Journal of Food Technology, Safety, and Sustainability, 2026, Vol. 1, No. 2, pp. 45-52
E-ISSN : 3163-7027, www.journal.unesa.ac.id/index.php/jftss

JOURNAL OF FOOD TECHNOLOGY, SAFETY, AND SUSTAINABILITY

The Effect of Starter Culture Addition on Cow's Milk and Plant-Based Milk Bases in Yoghurt Production

Muhamad Abdul Hafif*, Muhammad Ahyar Rusandi, Almalia Fajerin, Mareta Syahfon Naeni
Department of Food and Agricultural Products Technology, Faculty of Food Security, Universitas Negeri Surabaya, Surabaya, Indonesia

*Corresponding Author : 25142154029@mhs.unesa.ac.id

Article history:
Submitted 15 October 2026
Revised 21 October 2026
Accepted 25 October 2026

Keywords:
Cow's Milk Yoghurt;
Fermentation;
Lactic Acid Bacteria;
Plant-Based Yoghurt;
Starter Culture;

ABSTRACT

Yoghurt is a fermented product resulting from the activity of lactic acid bacteria and is recognized as a functional food with probiotic benefits. Conventionally, yoghurt is made from cow's milk; however, the growing demand for plant-based products has encouraged the development of soy milk-based yoghurt as a lactose-free alternative. Differences in substrate composition between cow's milk and plant-based milk affect starter culture performance and the quality of the resulting yoghurt. This literature review aims to analyze and compare the effect of starter culture addition on the microbiological, physicochemical, sensory, and functional characteristics of cow's milk-based and plant-based yoghurts, particularly soy milk. The method used was a literature study of accredited national journal articles published between 2015 and 2025 that discussed yoghurt fermentation using lactic acid bacteria and/or probiotics. The results show that cow's milk yoghurt has better gel stability, moderate viscosity, relatively stable pH, and consistent lactic acid production owing to the presence of lactose and casein. In contrast, plant-based yoghurt shows higher viscosity, protein content, and bioactive compounds such as isoflavones, but is more sensitive to variations in starter concentration, potentially causing excessive acidity and syneresis. The type and concentration of the starter culture and the fermentation conditions play an important role in determining yoghurt quality on both bases. Therefore, optimization of the starter culture and fermentation parameters is required to produce high-quality yoghurt, especially in plant-based formulations, in order to achieve a balance between probiotic viability, functional value, and consumer acceptance.

INTRODUCTION

Yoghurt is a coagulated dairy product resulting from the fermentation of lactic acid bacteria (LAB) that is widely recognized as a probiotic functional food. Conventionally, yoghurt is produced from cow's milk using a symbiotic starter culture of *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus*, which work protocooperatively to produce lactic acid and form the characteristic sensory properties (Surono, 2016). Recent developments show increasing demand for plant-based products, especially soy milk, because they are lactose-free and therefore safe for people with lactose intolerance, and because their isoflavone content acts as an antioxidant (Labiba et al., 2020). However, shifting the medium base from animal to plant sources poses significant challenges to starter culture performance, which directly affects probiotic viability, physicochemical characteristics, and the functional attributes of the final product.

Previous studies have confirmed that starter culture performance depends strongly on the composition of the fermentation medium. In cow's milk, the synergistic interaction between *S. thermophilus* and *L. bulgaricus* produces a low pH and a stable gel texture through casein coagulation (Hendarto et al., 2019). Additional probiotic cultures such as *Lactobacillus casei* not only enhance health benefits but also produce antimicrobial compounds such as bacteriocins, whose optimum activity against pathogens such as *Escherichia coli* and *Staphylococcus aureus* was reached after 24 h of fermentation (Purnomo et al., 2021). In contrast, in a soy milk base, different nutritional characteristics, such as oligosaccharide content (raffinose and stachyose), the absence of lactose, and a globulin protein profile, require adaptation of the starter culture. Labiba et al. (2020) showed that increasing the soybean ratio up to 25% increased the protein, fat, and aglycone isoflavone (genistein and daidzein) contents of soy yoghurt (soygurt), but was accompanied by increased viscosity and

decreased total LAB, presumably due to hindered nutrient diffusion and the mild antimicrobial properties of isoflavones. This finding is reinforced by Tandra et al. (2023), who found that adding a lower starter level (1%) to soy milk yoghurt actually resulted in higher organoleptic acceptance (taste, aroma, texture) than higher levels, even though its pH was higher (4.25). This indicates that the response of starter cultures to plant-based media is non-linear and complex, whereby optimization depends not only on the amount of inoculum but also on strain-specific interactions with substrate components.

