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Enhancing functional properties of probiotic yoghurt with curry leaves (*Murraya koenigii*) extract: A study on antimicrobial and antioxidant activity

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Abstract

The incorporation of natural plant extracts in dairy products is gaining attention for their potential health benefits. This study evaluates the effect of curry leaves (*Murraya koenigii*) extract on the antimicrobial and antioxidant properties of probiotic yoghurt while assessing its sensory acceptability. The antimicrobial activity of curry leaves extract was tested against *S. aureus*, *Salmonella* sp., *E. coli*, *Rhodotorula* sp., *Penicillium* sp., and *Aspergillus* sp. The extract exhibited antibacterial activity against *S. aureus* and *Salmonella* sp., with the highest inhibition at 300 mg/ml, but showed no effect against *E. coli* and fungal strains. The antioxidant potential of curry leaves extract was determined using the DPPH radical scavenging assay, which showed a concentration-dependent increase in inhibition, with an IC₅₀ value of 54.23 µg/ml. Probiotic yoghurt enriched with CLE demonstrated enhanced antimicrobial properties, particularly against *S. aureus* and *Salmonella* sp., while maintaining comparable activity against *E. coli* to that of control yoghurt. Sensory evaluation revealed that curry leaves extract incorporated probiotic yoghurt was well-accepted in terms of appearance, texture, flavor, and overall acceptability. These findings highlight the potential of curry leaves extract as a functional ingredient in probiotic yoghurt, contributing to the development of healthier and more sustainable dairy products with enhanced antimicrobial and antioxidant properties.

Keywords: Yoghurt, probiotic yoghurt, curry leaves, antioxidant activity, antimicrobial activity

Introduction

Curry leaves (*Murraya koenigii*), a staple in Indian cuisine, are widely recognized for their medicinal and functional properties. Rich in bioactive compounds such as polyphenols and flavonoids, curry leaves exhibit significant antimicrobial and antioxidant activity. Polyphenols, including catechins, quercetin, and rutin, contribute to their potent free radical-scavenging ability, while flavonoids enhance their protective effects against oxidative stress. These bioactive components make curry leaves a promising natural ingredient for improving the functional properties of dairy-based products [1].

Probiotic yoghurt is a well-established functional food known for its numerous health benefits, including gut health improvement, immune modulation, and metabolic regulation. The incorporation of bioactive plant extracts into probiotic yoghurt can further enhance its health-promoting properties, making it a superior functional food. Among these, natural antimicrobial and antioxidant compounds play a crucial role in extending the shelf life, improving sensory attributes, and enhancing the overall health benefits of probiotic yoghurt [2, 3].

Antimicrobial activity in probiotic yoghurt is particularly important in preventing spoilage and inhibiting pathogenic microorganisms, ensuring product safety and quality. Likewise, antioxidant activity helps to protect the probiotic culture from oxidative stress, maintaining its viability and functionality throughout storage [4, 5]. Given these potential advantages, this study aims to evaluate the effect of curry leaf extract on the antimicrobial and antioxidant activity of probiotic yoghurt, thereby exploring its potential as a natural functional additive.

Materials and Methods

Preparation of curry leaves extract

Fresh curry leaves were procured from local markets in Hebbal, Bengaluru. The leaves were separated from stalks, cleaned to remove foreign matter, and washed with potable water, followed by salt water, and rinsed again. They were then dried at 55 °C for 16-18 h, ground into a fine powder using a mixer grinder and sieved through a 60 mm mesh sieve. Hot water extraction of curry leaves was performed by thermal agitation technique prescribed by Hussain [6] with some modifications using a temperature-controlled magnetic stirrer. Ten grams of powdered leaves were extracted using 100 ml of hot distilled water (90 °C). A Teflon-coated magnetic stir bar was immersed in the extraction solution, and the beaker was sealed with aluminum foil before stirring for one hour at 90 °C. The extracts were then filtered through Whatman No. 4 filter paper and concentrated on a hot plate at 30-40 °C for 30 min until a constant weight was reached.

