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Research Article

Development and Nutritional Evaluation of a Flavoured Probiotic Whey-Based Beverage from Goat Milk

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Abstract | This study aimed to develop a nutritious, ready-to-drink whey-based beverage using goat milk, addressing the growing consumer demand in Malaysia due to its cultural significance and nutritional benefits. The formulation incorporated varying concentrations (0%, 2%, 4%, 6%, and 8%) of *Lactobacillus acidophilus* to enhance probiotic functionality while maintaining favorable sensory and nutritional properties. Physicochemical parameters including pH, moisture, protein, ash, fat, carbohydrate, and caloric value were assessed to evaluate nutritional composition. Results showed significant variation across formulations. Compared to the control, the cultured whey formulations had significantly lower moisture content and higher protein, carbohydrate, and energy levels ($p < 0.001$). Differences in ash and fat content were not statistically significant ($p > 0.05$). The pH values of both plain goat whey (Control) and cultured goat whey ranged from 4.3 to 4.5. Sensory evaluation involving 21 panelists indicated favorable responses in flavor, aroma, and texture, especially for the formulation containing 8% *L. acidophilus*, which received the highest overall acceptance. These findings support the feasibility of producing a palatable, probiotic-rich beverage from locally sourced goat milk whey. The final product offers a lactose friendly and culturally appropriate alternative to imported whey protein drinks, with potential nutritional benefits for health-conscious consumers, athletes, and individuals with lactose intolerance. The study contributes to sustainable dairy innovation in Malaysia and demonstrates the potential of goat milk whey as a value-added ingredient in functional beverages.

Keywords | Goat milk whey, Milk drink composition, Probiotic drink

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INTRODUCTION

In Malaysia, the goat farming industry plays a crucial role in providing high-quality protein through goat meat and milk, both valued for their nutritional benefits (Shahudin *et al*., 2018). Among these, goat's milk has gained recognition as a natural functional food, a term used to describe foods that offer health benefits beyond basic nutrition, such as providing essential vitamins and minerals (Al-Kaisy *et al*., 2023). Despite the prominence of cow's milk in the Malaysian dairy industry, there is a growing demand for goat's milk, partly driven by cultural and religious beliefs. For example, goat's milk is revered in Islam, as it is believed to be one of the foods consumed by the Prophet Muhammad, further enhancing its appeal among Muslim consumers (Umar *et al*., 2017).

One of the key considerations in dairy consumption is lactose intolerance, a condition that affects a significant portion of the global population. Individuals with lactose intolerance have varying thresholds for lactose consumption, with symptoms ranging from mild discomfort to severe gastrointestinal issues. Although goat's milk contains lactose, studies suggest that it may be better tolerated by some individuals compared to cow's milk, potentially due to its slightly lower lactose content (Rai *et al*., 2022). This makes goat's milk an attractive alternative for those seeking to avoid the adverse effects of lactose intolerance while still enjoy dairy products.

Lactose, a disaccharide found exclusively in milk and milk-derived products, requires hydrolysis by the enzyme lactase to be absorbed by the body. In cases where lactase is deficient, undigested lactose passes into the large intestine, leading to symptoms such as cramps, flatulence, diarrhea, and abdominal pain (Al-Kaisy *et al*., 2023). Given the nutritional composition of milk, which includes fat, high-quality protein, carbohydrates, vitamins, and minerals, the ability to consume milk without discomfort is of significant interest. Goat's milk, particularly from the Saanen breed, offers a balanced composition of 2.99% fat, 7.70% solids not fat (SNF), 2.79% protein, and 4.2% lactose, making it a nutritious option (Ibrahim and Jalil, 2022).

Whey, the liquid by-product of cheese production, is highly valued for its nutritional content, particularly its high concentration of whey protein. Whey protein is renowned for its easy digestibility and absorption, making it a popular dietary supplement, especially among athletes and fitness enthusiasts. Compared to cow's milk, goat's milk has a higher ratio of whey protein to casein, further enhancing its appeal (Roy *et al*., 2020). This makes whey protein extracted from goat's milk an attractive option for those seeking to improve muscle protein synthesis and recovery, as well as overall health (Ahmed *et al*., 2023).