Although there are many separate studies on the development of yoghurt from each medium base, there is a deep gap in systematic comparative studies analyzing the physiological behavior and fermentative performance of the same starter culture in cow's milk versus soy milk media. The existing literature tends to focus on optimizing parameters within a single type of medium without exploring the underlying mechanisms that cause differences in culture performance. Critical gaps include: (1) limited understanding of starter culture metabolism in degrading soy-specific components such as oligosaccharides and globulin proteins; (2) a lack of comparative data on the stability of probiotic viability and the production of bioactive compounds (such as bacteriocins and exopolysaccharides) in both media; (3) the absence of an integrated approach that optimizes technological parameters (such as viscosity and pH) together with sensory and functional attributes for plant-based products; and (4) the need to standardize effective starter consortia to produce soy-based yoghurt with quality equivalent to that of cow's milk yoghurt in microbiological, physicochemical, and functional terms.

Based on the identification of these gaps, this literature review aims to analyze and synthesize the latest scientific evidence on the effect of adding various types, combinations, and concentrations of starter cultures on the microbiological, physicochemical, sensory, and functional characteristics of yoghurt produced from cow's milk and plant-based milk (particularly soy milk). By directly comparing findings from various studies, this review is expected to reveal patterns of starter culture adaptation, identify key limiting factors in the fermentation of plant-based media, and formulate inoculum optimization strategies for developing alternative yoghurt products that are not only sensorially acceptable but also have competitive probiotic and functional value.

MATERIALS AND METHODS

Literature Search Strategy

Scientific literature was collected from national journals and commonly used electronic databases, such as Google Scholar and university journal portals. The search focused on articles discussing the effect of adding starter cultures to cow's milk yoghurt and plant-based milk yoghurt (especially soy milk and several other plant materials such as nuts and coconut milk) published between 2014 and 2025. The keywords used included "cow's milk yoghurt", "plant-based yoghurt/soygurt", "starter culture", "lactic acid bacteria", and "probiotic", combined with Boolean operators (AND, OR) to narrow the search results. Only accredited national journal articles reporting experimental research on yoghurt or soygurt fermentation were considered in this review.

Inclusion criteria:

a) Original research or review articles in accredited national journals.
b) Topic related to the fermentation of cow's milk yoghurt and/or plant-based milk yoghurt with the addition of lactic acid bacteria and/or probiotic starter cultures.
c) Publication period between 2014 and 2025.
d) Presents at least one of the following parameters: pH or titratable acidity, physical properties (viscosity, syneresis, total solids), microbiological characteristics (total LAB, probiotic viability), chemical composition (protein, fat, isoflavones), or sensory quality.

Exclusion criteria:

a) Articles discussing non-yoghurt fermented products.
b) Non-scientific publications such as opinions, news, or proceedings without clear quantitative data.
c) Articles not available in full-text form.

Data Analysis and Extraction

From the search results, ten national journal articles were obtained that met the inclusion criteria and did not violate the exclusion criteria. From each article, data were extracted on the type and combination of starter cultures (e.g., *S. thermophilus, L. bulgaricus, L. casei, L. plantarum, L. acidophilus, Bifidobacterium*), the type of substrate (cow's milk, soy milk, mixed animal-plant milk), inoculum concentration, and fermentation time and temperature, together with pH, titratable acidity, viscosity, syneresis, chemical composition, LAB/probiotic viability, and sensory test results. The collected data were analyzed and compared between cow's milk-based and plant-based yoghurts to identify patterns of starter culture performance and their impact on the microbiological, physicochemical, sensory, and functional properties of the product.

RESULTS AND DISCUSSION

A. Results: Comparative Quality Profile of Animal-Based and Plant-Based Yoghurts

The results of various studies show that lactic acid bacteria (LAB) starter cultures have very different physicochemical effects and metabolic responses on cow's milk substrates (rich in lactose and casein) and

plant-based substrates (rich in oligosaccharides/globulins). During fermentation, the pH of cow's milk decreases and acidity increases, but each substrate has different characteristics.