Antimicrobial activity of curry leaves extract

Antimicrobial activity of the curry leaves extract against *Escherichia coli*, *Salmonella* sp., *Staphylococcus aureus*, yeast *Rhodotorula* sp. and mold *Penicillium* sp. and *Aspergillus* sp. was evaluated. Overnight grown each pathogenic bacterial suspension in nutrient broth (~ 10⁶ CFU/ ml) was swabbed on the surfaces of Mueller-Hinton agar plates using sterile cotton swabs. Lawn cultures of *Rhodotorula* sp., *Penicillium* sp. and *Aspergillus* sp. were smeared uniformly on the surface of malt extract agar using sterile cotton swab. The plates were allowed to dry and wells of 7 mm were made using sterile 7 mm diameter borer and 100 µL of the extract (100, 150, 200, 250, and 300 mg dried extract/ml dimethyl sulfoxide (DMSO-0.1%)) was transferred to wells. The plates were left at room temperature for one hour before incubating at 37 °C for 24 h for bacteria and at 30 °C for 3-5 days for yeast and molds without inverting the plates. The effect of solvent control DMSO (0.1%) on the growth of microorganisms was also evaluated. The inhibitory zone area was measured around the well. Extract producing more than 1 mm inhibitory zone formation around the well was considered as having antibacterial activity against the particular pathogen [7].

Antioxidant activity of curry leaves extract

The antioxidant activity was measured by DPPH radical

scavenging assay using the scavenging activity of the stable 2,2-Diphenyl-1-picrylhydrazyl (DPPH) radical and was determined according to the procedure given by El-sayed *et al.* [7] and Nariya *et al.* [8] with some modifications. The stock solution of the leaf extract was prepared at the concentration of 1 mg/ml in the solvent used for its extraction and was then diluted 0.1 mg/ml in distilled water. From this, various concentrations (10, 15, 25, 50, and 60 µg/ml) of leaf extract were made. A volume of 2 ml of freshly prepared DPPH radical solution (0.15 mM) in 95% ethanol was added to 1 ml of extracts in different concentrations. The contents of the tubes were mixed vigorously and allowed to stand in the dark for 30 min at room temperature and absorbance was measured at 517 nm using a spectrophotometer. Ascorbic acid was used as a reference standard and dissolved in distilled water to make the stock solution with the same concentration as that of the leaf extract of *M. koenigii*. A control sample was prepared by adding 2 ml of DPPH to 1 ml of 95% ethanol and 95% methanol was used as blank and % scavenging of the DPPH free radical was calculated using Equation 1:

$$\% \text{ inhibition} = \{(A_{\text{control}} - A_{\text{sample}})/A_{\text{control}}\} \times 100 \quad (1)$$

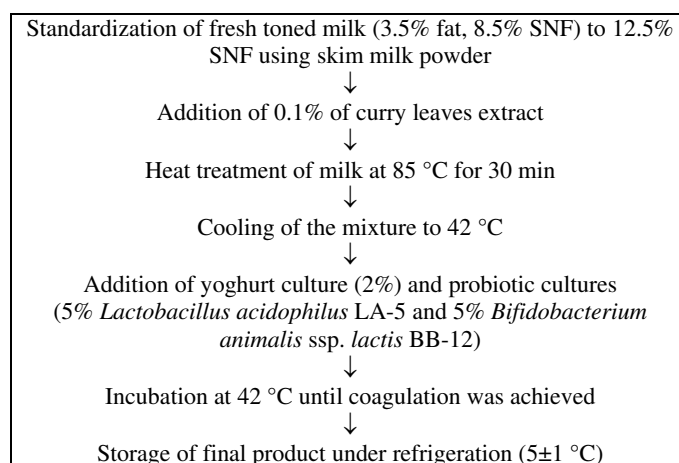
where,

A_{control} = Absorbance of control sample and A_{sample} = Absorbance of DPPH along with different concentrations of extracts.

The results were plotted as the % inhibition against the concentration of the sample and the IC₅₀ which denotes the amount (mg) of the leaf extract in 1 ml solution required to reduce initial concentration of DPPH radicals by 50% was also calculated from the equation of line obtained by plotting a graph of concentration versus % inhibition.