Despite these advantages, the Malaysian market currently lacks a ready-to-drink whey protein beverage made from goat's milk. Most whey protein products are imported and are predominantly made from cow's milk. This creates a significant gap in the market, especially for consumers who seek the benefits of a milk alternative derived from goat's milk. Furthermore, reliance on imported whey protein contributes to higher prices, making these products less accessible to the general population.

The absence of a locally produced whey-based goat milk drink presents an opportunity for innovation in the Malaysian dairy industry. By developing a whey protein drink that leverages locally produced goat's milk, it is possible to create a product that not only meets the nutritional needs of consumers but also aligns with cultural preferences and dietary restrictions. The development of such a product could also contribute to the local economy by reducing reliance on imports and providing a new market for Malaysian goat farmers.

In response to this identified gap, the objective of this research is to develop a flavoured probiotic whey-based drink from goat milk. This formulation will be designed to appeal to a broad consumer base by enhancing the taste and aroma of goat's milk, which some people find off-putting due to its strong odour. The inclusion of probiotics is intended to further boost the health benefits of the drink, particularly in supporting gut health. Additionally, the research will focus on evaluating the nutritional value of the final product to ensure that it provides a complete protein profile and meets the dietary needs of consumers.

MATERIALS AND METHODS

Animal selection and management

The milk samples from Saanen goats (2–3 years old, n = 10) used in this research originated from UniSZA Pasir Akar Farm, located in Jerteh, Terengganu. The Saanen breed was selected for milk collection due to its body condition score (BCS) of 2–3, consistent body weight, good health, and symmetrical udder. The goats were raised in a confined housing system with limited land access (Ibrahim *et al*., 2025).

The goat milk sample was collected and pasteurized at 63°C for 30 minutes. The pasturized milk was immediately chilled at 4°C and then transported to the Food Industry laboratory in Besut Campus, University Sultan Zainal Abidin (UniSZA), Terengganu.

Goat milk whey

The goat milk was collected using a hand-milking technique, adapted from Perin *et al*. (2019) and Nasir *et al*. (2018). The goat milk whey was processed based on a previous study with modifications from Ahmed *et al*. (2023), involving citric acid-induced coagulation and subsequent whey separation through filtration. The production of goat milk whey involved several key steps to ensure quality and safety. Initially, the milk was heated to 85 ± 2°C while being continuously stirred to prevent burning. Once the desired temperature was reached, the milk was removed from the heat source, and citric acid was added at 12% v/v. The mixture was briefly stirred and then allowed to cool to room temperature, promoting curd formation (milk protein coagulation). The curd was strained using cheesecloth to separate the whey. The resulting goat milk whey (GMW) was stored at a controlled temperature of 4 ± 1°C prior to the addition of the starter culture.

Starter culture and formulation

The commercial *Lactobacillus acidophilus* was used as a starter culture in the GMW and the formulation is listed in Table 1. A total of five formulations were prepared based on various levels of *L. acidophilus* viz., 0%, 2%, 4%, 6%, and 8%. The GMW formulations and the addition of commercial *L. acidophilus* were prepared based on a previous study with modifications (Skryplonek *et al.*, 2019). These mixtures were then fermented in an incubator at an optimal temperature of 37°C for 24 hours, covered with food-grade plastic wrap to facilitate bacterial growth (Pescuma *et al.*, 2010). The whey-based drinks were formulated in five trials. The prepared drinks were bottled in cleaned and sealed containers to ensure air-tight conditions. Subsequently, the filled bottles were stored in a refrigerator at 4 ± 1°C for further analysis (Ahmed *et al.*, 2023).

Physicochemical analysis

Determination of pH Value

A digital pH meter was calibrated using commercial buffer solutions at pH 4 and 7, following the manufacturer's instructions.