1. Fermentation Activity and Acidity Characteristics (pH and Titratable Acidity)

Fundamental differences in substrate composition markedly influence acidification kinetics in cow's milk-based and plant-based yoghurts.

a) Cow's Milk Base (Animal-Based)

In cow's milk yoghurt, starter combinations (such as *S. thermophilus, L. bulgaricus, L. acidophilus, Bifidobacterium*, and *L. casei*) had a significant effect ($P < 0.05$) on viscosity and titratable acidity (TA) but tended not to affect the pH value. This suggests that the buffering system of casein in cow's milk is able to offset pH changes even as acid production increases. The ideal LAB combination in cow's milk can yield a TA of up to 0.94%. Su'i et al. (2025) reported lactic acid contents of 0.986–1.438% in milk + coconut milk yoghurt, which fall within the Indonesian National Standard (SNI) range of 0.5–2.0%.

b) Plant-Based Base (Soygurt/Soy Milk)

In soygurt (soy yoghurt), the acidity level is highly sensitive to the starter dose. Tandra et al. (2023) reported that a higher addition of yoghurt starter significantly lowered the pH of soy yoghurt, from pH 4.25 at 1% starter to pH 3.24 at 3.5% starter, with the highest acidity at the maximum starter concentration. However, such an extremely low pH is often inversely related to panelist acceptance. Conversely, soygurt with the highest soybean ratio (25%) showed a relatively higher pH (4.63), indicating an inhibitory effect on LAB at high isoflavone concentrations or excessive viscosity.

c) Other Plant-Based Substrates

Fadhilla et al. (2024) found that *Lactobacillus acidophilus* culture gave the lowest pH (3.32) in Mucuna bean flour-based yoghurt after 72 h of fermentation. This shows that different starters (such as *L. acidophilus* compared with the classic *L. bulgaricus/S. thermophilus* combination) have the ability to accelerate lactic acid production. Other plant-based fermented products, such as coconut milk, showed a pH range of 3.57 to 3.87 and a TA range from 0.82%, showing that non-soy plant matrices are also capable of reaching significant acidity levels (Yanuar & Sutrisno, 2015). Optimal fermentation time is also crucial in achieving fermentation parameters that meet the standard. Overall, fermentation parameters such as final pH and total lactic acid are strongly influenced by the type and concentration of the starter and by fermentation duration (Fadhilla et al., 2024). The pH values of these products are compared in Table 1 and Figure 1.

Table 1. Comparison of pH in animal-based and plant-based yoghurts

Product	pH
Soygurt, 1% starter	4.25
Soygurt, 3.5% starter	3.24
Soygurt, 25% soybean	4.63
Mucuna (benguk bean) yoghurt	3.32
Milk + coconut milk yoghurt	3.57–3.87

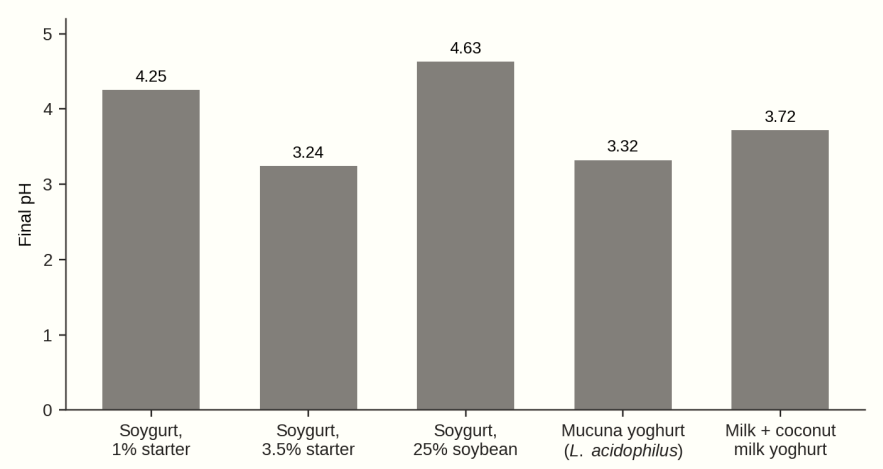


Figure 1. Comparison of the pH of fermented products. The bar for milk + coconut milk yoghurt is plotted at the midpoint (3.72) of the reported range (3.57–3.87).

2. Physical Properties (Viscosity, Syneresis, and Total Solids)

The effect of starter addition on texture shows a clear contrast between animal-based and plant-based bases.

a) Cow's Milk Base

The starter combination significantly affected viscosity. The complete starter combination (ST, LA, B, LC) in cow's milk yoghurt produced the highest viscosity, reaching 2,918.00 cP. The stability (syneresis) of cow's milk yoghurt can be affected by starter addition and fermentation time, although its water content is relatively stable (87.00%-87.70%). The viscosity values are compared in Table 2.