Preparation of probiotic yoghurt with curry leaves extract

Probiotic yoghurt with optimized concentration of curry leaves extract (0.1%) was prepared by following the method adopted by Saeed *et al.* [9] with some modifications. A mango flavoured variant of probiotic yoghurt with curry leaves extract was also prepared. Probiotic yoghurt sample without curry leaves extract and mango flavor served as the control.



Antimicrobial activity of probiotic yoghurt with curry leaves extract

Antimicrobial activity of the yoghurt against Gram negative pathogens such as *Escherichia coli*, *Salmonella* sp., Gram positive *Staphylococcus aureus*, yeast *Rhodotorula* sp. and molds *Penicillium* sp. and *Aspergillus* sp. was evaluated. Overnight grown each pathogenic bacterial suspension in nutrient broth was swabbed on the surfaces of Mueller-Hinton agar plates using sterile cotton swabs. Lawn cultures of *Rhodotorula* sp., *Penicillium* sp. and *Aspergillus* sp. were smeared uniformly on the surface of malt extract agar using sterile cotton swab. The plates were allowed to dry and wells of 7mm were made using sterile 7 mm diameter borer and 50 μ L yoghurt was fed into the well and then incubated at 37 °C for 24 h. Observations were made by measuring the zone of inhibition based on the diameter of the clear area formed around the well [10].

Antioxidant activity of probiotic yoghurt with curry leaves extract

Antioxidant Activity was determined using the DPPH radical scavenging assay. To 10g of yogurt sample 30 ml of 80 % V/V methanol was added and properly mixed. After that, the obtained mixture was centrifuged for 10 min at 4000 rpm. The centrifuged supernatant was used for determination of antioxidant activity. 0.5 ml of supernatant obtained was thoroughly mixed with 4 ml of ethanolic solution of 0.15 mM DPPH free radical. The volume was adjusted to 10 ml with distilled water and incubated in dark at room temperature for 30 min. The absorbance was measured at 517 nm through spectrophotometer. Sterilized water was used as blank and DPPH solution in ethanol served as the control. The DPPH free radical scavenging

ability was then determined as the percentage inhibition of DPPH free radical using the Equation 1 mentioned [11].

Sensory analysis of probiotic yoghurt with curry leaves extract

Sensory analysis of the developed probiotic yoghurt with curry leaves extract was done by 10 trained panelists (6 females and 4 males) having enough knowledge about the quality of the yoghurt and food science, belong to the Dairy Science College, KVAFSU. The samples were evaluated using a nine-point hedonic scale [12]. Score = 1 has been assigned for “like extremely” and score = 9 has been assigned for “dislike extremely”. Yoghurt samples were analyzed for colour, appearance, body, texture, flavor, and overall acceptability.

Results and Discussion

Antimicrobial activity of curry leaves extract

The extract showed no zone of clearance (NZC) against *E. coli*, *Rhodotorula* sp., *Penicillium* sp., and *Aspergillus* sp. at all tested concentrations (Figure 1(A)). The extract showed activity against *Salmonella* sp. only at the highest concentration of 300 mg/ml, producing a zone of clearance of 15 mm (Figure 1 (B)). The extract exhibited antibacterial activity against *S. aureus* at concentrations of 150 mg/ml (11 mm), 200 mg/ml (13 mm), 250 mg/ml (14 mm), and 300 mg/ml (16 mm) as shown in Figure 1 (C). The highest inhibition was observed at 300 mg/ml, with a zone of clearance of 16 mm, which was significantly different as indicated by the superscript ‘a’ and a critical difference (CD) value of 2.896 at $P=0.05$. The negative control (0.1% DMSO) showed no antimicrobial activity against any of the tested microorganisms. The results are illustrated in Table 1.