Determination of moisture content

Moisture content was determined using the oven-drying method described by Rosmawati *et al.* (2015). A 5 mL sample of GMW was dried at 105°C for 24 hours in a drying oven until a constant weight was achieved.

Determination of ash

A 5 mL sample was weighed in dry crucibles and heated overnight in a muffle furnace at 550°C, following the method described by Rosmawati *et al.* (2015).

Determination of fat

Fat content was determined using the Soxhlet extraction method (Rosmawati *et al.*, 2015). A 5 g portion of the freeze-dried sample was extracted with petroleum ether (40–60°C).

Determination of protein content

Protein content was determined using the Kjeldahl method, as outlined by Azemi *et al.* (2021). One gram of sample was digested, distilled, and titrated. The protein content was calculated using a nitrogen-to-protein conversion factor of 6.25.

Determination of carbohydrates and energy

The carbohydrates content (Kassegn, 2018) and energy (Rosmawati *et al.*, 2015) was calculated based on the following formula:

% total carbohydrate= 100 – %(Protein + Fat + Moisture + Ash)

Energy (kcal/100g) = [(Protein (g/100g) x 4 kcal) + (Fat (g/100g) x 9 kcal) + (Carbohydrate (g/100g) x 4 kcal)]

Sensory assessment

Approval from the UniSZA Human Research Ethics Committee (UHREC) was obtained before conducting the sensory test, under the code UniSZA/UHREC/2024/664. Sensory evaluation was performed using a 9-point hedonic scale (Castro *et al.*, 2013), where a score of 9 represented "like extremely" and 1 represented "dislike extremely." A group of 21 students (n= 21) from the Faculty of Bioresources and Food Industry, UniSZA, evaluated the sensory attributes of the GMW, including colour, aroma, taste, texture, sweetness level, sourness level, off-flavour, and overall preference. The samples were presented at 5 ± 1°C and served in paper cups with random digit numbers. Each participant received 30 mL of each sample and was instructed to drink water between tastings to cleanse the palate.

Statistical analysis

All tests were performed in triplicate, and values are reported as mean ± standard deviation. Using Minitab Statistical Software, one-way ANOVA with subsequent comparison of the means by Tukey's test was used to analyze the data on the pH and nutritional content of the flavoured probiotic whey-based goat milk drink formulations. Data were plotted using Origin 9.0 SR2 (OriginLab Corporation, Northampton, MA), and differences were considered statistically significant at $p < 0.05$ (Zhao *et al.*, 2020). For sensory data, the Kruskal-Wallis test was applied to compare the medians of three or more independent groups to determine statistically significant differences ($p < 0.05$).

Table 1: Formulation of flavoured probiotic *Lactobacillus acidophilus* whey-based goat milk drink.

Formulation	Whey (ml)	*Lactobacillus acidophilus* starter culture (v/v%)	Orange flavour (v/v%)	Fructose (w/v%)	Isolated soy protein (w/v%)	CMC (w/v%) + 40% (v/v%) water
1	50	0	8	1	1	0.5
2	50	2	8	1	1	0.5
3	50	4	8	1	1	0.5
4	50	6	8	1	1	0.5
5	50	8	8	1	1	0.5

Note: CMC: carboxymethyl cellulose

RESULTS AND DISCUSSION

pH value

As shown in Figure 1, the pH values of both plain goat whey (Control) and cultured goat whey were ranged from 4.3 to 4.5. A statistically significant difference ($p < 0.05$) was observed between the pH of the plain goat whey (Control) and the cultured goat whey. The variation in acidity can be attributed to post-acidification following culturing, a common phenomenon in fermented dairy products. This finding is consistent with Castro *et al.* (2013), who reported similar results when *L. acidophilus* was added to whey and incubated to promote bacterial growth. The viability of probiotics in the dairy beverages did not affect the whey content, indicating that the probiotic strain maintained its capacity to metabolize the peptides present in the whey.