Table 2. Viscosity of animal-based and plant-based yoghurts

Product	Viscosity (cP)
Cow's milk yoghurt	2,918
Soygurt (25% soybean)	7,111.4

b) Plant-Based Base (Soygurt)

Soygurt shows the potential to reach extremely high viscosity. Soygurt with a 25% soybean ratio produced a viscosity of up to 7,111.4 cP. The increase in soygurt viscosity correlates strongly with high total solids and fat. In the tested soygurt, the fastest fermentation/highest starter dose (*L. plantarum* L_2K_3) produced the highest syneresis (4 mm), showing that overly rapid acidification damages the stability of the plant-based gel, resulting in a weak gel matrix. According to research on red bean milk yoghurt, the ratio of base material and incubation time strongly affect the viscosity of the product (Purnomo et al., 2021). Figure 2 illustrates the viscosity difference between the two bases.

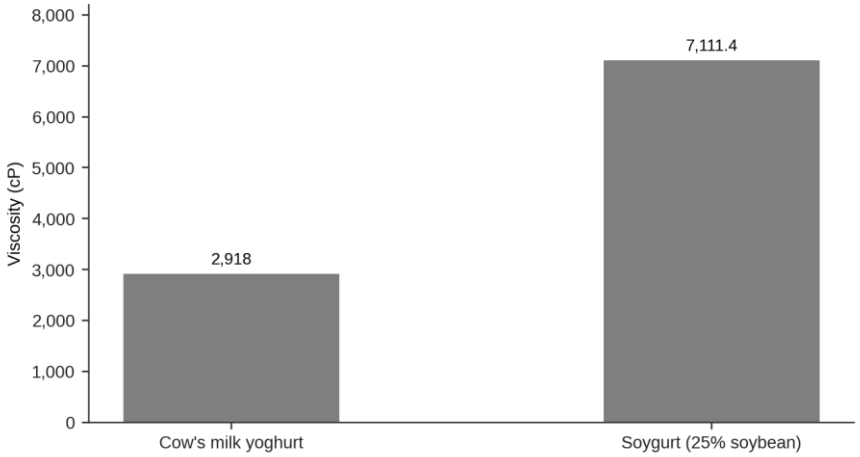


Figure 2. Viscosity of animal-based and plant-based yoghurts.

3. Chemical and Nutritional Components

The final nutritional composition of yoghurt depends on the milk source and starter, with the role of the starter in modifying nutrients differing greatly between animal-based and plant-based bases.

a) Cow's Milk Base

The protein content of cow's milk yoghurt is typically between 3 and 4 percent (SNI minimum 3.5%), with fat content influenced by the starter (Sulistiawan et al., 2025). Starter variation significantly reduced the fat content of cow's milk yoghurt (average 3.05 to 3.45%, in accordance with the SNI minimum of 3%), but did not change the protein and water contents. The activity of lipase enzymes produced by LAB breaks down fat into fatty acids. Conversely, the protein content of cow's milk yoghurt tended not to be significantly affected by the type of starter combination (average 2.75–2.98%, meeting the SNI minimum of 2.7%).

b) Plant-Based Base (Soygurt)

Table 3. Comparison of the nutritional composition of animal-based and plant-based yoghurts

Parameter	Cow's milk yoghurt	Soygurt (25% soybean)
Protein	2.75–2.98%	5.98%
Fat	3.05–3.45%	11.61%

After fermentation, the protein level of plant-based yoghurt can be equal to or higher than before. According to Labiba et al. (2020), a certain soygurt type (F3, containing 25% soybean) had a significant protein content (5.98%) and an exceptionally high fat content (11.61%), exceeding the SNI standard for cow's milk yoghurt. This high fat content is attributed to the inability of LAB lipase enzymes to hydrolyze long-chain plant fats, also known as linoleic acid. Table 3 compares the protein and fat contents of the two bases.

c) Functional Components

First and foremost, soy milk contains abundant isoflavones. Containing 250 milligrams of genistein per gram and 173 milligrams of daidzein per gram, soybean fermentation significantly increases isoflavone

bioavailability. Genistein levels increased by up to 73% (or 77% in other studies) and daidzein by up to 42% (or 49% in other studies), making soygurt an isoflavone-rich probiotic drink. Moringa leaf yoghurt has a high calcium content (~18.23 mg) and a low iron content (~10.9 mg) per serving, although mineralization varies across bases (Fajaratri & Ismawati, 2022). Importantly, starter cultures can optimize nutritional value: the increase in viscosity and total solids (due to protein and fat) in the fermentation of plant-based yoghurt also improves texture without reducing the proximate composition. The isoflavone increases are summarized in Table 4.