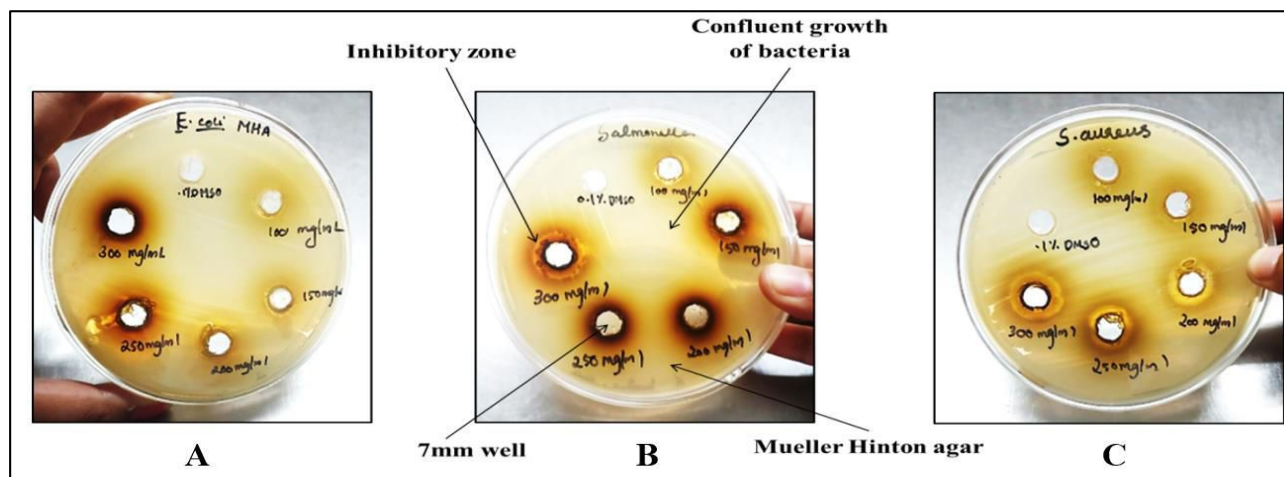


Fig 1: Antimicrobial activity of curry leaves extract (100-300 mg/ml) against A) *E.coli*, B) *Salmonella* sp., and C) *S. aureus*

Table 1: Antimicrobial activity of curry leaves extract

Concentration (mg/ml)	Zone of clearance (mm)					
	<i>E. coli</i>	<i>Salmonella</i> sp.	<i>S. aureus</i>	<i>Rhodotorula</i> sp.	<i>Penicillium</i> sp.	<i>Aspergillus</i> sp.
100	NZC	NZC	NZC	NZC	NZC	NZC
150	NZC	NZC	11 ^b	NZC	NZC	NZC
200	NZC	NZC	13 ^b	NZC	NZC	NZC
250	NZC	NZC	14 ^{ab}	NZC	NZC	NZC
300	NZC	15	16 ^a	NZC	NZC	NZC
0.1% DMSO (-Ve control)	NZC	NZC	NZC	NZC	NZC	NZC
CD ($P=0.05$)	-	-	2.896	-	-	-

*Values are expressed as mean of triplicate determination (n=3). Different alphabet superscripts within the same column are significantly different, while same superscripts indicate no significant difference ($P = 0.05$). CD-Critical difference; NZC-No Zone of clearance; DMSO-Dimethyl sulfoxide.

These findings align with the report by Rana ^[13], which showed no inhibition zone against *E. coli* at 100 to 300 mg/ml of aqueous curry leaves extract. Similarly, Kavitha *et al.* ^[14] found no inhibition zones against *E. coli*, *Salmonella*, and *S. aureus* using a 100 mg/ml aqueous curry leaves extract. However, our results contrast with the findings of Al Harbi *et al.* ^[15], who observed zones of inhibition of 12 and 14 mm against *S. aureus* at 250 and 500 mg/ml of aqueous curry leaves extract, and 25 and 32 mm against *E. coli* at the same concentrations. The discrepancy could be attributed to variations in extraction methods, bacterial strains, or environmental conditions. Smaller inhibition zones of 4.5, 4, and 5 mm against *E. coli*, *Salmonella typhimurium*, and *S. aureus* respectively at 750 mg/ml of aqueous extract was reported by another study ^[16]. The lower activity observed in their study compared to ours could be due to the higher concentrations required for effectiveness or differences in bacterial susceptibility. Regarding antifungal activity, the results align with findings from Izionworu ^[17], who reported that aqueous curry leaves extracts were less effective, whereas ethanol extracts exhibited greater inhibitory activity against *Penicillium camemberti* and *Aspergillus niger* with minimum inhibitory concentration of 20 g/ml.