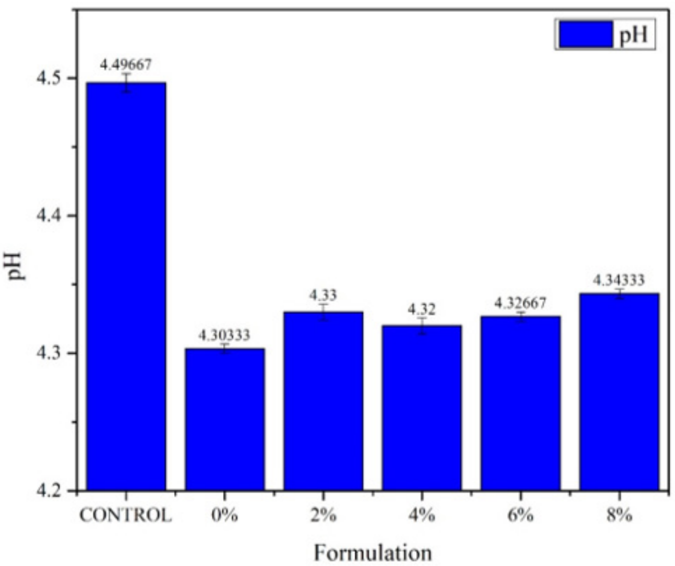

Figure 1: pH of plain goat whey (Control) and different formulations of flavoured probiotic whey-based goat milk drink.

Meanwhile, the research by León-López *et al.* (2020) on plain goat whey also supports these findings, reporting pH values for acid whey in the range of 4.4 to 4.8. In Figure 1, the Control group recorded a pH value of 4.5, which was less acidic than the pH values of the cultured whey containing different concentrations of *L. acidophilus*, ranging from 4.30 to 4.34. The addition of *L. acidophilus* at varying concentrations slightly lowered the initial pH, consistent with the findings of Skryplonek *et al.* (2019).

Moisture content analysis

The mean moisture values of cultured goat whey with varying concentrations of *L. acidophilus* (0%, 2%, 4%, 6%, and 8%), along with plain goat whey (Control), are presented in Table 2. The moisture content of the Control (93.99%) was significantly higher than that of the cultured whey formulations ($p = 0.000$).

According to Ahmed *et al.* (2023), the moisture content of whey-based beverages typically ranges from 75.60% to 86.20%. However, in some cases, the moisture content may increase with the addition of water during formulation. The moisture level observed in the Control sample aligns with the findings of Galdino *et al.* (2021), who reported similar moisture values (93%) for goat whey. The incorporation of isolated soy protein and carboxymethyl cellulose (CMC) powder lowers the moisture level, as evidenced by cultured whey reduced moisture content when compared to the Control. This result is consistent with that Salehi *et al.* (2024), who attribute the reduced moisture content to the inherently low moisture levels in isolated soy protein powders and CMC powder. Additionally, differences in moisture content among the formulations may be influenced by storage conditions, particularly moisture loss during cold storage (Mabrouk, 2015).

Protein content analysis

A significant difference ($p = 0.000$) in protein content was observed between the Control and the cultured goat whey formulations with varying concentrations of *L. acidophilus* (0%, 2%, 4%, 6%, and 8%) as shown in Table 2. The protein content of the Control was 0.62%, which is slightly lower than the 0.85% protein content reported by Pescuma *et al.* (2010) for liquid whey. This discrepancy indicates that supplementation is required to meet the nutritional goals of this study.

Table 2: Effect of different formulations of the flavoured probiotic whey-based goat milk drink on nutritional content.