Table 4. Increase in isoflavones due to soygurt fermentation

Component	Increase
Genistein	73–77%
Daidzein	42–49%

4. Organoleptic Profile and Consumer Acceptance

Starter culture influences the sensory attributes of yoghurt, with product acceptance strongly influenced by starter dose and substrate type.

a) Effect of the Starter on Sensory Properties

Tandra et al. (2023) found that adding starter culture significantly improved the perceived color, taste, aroma, and thickness of soy milk yoghurt ($p < 0.05$). All organoleptic parameters, such as taste, color, texture, and aroma, can be influenced by the starter. Similarly, Zainuddin (2014) reported significant differences in the organoleptic test results of soygurt related to starter concentration and fermentation time.

b) The Acidity Dilemma of Soygurt

A contradiction arises in soygurt: although a high starter concentration produced maximum acidity/thickness (pH 3.24), panelists most preferred the soygurt with the lowest starter dose (S1, pH 4.25). This indicates high consumer sensitivity to excessive sourness (below pH 4.0), which can worsen the beany flavor of soybeans.

c) Sensory Optimization

As an illustration, a Moringa leaf yoghurt formulation (full cream milk + Biocult starter) produced a well-liked salty-sour taste, pale green color, characteristic milky aroma without any Moringa leaf odor, and a soft, homogeneous texture (Fajaratri & Ismawati, 2022). This indicates that although plant-based yoghurts tend to have a more “plant-like” or “nutty” flavor, the choice of starter and ingredient proportions can optimize sensory acceptance.

d) The Role of Fortification

Efforts to improve the acceptance of plant-based yoghurt have proven successful through fortification. Almond milk yoghurt with added dates significantly increased panelists’ acceptance of taste, aroma, and viscosity. A date concentration of 30% in almond yoghurt even fell within the “like” category (3.83 ± 0.75). With the right starter, the “beany” aroma can be reduced while the characteristic sour flavor of yoghurt is maintained.

5. Microbiological and Functional Activity

Starter addition determines the probiotic microbial population and antibacterial activity of yoghurt in both milk bases studied. The total LAB counts of the products discussed are listed in Table 5.

Table 5. Total lactic acid bacteria (LAB) in various products

Product	Total LAB (CFU/mL)
Soygurt (pH 4.63)	3.7×10^7
Moringa yoghurt	3.2×10^7
Milk + coconut milk yoghurt	3.0×10^6

a) Lactic Acid Bacteria Population

All yoghurt formulas, both animal-based and plant-based, generally meet the SNI threshold for lactic acid bacteria (≥10^7 CFU/mL). Labiba et al. (2020) reported a total LAB in the selected soygurt of ~3.7×10^7 CFU/mL (pH 4.63). Similar figures were found in Moringa yoghurt (~3.2×10^7 CFU/mL) (Fajaratri & Ismawati, 2022). In contrast, Su’i et al. (2025) recorded milk + coconut milk yoghurt with a total LAB of ~3.0×10^6 CFU/mL (almost approaching the standard). These counts are illustrated in Figure 3.

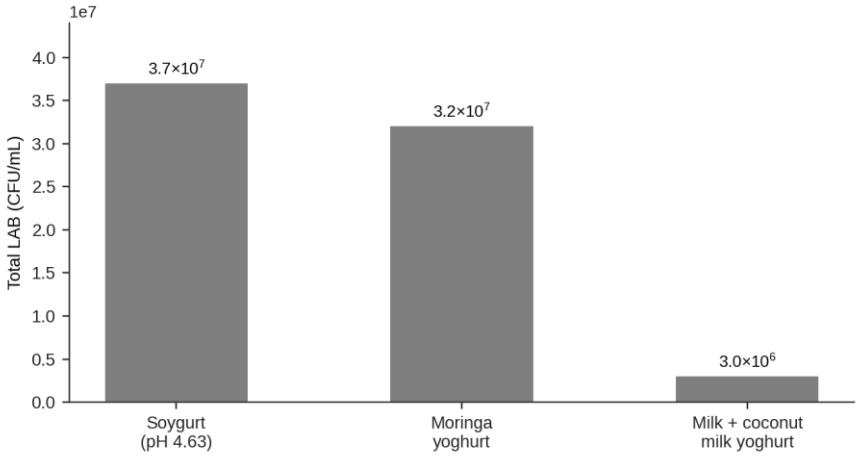


Figure 3. Number of lactic acid bacteria in various yoghurt products.