The observed antibacterial activity in our study could be attributed to the presence of phenolic compounds, particularly gallic acid, known for their antibacterial effects ^[18]. Additionally, the extract was more effective against Gram-positive *S. aureus* than Gram-negative bacteria. This is likely due to the simpler, more permeable cell wall structure of Gram-positive bacteria, which primarily consists of peptidoglycan, making them more susceptible to antibacterial agents. In contrast, Gram-negative bacteria, such as *E. coli*, have a more complex outer membrane with lipopolysaccharides that act as a barrier to harmful compounds ^[19]. This structural difference explains the absence of inhibition zones for Gram-negative bacteria, particularly *E. coli*, in our study. Overall, the results indicate that curry leaves extract possesses selective antibacterial activity, particularly against Gram-positive bacteria, supporting its potential as a natural antimicrobial agent.

Antioxidant activity of curry leaves extract

DPPH radical scavenging activity of aqueous curry leaves extract was found to be 13.05 and 54.06% inhibition at a concentration of 10 and 60 µg/ml respectively and the IC₅₀ value was found to be 54.23 µg/ml. The results of DPPH radical scavenging assay shows that as the concentration of curry leaves extract rises from 10 to 60 µg/ml the percentage of inhibition increases, indicating the presence of

compounds acting as radical scavengers or antioxidants capable of donating hydrogen or electrons to DPPH, which is a nitrogen-centered free radical ^[20].

Kumari *et al.* ^[21], reported that the IC₅₀ value of 58.62 and 114.24 µg/ml for methanolic and petroleum ether (60-80°C) extracts of curry leaves respectively, which were higher than the values obtained in the current study. Since a smaller IC₅₀ value indicates a greater radical scavenging activity and, consequently, a higher antioxidant capacity, the results obtained suggest a potentially superior antioxidant efficacy of the extracts tested in this study ^[22]. Devatkal *et al.* ^[23], reported the % inhibition of 100 µg/ml of hot water extract of curry leaves as 61.4%. In their study they found out that extracts of curry leaves may act as electron donors and they can react with free radicals to convert them into more stable products and terminate radical chain reactions. They also observed that antioxidant activity appears to be directly correlated to the polyphenol content and flavonoid compounds present in them. Research further attributes this activity to various phenolic compounds, including caffeic acid, ferulic acid, gallic acid, chlorogenic acid, cinnamic acid, and vanillic acid, as well as flavonoids like myricetin, quercetin, and kaempferol, along with carbazole alkaloids. These bioactive compounds play a key role in scavenging free radicals, reducing oxidative stress, and preventing cellular damage, positioning curry leaves as a valuable source of dietary antioxidants that help prevent oxidative stress-related diseases ^[21, 24].

Antimicrobial activity of probiotic yoghurt with curry leaves extract

Against *E. coli* the control probiotic yoghurt exhibited an inhibition zone of 13.92 mm, while curry leaves extract incorporated probiotic yoghurt and mango-flavoured curry leaves extract incorporated probiotic yoghurt showed similar inhibition zones of 13.37 and 13.2 mm, respectively as shown in Figure 2 (A). In case of *Salmonella* sp. the inhibition zone increased significantly from 11.52 mm in control probiotic yoghurt to 17.95 mm in curry leaves extract incorporated probiotic yoghurt and 17.88 mm in mango-flavoured curry leaves extract incorporated probiotic yoghurt (Figure 2 (B)). The control probiotic yoghurt exhibited an inhibition zone of 15.62 mm against *S. aureus*. A substantial increase in the zone of clearance was observed in curry leaves extract incorporated probiotic yoghurt (20.15 mm) and its mango-flavoured variant (20.02 mm) as shown in Figure 2 (C). No zone of clearance (NZC) was observed for *Rhodotorula* sp., *Penicillium* sp., and *Aspergillus* sp. in any of the yoghurt samples. The results are presented in Table 2.