Formulation	Moisture (%)	Protein (%)	Ash (%)	Fat (%)	Carbohydrate (%)	Energy (kcal)
Control	93.99 ± 0.01^a	0.62 ± 0.01^d	0.02 ± 0.01	0.0011 ± 0.00^a	5.37 ± 0.03^e	23.97 ± 0.11^d
0%	92.48 ± 0.05^b	1.10 ± 0.01^a	0.04 ± 0.02	0.0010 ± 0.00^a	6.38 ± 0.01^d	29.91 ± 0.09^c
2%	92.31 ± 0.02^c	0.99 ± 0.01^b	0.04 ± 0.01	0.0010 ± 0.00^a	6.66 ± 0.05^c	30.62 ± 0.20^b
4%	92.06 ± 0.02^d	1.10 ± 0.03^a	0.04 ± 0.00	0.0009 ± 0.00^a	6.81 ± 0.04^b	31.65 ± 0.09^a
6%	91.96 ± 0.04^e	0.95 ± 0.02^{bc}	0.04 ± 0.02	0.0004 ± 0.00^a	7.05 ± 0.04^a	32.00 ± 0.20^a
8%	92.06 ± 0.05^d	0.93 ± 0.04^c	0.04 ± 0.01	0.0002 ± 0.00^a	6.97 ± 0.03^a	31.59 ± 0.21^a
p-value	0.000	0.000	0.182	0.842	0.000	0.000

Each value is expressed as mean ± standard deviation (SD). $^{a-e}$ means that have different lowercase superscripts differ significantly ($P < 0.05$) according to Tukey's test.

According to Punoo *et al.* (2023), the use of isolated soy protein is what causes the prepared drinks to increase in protein proportion. Though isolated soy protein should contribute about 0.9% protein in this experiment, the percentages do not match data from other research (Punoo *et al*., 2023), where isolated soy protein comprises more than 90% protein on a dry basis. This variation may result from differences in the quality and composition of the isolated soy protein powder used. As Zhang *et al.* (2024) explained, the physicochemical properties and functional characteristics of isolated soy protein are influenced by the raw materials and processing techniques. Furthermore, Schmid *et al.* (2024) found that variability in protein concentration across soy protein isolates is associated with different purification methods employed by various manufacturers.

Ash content analysis

Table 2 presents the mean ash concentrations for the formulations of flavoured probiotic whey-based goat milk drinks with different percentages of *L. acidophilus* (0%, 2%, 4%, 6%, and 8%) and plain goat whey (Control). The following values were recorded: Control (0.02 ± 0.01), 0% (0.04 ± 0.02), 2% (0.04 ± 0.01), 4% (0.04 ± 0.00), 6% (0.04 ± 0.02), and 8% (0.04 ± 0.01). The samples do not significantly differ from one another ($p > 0.05$). However, as shown in Table 2, there was a slight increase in ash content in the formulated drinks compared to the Control, which can be attributed to the addition of soy protein isolate and orange flavour.

This observation aligns with findings from Bhavsagar *et al.* (2010), Babar *et al.* (2008), Pownall *et al.* (2010), and Hiralal and Raj (2014), who reported that the inclusion of fruits and vegetables in whey beverages increases ash content. Similarly, Ahmed *et al.* (2023) noted that flavouring additives, such as orange flavour, could elevate ash levels in beverages. The ash content in functional drinks provides an estimation of their mineral content. In whey, the predominant minerals are sodium and potassium, although other minerals such as oxides, sulphates, phosphates, nitrates, chlorides, and halides may also be present (León-López *et al*., 2020).

Fat content analysis

As shown in Table 2, there was no significant difference ($p > 0.05$) in the fat contents of the plain goat whey (Control) and the formulations of flavoured probiotic whey-based goat milk drinks with different percentages of *L. acidophilus* (0%, 2%, 4%, 6%, and 8%). These findings are consistent with those of Kucheryavskiy and Lomborg (2015) and León-López *et al.* (2020), who emphasized that whey is a low-fat ingredient suitable for producing reduced-fat beverage products.

According to Deak *et al.* (2008), the processing method for soy protein involves milling soybeans and extracting oil typically using hexane as a solvent. The defatted soybean meal is then used to extract proteins. Techniques such as aqueous extraction, membrane processing (e.g., ultrafiltration and reverse osmosis), and acid or alkali precipitation are employed. These methods yield products with low fat content by extracting soluble proteins and removing non-protein components like fats and carbohydrates (Astawan and Prayudani, 2020).