b) Antimicrobial Activity

In addition to numbers, probiotic viability is also influenced by fermentation conditions. According to Purnomo et al. (2021), the best fermentation, at 24 h, produced bacteriocins (antibacterial) that were more effective against *E. coli* and *S. aureus* (inhibition zone of 8–9 mm). In cow's milk yoghurt, bacteria such as *Lactobacillus casei* have been shown to increase antioxidant activity (free radical inhibition) by up to 98.70%. This adds a functional dimension to the animal-based base beyond basic nutrition.

c) Probiotic Implications

These results indicate that starter cultures (including *L. casei*, *L. acidophilus*, etc.) not only drive fermentation but also enhance the biological activity of yoghurt, both as probiotics and as antimicrobial agents, in both milk bases studied (Fadhilla et al., 2024).

B. Discussion: Fermentation Mechanisms and Matrix Effects

1. Substrate Limitations and Metabolic Adaptation of LAB

Fundamental differences in substrate determine starter performance and result in different final product characteristics (Tandra et al., 2023).

a) Mechanisms in Cow's Milk

Lactose is an easily accessible substrate in cow's milk, allowing *L. bulgaricus* and *S. thermophilus* to proliferate protocooperatively very well. As the main protein, cow's milk casein forms a stable gel matrix through structured isoelectric precipitation. The buffering system of casein is able to resist drastic pH fluctuations even as lactic acid production increases. Various starter combinations produced only minor variations in protein and water content, indicating the inherent stability of the casein matrix.

b) Challenges in Plant-Based Milk

In plant-based milk (soy milk), the starter must contend with oligosaccharides (raffinose and stachyose) in place of lactose. To use them, LAB must possess or express the enzyme α-galactosidase. Successful fermentation (pH as low as 3.24 at 3.5% starter) shows that starters (including the *L. plantarum* tested) can adapt. However, an overly rapid acidification rate often results in damage to the soy globulin protein matrix, manifested as high syneresis (4 mm). Soy globulin proteins do not have the same gel stability as casein and are therefore more susceptible to syneresis at very low pH.

2. Viscosity Factors and Barriers to Culture Growth

The high viscosity of soygurt (7,111.4 cP) is due to the high content of soybean total solids, which have a high water-absorption capacity (hydrophilic nature). However, such extreme viscosity actually backfires on culture growth.

a) Diffusion Barriers

The increase in viscosity and the accompanying decrease in water content hinder the diffusion of nutrients essential for LAB, causing a decrease in total LAB in the soygurt formula with the highest soybean ratio (pH 4.63 with LAB of 3.7×10^7 CFU/mL, which still meets the standard but is at the lower limit). This physical barrier limits the growth of probiotic cultures even though the substrate is available. This contrast explains why increasing the concentration of plant-based raw material does not always increase fermentation activity linearly.

b) Texture Optimization

With the complete starter combination in a cow's milk base, ideal viscosity (2,918 cP) can be achieved without inhibiting LAB growth because of the more stable casein system. This shows that making plant-based yoghurt requires a more careful balance among base material concentration, starter dose, and fermentation time to achieve the desired texture without sacrificing probiotic viability.

3. Biochemical Inefficiency of Plant Fats and Functional Potential

a) Limitations of Fat Hydrolysis

The performance of LAB lipase enzymes in plant-based media is very limited. The soygurt fat content is far above the SNI standard for cow's milk yoghurt (11.61% vs. 3.05 to 3.45%), indicating a failure to hydrolyze plant fats, which are dominated by linoleic acid, a long-chain unsaturated fatty acid. Lipase enzymes produced by LAB are better at hydrolyzing the short- and medium-chain triglycerides typically found in cow's milk, but are less effective at hydrolyzing the more complex plant lipid structures. In light of this contrast, the best starter for cow's milk is not always suitable for plant-based substrates for fat modification.

b) Advantages of Isoflavone Biotransformation

Conversely, the ability of LAB to produce the enzyme β-glucosidase in soygurt is a unique functional advantage. This enzyme converts inactive isoflavone glycosides into aglycones, such as genistein and daidzein, which have higher bioavailability and antioxidant activity. The biotransformation efficiency increase reached 73–77 percent and 42–49 percent after fermentation. Therefore, the soygurt starter functions as a nutrient biotransformer and yields a phyto-probiotic product with higher phytochemical content than a cow's milk base (Firdatama & Priyanti, 2021).

c) Health Implications

The aglycone isoflavones produced have higher biological activity. These include lower estrogenic effects, antioxidant activity, and the potential to protect the cardiovascular system. Fermented soy yoghurt is not only lactose-free but also functions well and offers additional health benefits that cow's milk yoghurt does not have.