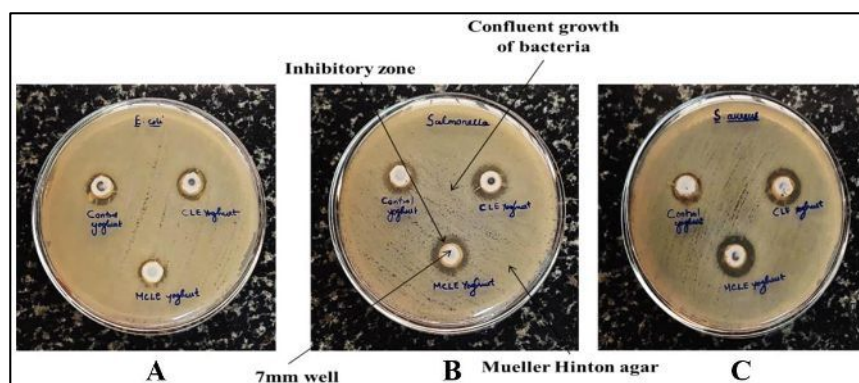


Fig 2: Antimicrobial activity of probiotic yoghurt with curry leaves extract against A) *E. coli*, B) *Salmonella*, and C) *S. aureus*

Table 2: Antimicrobial activity of probiotic yoghurt with curry leaves extract

Samples	Zone of clearance (mm)					
	<i>E. coli</i>	<i>Salmonella</i> sp.	<i>S. aureus</i>	<i>Rhodotorula</i> sp.	<i>Penicillium</i> sp.	<i>Aspergillus</i> sp.
PY (Control)	13.92 ^a	11.52 ^b	15.62 ^b	NZC	NZC	NZC
PYCLE	13.37 ^a	17.95 ^a	20.15 ^a	NZC	NZC	NZC
MPYCLE	13.2 ^a	17.88 ^a	20.02 ^a	NZC	NZC	NZC
C.D (<i>P</i> = 0.05)	2.504	1.421	2.238	-	-	-

*Values are expressed as mean of triplicate determination (n=3). Different alphabet superscripts within the same column are significantly different, while same superscripts indicate no significant difference (*P* = 0.05). CD-Critical difference; NZC-No Zone of clearance; PY-Probiotic yoghurt; PYCLE-Probiotic yoghurt with 0.1% curry leaves extract; MPYCLE-Mango flavoured probiotic yoghurt with 0.1% curry leaves extract

In comparison, Azizkhani *et al.* [25] reported antimicrobial activity in cow milk yoghurt against all tested pathogens, including *A. niger* (7.6 mm) and *Penicillium* sp. (3.1 mm), unlike our study, where no inhibition was observed against these fungi. Their study also showed inhibition zones of 17.9 mm for *S. aureus*, 12.4 mm for *E. coli*, and 10.3 mm for *Salmonella enterica*, which are generally lower than the values observed in our curry leaves extract incorporated yoghurt, highlighting the enhanced antibacterial potency conferred by curry leaves extract. Hanifah *et al.* [19] found that yoghurt supplemented with *Lactobacillus acidophilus* IIA-2B4 showed no inhibition against *A. niger*, similar to our findings, but exhibited zones of inhibition of 18 mm for *S. aureus*, 5.88 mm for *E. coli*, and 5.64 mm for *Salmonella typhi*. The addition of roselle extract in their study further enhanced antimicrobial activity, with inhibition zones increased to 19.98 mm for *S. aureus*, 11.88 mm for *E. coli*, and 18.15 mm for *Salmonella typhi*. These results were comparable to the enhanced antimicrobial effects observed in our study with curry leaves extract, particularly against *S. aureus* and *Salmonella* sp. Overall, the enhanced antibacterial activity in our curry leaves extract incorporated probiotic yoghurt suggests its potential as a natural antimicrobial agent, particularly against *S. aureus* and *Salmonella* sp. It is also clear that probiotic yoghurt with or without addition of curry leaves extract were unable to inhibit yeast and molds used in the study. This suggests that the compounds produced during fermentation either lacked antifungal activity or were present at concentrations too low to exhibit significant antifungal effects. Another possible reason for the survival of yeast and mold could be their ability to thrive in acidic environments [19].