Carbohydrate content analysis

As shown in Table 2, the carbohydrate content of the flavoured probiotic whey-based goat milk drinks with varying percentages of *L. acidophilus* (0%, 2%, 4%, 6%, and 8%) differed significantly ($p= 0.000$) from that of the plain goat whey (Control). The Control sample contained 5.37% carbohydrates, which can be attributed to the natural composition of whey, including key proteins (α-lactalbumin, β-lactoglobulin, and serum albumin), minerals, vitamins, and carbohydrates primarily lactose, which accounts for approximately 70% of the total solids (Tsakali *et al*., 2007; Macwan *et al*., 2016). In contrast, the cultured whey samples (0%, 2%, 4%, 6%, and 8%) showed higher carbohydrate percentages 6.38%, 6.66%, 6.81%, 7.05%, and 6.97%, respectively. This increase is attributed to the addition of fructose as a flavouring agent. Holesh *et al.* (2023) noted that carbohydrates include monosaccharides (glucose, galactose, fructose) and disaccharides (such as sucrose and lactose), which contribute to the total sugar content.

Our results illustrate a gradual increase in carbohydrate percentage between the control and the formulated drinks, which may also be influenced by the varying sucrose content introduced along with the starter culture of *L. acidophilus* from commercial probiotic drinks. Consequently, the formulated beverages showed higher carbohydrate levels compared to the control. According to Hyseni *et al.* (2021), approximately 92.42% of the carbohydrates in similar functional beverages are composed of sugars; therefore, an increased use of sucrose contributes to a rise in total carbohydrate content.

Energy content analysis

As presented in Table 2, the energy content of the flavoured probiotic whey-based goat milk drinks with varying percentages of *L. acidophilus* (0%, 2%, 4%, 6%, and 8%) differed significantly ($p = 0.000$) from that of the plain goat whey (Control). Carbohydrates serve as a primary source of energy (Holesh *et al*., 2023), and total energy (kcal) was calculated by multiplying the contents of protein and carbohydrates by 4 and fat by 9 (Sharma *et al*., 2013). Thus, the differences in energy values among formulations are primarily due to variations in their carbohydrate, fat, and protein contents.

Table 3: Z-values of descriptive statistics and *p*-values from Kruskal–Wallis test for the 9-point hedonic scores of sensory attributes across different formulations of flavoured probiotic *Acidophilus* whey-based goat milk drink.

Formulation	Attributes							
	Appearance (colour)	Aroma (smell)	Taste	Texture	Sweetness level	Sourness level	Off level	Overall preference
0%	-0.02	0.32	0.14	-2.14	-0.78	-0.35	-1.41	-1.04
2%	-1.78	-1.55	-0.96	-1.13	-0.28	-1.25	-1.30	-1.44
4%	-0.14	0.00	-0.64	0.13	0.08	-0.88	-1.10	-0.99
6%	-0.18	-0.17	-1.66	0.34	-1.47	-0.66	0.33	-0.73
8%	-0.18	1.41	3.13	2.80	2.44	3.15	3.48	4.20
p-value	0.163	0.433	0.020*	0.022*	0.0116*	0.031*	0.007*	0.001*

*($p < 0.05$) means differ significantly according to the Kruskal-Wallis test.

Álvarez (2013) emphasized that the addition of sugars to food and beverages significantly contributes to an increase in energy content. This shows a gradual increase in energy levels in the formulated drinks compared to the control. Therefore, it is suggested that, for future formulation development, the starter culture used in probiotic drinks should be free from added sugars to ensure that the energy value truly reflects only the composition of the formulated drink. This approach would allow for a more accurate assessment of the nutritional contribution of each ingredient to the overall energy content.

Sensory evaluation analysis

A sensory evaluation was conducted on the formulations of the flavoured probiotic whey-based goat milk drinks (Table 3) to assess appearance, aroma, taste, texture, sweetness level, sourness level, presence of off-flavours, and overall preference. A panel of 21 assessors used a 9-point Hedonic scale ranging from 1 (dislike extremely) to 9 (like extremely) to record their perceptions.