4. Implications for Sensory Quality and Formulation Strategy

a) pH Optimization and Acceptance

Differences in flavor acceptance in soygurt carry important implications for formulation. Consumers reject the excessive acidity caused by high starter doses (pH 3.24). Therefore, to improve soygurt quality, the focus should be on flavor balance (pH 4.0–4.25) rather than on the highest acidification. It is strongly recommended to use the lowest starter dose or a short fermentation, because they produce lower amounts of lactic acid, which eliminates the beany flavor of soybeans without reducing probiotic activity (total LAB remains at least 10^7 CFU/mL).

b) Flavor-Balancing Strategy

Adding natural sweeteners or stabilizing agents (such as dates in almond yoghurt, with an acceptance of 3.83 ± 0.75) or prebiotics in soygurt (Firdatama & Priyanti, 2021) is essential to: (1) mask the characteristic beany off-flavor of soybeans, (2) balance the overly dominant sourness at low pH, and (3) increase viscosity without relying on excessive soybean total solids that inhibit LAB.

c) Product Differentiation

Differential starter selection can also optimize the sensory profile. *L. acidophilus*, which produces a very low pH (3.32), may be more suitable for applications requiring a longer shelf life or high antimicrobial activity, whereas the classic combination of *L. bulgaricus*/*S. thermophilus* at a low dose is more suitable for products where sensory acceptance is the top priority.

5. Synthesis of Findings and Practical Implications

Across studies, it can be concluded that animal-based and plant-based yoghurts show similar fermentation responses in terms of decreasing pH and increasing acidity with starter dose (Labiba et al., 2020), but with different mechanisms and final characteristics owing to differences in substrate composition (Tandra et al., 2023). Table 6 summarizes the general comparison.

Table 6. General comparison of animal-based and plant-based yoghurts

Aspect	Animal-based yoghurt	Plant-based yoghurt
Gel stability	High (casein)	Low (globulin)
Fermentation pH	More stable	More sensitive
Viscosity	Tends to be moderate	Very high (7,111 cP)
Functional components	High in Ca, B12	High in isoflavones

a) Similarities

In both bases, increasing the starter generally improves sensory quality up to a certain optimum (Tandra et al., 2023), and all products can meet the SNI microbiological standard (≥10^7 CFU/mL LAB) (Zainuddin, 2014).

b) Key Differences

Final characteristics are influenced by differences in initial composition. Plant-based yoghurt, particularly soy-based, offers advantages in isoflavones and higher protein differentiation, although it requires sugar fortification or a specific starter to mimic animal milk fermentation, and pH optimization to avoid excessive sourness (as encountered in soygurt and red bean yoghurt). Cow's milk yoghurt has better casein gel stability and a fat profile that is more readily modified by LAB enzymes.

c) Formulation Recommendations

Overall, local and international literature agree that the selection and dosage of starter cultures can be optimized to modulate the pH, nutritional value, texture, and probiotic activity of yoghurt, whether from cow's milk or plant-based alternatives (Fadhilla et al., 2024). For plant-based yoghurt, the most promising approaches are: (1) using a moderate starter dose (1–2%) to reach a pH of 4.0–4.25 that balances probiotic activity and sensory acceptance, (2) adding natural sweetener fortification or prebiotics to improve taste and texture, (3) optimizing fermentation time (24–48 h) to maximize isoflavone biotransformation without causing excessive syneresis, and (4) considering the use of specific starters that produce α-galactosidase and β-glucosidase enzymes to improve substrate utilization and the production of functional components.

