the highest, and treatment T_7 is the lowest.. From 7.65 to 8.36 are the flavour ratings. T_7 is rated as having the least taste, while T_2 has the top score.

Aroma ratings range from 7.53 to 7.92. T_7 has the lowest aroma rating, while T_3 has the highest rating. The overall evaluation ratings range from 7.65 to 8.20. T_7 has the lowest overall rating, while T_2 has the highest rating

Table 2 :Effect of soy milk and cow milk addition on the sensory characteristics of yogurt

Treatment	Colour	Texture	Taste	Aroma	Overall Acceptability
T1	8.02 ± 0.11^{a}	7.90 ± 0.10^{ab}	7.90 ± 0.10^{abc}	7.60 ± 0.30^{a}	7.94 ± 0.17^{b}

T2	8.18±0.13 ^{ab}	7.97±0.31 ^{b}	8.36±0.33 ^{c}	7.58±0.26^{a}	8.20±0.19 ^{a}
T3	7.93±0.30 ^{a}	7.73±0.34 ^{ab}	7.74±0.18 ^{ab}	7.92±0.13 ^{a}	7.85±0.14^{a}
T4	7.81±0.14^{ab}	7.92±0.13 ^{b}	7.73±0.20 ^{ab}	7.80±0.40 ^{a}	7.86±0.21 ^{b}
T5	8.57±0.10 ^{ab}	7.83±0.20 ^{ab}	8.22±0.32 ^{bc}	7.68±0.28 ^{b}	8.00±0.13 ^{b}
T6	8.31±0.30 ^{ab}	7.73±0.20 ^{ab}	7.98±0.22 ^{bc}	7.57±0.23 ^{b}	7.65±0.25 ^{a}
T7	7.64±0.13 ^{a}	7.66±0.21^{a}	7.65±0.20 ^{ab}	7.53±0.10 ^{a}	7.86±0.20 ^{a}

The highest titratable acidity is observed in T_7 with a value of 1.25±0.02%, indicating a stronger acidic nature compared to other treatments. The lowest titratable acidity is found in T_1, measuring at 0.72±0.05%, suggesting a milder acidity. Mid-range values for titratable acidity include T_2 (0.90±0.02%), T_3 (0.97±0.01%), T_4 (0.76±0.01%), T_5 (1.15±0.02%), and T_6 (1.18±0.02%). The difference between the highest and lowest values is 0.53%.

The pH values across the treatments indicate varying levels of acidity. The highest pH is recorded in T_1 at 4.60±0.40, suggesting it is the least acidic. Conversely, T_4 has the lowest pH value of 4.27±0.24, indicating the highest acidity. Other treatments fall within the mid-range, including T_2 (4.44±0.03), T_3 (4.34±0.03), T5 (4.56±0.02), T_6 (4.28±0.01), and T_7 (4.62±0.01). The range difference between the highest and lowest pH is 0.33.

The highest total phenolic content is found in T_5, with a value of 1.91±0.02%, indicating a rich presence of phenolic compounds. The lowest value is observed in T_3 at 0.55±0.05%, indicating the least presence of phenolic compounds. Mid-range values include T_1 (1.36±0.16%), T_2 (1.80±0.01%), T_4 (1.33±0.03%), T_6 (1.70±0.04%), and T_7 (0.51±0.01%). The difference between the highest and lowest values is 1.36%.

The highest total flavonoid content is recorded in T_7 at 8.98±0.08%, indicating a substantial presence of flavonoids. The lowest content is found in T_2 at 7.03±0.02%, suggesting the least presence of flavonoids. Mid-range values include T_1 (9.80±0.01%), T_3 (8.92±0.05%), T_4

(7.83±0.01%), T_5 (9.23±0.48%), and T_6 (7.86±0.21%). The range difference between the highest and lowest values is 1.95%.

The highest total soluble solids content is observed in T_2 at 1.36%, indicating a higher concentration of dissolved solids. The lowest value is found in T_4 at 0.45%, suggesting a lower concentration of dissolved solids. Other treatments fall within the mid-range, including T_1 (0.69%), T_3 (0.73%), T_5 (0.56%), T_6 (0.48%), and T_7 (0.78%). The difference between the highest and lowest values is 0.91%.

Table 3 – Analysis of developed new product

Treatments (T)	Titratable acidity (%)	pH	Total phenolic content (%)	Total Flavanoid content (%)	Total soluble Solids (%)
T_1	$0.72±0.05^{a}$	$4.60±0.40^{a}$	$1.36±0.16^{bA}$	$9.80±0.01^{bc}$	0.69
T_2	$0.90±0.02^{a}$	$4.44±0.03^{a}$	$1.80±0.01^{bB}$	$7.53±0.02^{aA}$	1.36
T_3	$0.97±0.01^{a}$	$4.34±0.03^{a}$	$0.55±0.05^{aA}$	$8.92±0.05^{aB}$	0.73
T_4	$0.76±0.01^{a}$	$4.27±0.24^{a}$	$1.33±0.03^{bA}$	$7.83±0.01^{bA}$	0.45
T_5	$1.15±0.02^{a}$	$4.56±0.02^{a}$	$1.91±0.02^{bc}$	$9.23±0.48^{aB}$	0.56
T_6	$1.18±0.02^{b}$	$4.28±0.01^{b}$	$1.70±0.04^{aB}$	$7.86±0.21^{b}$	0.48
T_7	$1.25±0.02^{b}$	$4.62±0.01^{a}$	$0.51±0.01^{aA}$	$8.98±0.08^{aB}$	0.78

4. Conclusion

Cow milk, a traditional ingredient in yoghurt, is rich in protein, calcium, vitamin D, and B vitamins, offering complete proteins and beneficial probiotics. However, it also contains cholesterol and saturated fats. With changing dietary preferences, soy milk has emerged as a popular alternative. This thesis will explore the differences and similarities between cow milk and soy milk yoghurt. While cow milk yoghurt is nutrient-dense and probiotic-rich, soy milk yoghurt provides its own health benefits, including being cholesterol-free. Future research should aim to optimize the fermentation process for soy milk yoghurt and examine its long-term health effects. Yogurt's texture may be altered by mixing soy and cow's milk, giving it a creamier, thicker consistency. Soy proteins contribute to improved gel formation during fermentation.Fermentation Process: Because the protein profiles in the mix complement one another, it may shorten the time it takes for yoghurt to set.

Blending soy and cow's milk together to make yoghurt is a good way to improve its taste and reach a wider audience. The study finds that the enhanced yoghurt upholds premium criteria for acceptability, taste, and texture. The dairy sector may see new avenues for research and business prospects as a result of this breakthrough in yoghurt manufacturing, which might give rise to a new class of functional dairy products targeted at customers with dietary restrictions and health concerns.

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