Table 3 shows the Z-values from the descriptive statistics and the p-values obtained from the Kruskal–Wallis test. The results indicate that the appearance and aroma of the drinks did not differ significantly across the formulations ($p > 0.05$), likely due to the consistent use of orange flavouring, which contributed to similar colour and aroma profiles. Additionally, the probiotics enhanced the volatile compounds, improving the overall aroma and reducing the characteristic goaty odour, as reported by Bezerril *et al*. (2022).

In contrast, taste, texture, sweetness, sourness, and overall preference showed significant differences ($p < 0.05$) across the formulations with varying percentages of *L. acidophilus*. The presence of the probiotic culture during fermentation increased the concentration of organic acids, primarily lactic and propionic acids, which influenced the sourness and flavour profiles of the drinks. As lactic acid contributes a tangy and mildly refreshing taste, increasing its concentration enhances the sensory experience (Bezerril *et al*., 2022). Furthermore, undissolved powdered ingredients, such as isolated soy protein, may have led to a grainy or powdery mouthfeel, affecting the texture of certain formulations (Agorastos *et al*., 2020). According to Jayasinghe *et al*. (2017), individual differences in sweet taste perception also play a role in sensory preference. Their study suggests that people who perceive a higher intensity of sweetness often prefer beverages with lower sugar concentrations, contributing to variations in consumer preferences despite equal sugar content across samples.

Overall, the 8% formulation was the most preferred by the panel, particularly in terms of taste, as indicated by the highest Z-value. This aligns with findings by León-López *et al*. (2020), which suggest that lactose-consuming microbes and lactic acid bacteria can enhance the flavour and aroma of fermented dairy beverages. Although sugar typically enhances consumer acceptability (Álvarez, 2013), the findings from this study reveal that sourness levels and the presence of probiotics play an equally important role in shaping overall preference.

CONCLUSION

This study successfully developed a flavoured probiotic whey-based goat milk drink by utilizing goat whey, orange flavour, and fructose to enhance the taste, along with isolated soy protein powder to increase the protein content and improve the overall nutritional properties of the product. Nutritional evaluation was conducted by measuring moisture, ash, protein, fat, carbohydrate, and energy content to assess the effectiveness of incorporating goat whey in producing a nutritionally enhanced beverage aligned with Malaysian consumer preferences.

Sensory assessment revealed that the formulation containing 8% *Lactobacillus acidophilus* was the most preferred, receiving the highest ratings for overall taste among all formulations. However, the study faced certain limitations. The choice of flavouring agents compatible with the natural sourness of acid whey was limited, and masking the characteristic goaty odour of whey remained a challenge with certain flavour combinations.

Despite these limitations, the development of a probiotic drink utilizing goat whey with improved taste and protein content has the potential to significantly increase the commercial value of goat whey in Malaysia. The product demonstrates quality comparable to similar international offerings and caters to consumer demand for both palatable and nutritious options. Further research is recommended prior to commercial-scale production, focusing on shelf-life extension, quality enhancement through the use of stabilizers and additional flavouring agents, process optimization, and scientific validation of its safety and health benefits.

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NOVELTY STATEMENT

This study presents a novel development of a flavoured probiotic whey-based beverage formulated from goat milk. The novelty lies in utilizing goat milk whey, a locally available by-product, as a base for producing a functional probiotic drink with enhanced nutritional composition, sensory acceptance, and lactose-friendly properties. This innovation contributes to sustainable dairy utilization and provides a culturally relevant alternative to imported whey-based products in Malaysia.

AUTHOR'S CONTRIBUTION

The research study was designed and the original paper was written by Noor Syaheera Ibrahim and Aida Aqilah Arshad, Ishamri Ismail assisted in the whey formulation and experiments, Nurul Huda reviewed the manuscript. Premy Puspitawati Rahayu reviewed the data and statistical analysis.

Generative AI and AI-assisted technology statement

No generative AI or AI-assisted technologies were used in the design, analysis, or writing of this manuscript. Only standard grammar and language correction tools were applied to improve readability.

Conflict of interest

The authors have declared no conflict of interest.

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