CONCLUSIONS

This study shows that cow's milk yoghurt and plant-based yoghurt differ significantly in their fermentation response to the addition of LAB starter cultures. Cow's milk yoghurt with a combined starter (*S. thermophilus, L. bulgaricus, L. acidophilus, Bifidobacterium, L. casei*) showed good gel stability, a viscosity of 2,918 cP, controlled pH, and lactic acid of 0.94–1.438% in accordance with SNI. In contrast, soygurt showed a very thick texture (7,111.4 cP), high protein (5.98%), and higher active isoflavones (genistein 73–77%, daidzein 42–49%) from the 25% soybean formula, making it an excellent functional product. The main problems are the high fat content (11.61%) because LAB lipase is ineffective, syneresis caused by the weak globulin structure, and a barrier to probiotic growth due to excessive viscosity. The absence of lactose, the weak buffering system, and the beany flavor at low pH are also key issues. One of the best solutions is to use a 1–2% starter at pH 4.0–4.25, reinforce the formulation with sweeteners or prebiotics, ferment for 24–48 h, and use strains that produce α-galactosidase and β-glucosidase. Both types of yoghurt met the LAB standard of at least 10^7 CFU/mL, indicating that, although the mechanisms differ, both are able to adapt cultures. The development of a competitive plant-based yoghurt depends not only on lowering the pH; it also requires a balance among probiotic activity, functional value, and consumer acceptance.

REFERENCES

Fadhilla, R., Muslim, S. Z., Nora, A., & Wahyuni, Y. (2024). Evaluasi nilai gizi dan antioksidan yogurt nabati berbahan dasar kara benguk (*Mucuna pruriens*) menggunakan variasi kultur starter. *Nutrire Diaita, 16*(1), 29–36. https://doi.org/10.47007/nut.v15i01.7648

Fajaratri, V. R., & Ismawati, R. (2022). Pengaruh penggunaan jenis susu dan starter terhadap hasil jadi yoghurt daun kelor (Moringa yoghurt). *Jurnal Gizi Universitas Negeri Surabaya, 2*(3), 172–180.

Firdatama, A., & Priyanti, E. (2021). Analisis penerimaan yoghurt sari almond dengan penambahan kurma [Analysis of the acceptance of almond milk yoghurt with the addition of dates]. *AGRITEKNO: Jurnal Teknologi Pertanian, 10*(2), 83–88. https://doi.org/10.30598/jagritekno.2021.10.2.83

Hendarto, D. R., Handayai, A. P., Esterelia, E., & Handoko, Y. A. (2019). Mekanisme biokimiawi dan optimalisasi *Lactobacillus bulgaricus* dan *Streptococcus thermophilus* dalam pengolahan yoghurt yang berkualitas. *Jurnal Sains Dasar, 8*(1), 13–19.

Labiba, N. M., Marjan, A. Q., & Nasrullah, N. (2020). Pengembangan soyghurt (yoghurt susu kacang kedelai) sebagai minuman probiotik tinggi isoflavon. *Amerta Nutrition, 4*(3), 244–249. https://doi.org/10.20473/amnt.v4i3.2020.244-249

Purnomo, D., Apridamayanti, P., & Sari, R. (2021). Potensi antibakteri dari susu fermentasi dengan starter *Lactobacillus casei* terhadap *Escherichia coli* dan *Staphylococcus aureus*. *Jurnal Cerebellum, 6*(2), 31. https://doi.org/10.26418/jc.v6i2.45301

Su'i, M., Cendia, M. P., & Anggraeni, F. D. (2025). Pengembangan produk yoghurt dari santan kelapa dan susu sapi (kajian dari suhu dan lama inkubasi). *Agrointek: Jurnal Teknologi Industri Pertanian, 19*(1), 104–113. https://doi.org/10.21107/agrointek.v19i1.17429

Sulistiawan, D., Wanniatie, V., Qisthon, A., & Husni, A. (2025). Kualitas kimia yoghurt susu sapi dengan menggunakan kombinasi starter yang berbeda. *Jurnal Riset dan Inovasi Peternakan, 9*(2), 14–19. https://doi.org/10.23960/jrip.2025.9.2.403-411

Tandra, Y. M., Hasdar, M., & Daryono. (2023). Pengaruh kadar starter terhadap sifat organoleptik yogurt susu kedelai (*Glycine max*). *Ulil Albab: Jurnal Ilmiah Multidisiplin, 2*(6), 2536–2542. https://doi.org/10.56799/jim.v2i6.1657

Yanuar, E. S., & Sutrisno, A. (2015). Minuman probiotik dari air kelapa muda dengan starter bakteri asam laktat *Lactobacillus casei*. *Jurnal Pangan dan Agroindustri, 3*(3), 909–917. https://jpa.ub.ac.id/index.php/jpa/article/view/213/220

Zainuddin. (2014). Pengaruh konsentrasi starter dan lama fermentasi terhadap mutu yoghurt sari kedelai. *Jurnal Agrina, 1*(1), 1–9.