Antioxidant activity of probiotic yoghurt with curry leaves extract

The antioxidant activity, measured by DPPH % inhibition, was found to be significantly higher in probiotic yoghurt with curry leaves extract and its mango flavoured variant with values 81.86% and 81.43% respectively, compared to

the control with 73.35%. This indicates that curry leaves extract enhances antioxidant properties, contributing to the yoghurt's functional benefits.

According to Zhang *et al.* [26], the antioxidant activity of yoghurt samples enriched with 0.05, 0.1, and 0.2% moringa leaves extract was approximately 41.2, 59.7, and 71.6%, respectively, as measured by the DPPH radical-scavenging assay. In contrast, the control sample showed a much lower antioxidant activity of about 9.8%. The enhanced antioxidant potential in the moringa-supplemented yoghurts was attributed to the presence of flavonoids such as quercetin and kaempferol. Felfoul *et al.* [27] reported that yoghurts enriched with 1% ginger powder exhibited an antioxidant activity of 80.23%, while the control yoghurt showed 63.33%. The high DPPH radical scavenging activity observed in the control sample was linked to the presence of bioactive peptides and free amino acids with antioxidant properties produced during the fermentation by lactic acid bacteria. The enhanced antioxidant activity in the ginger-supplemented yoghurt was attributed to the microbial metabolism of phenolic compounds from the ginger powder and the formation of new phenolic acids during acidification. According to Gjorgievski *et al.* [28], the antioxidant activity of milk fermented with symbiotic cultures of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus* was 52.44%. In contrast, milk fermented individually with probiotic strains of *Lactobacillus acidophilus* and *Bifidobacterium bifidum* showed antioxidant activities of 63.99% and 54.93%, respectively. The higher antioxidant activity observed in our study could be attributed to the combined use of all four bacterial cultures.

Sensory analysis of probiotic yoghurt with curry leaves extract

The sensory analysis of probiotic yoghurt samples revealed notable differences in color and appearance, body and texture, flavour, and overall acceptability as shown in Table 3.

Table 3: Sensory analysis of probiotic yoghurt with curry leaves extract

Samples	Sensory attributes				
	Color and appearance	Body and Texture	Flavour	Overall acceptability	Remarks
PY (Control)	7.83 ^a	7.33 ^b	7.5 ^a	7.5 ^b	• Visible whey separation • Very soft body and texture
PYCLE	7.83 ^a	8.66 ^a	7.6 ^a	8.5 ^a	• No whey separation • Good body and texture
MPYCLE	7.66 ^a	8.33 ^a	6.6 ^b	6.83 ^b	• No whey separation • Good body and texture • Slight bitter taste
C.D (<i>P</i> = 0.05)	0.856	0.605	0.494	0.699	-

*Values are expressed as mean of triplicate determination (n=3). Different alphabet superscripts within the same column are significantly different, while same superscripts indicate no significant difference (*P* = 0.05); CD-Critical difference; PY-Probiotic yoghurt; PYCLE-Probiotic yoghurt with 0.1% curry leaves extract; MPYCLE-Mango flavoured probiotic yoghurt with 0.1% curry leaves extract

Control probiotic yoghurt received a mean score of 7.83 for color and appearance, 7.33 for body and texture, 7.5 for flavour, and 7.5 for overall acceptability. It exhibited visible whey separation and a very soft body and texture. In contrast, probiotic yoghurt with curry leaves extract scored 7.83 for color and appearance, 8.66 for body and texture, 7.6 for flavour, and 8.5 for overall acceptability. It showed no whey separation and had good body and texture. Meanwhile, mango-flavoured probiotic yoghurt with curry leaves extract obtained scores of 7.66 for color and appearance, 8.33 for body and texture, 6.6 for flavour, and 6.83 for overall acceptability. Although it exhibited no whey separation and maintained good body and texture, it was noted for a slight bitter taste and a slight medicinal flavor. This highlights the need for flavor optimization and suggests exploring flavor alternatives such as vanilla, pistachio, or pineapple to better complement the curry leaves extract. Several studies have demonstrated that incorporating plant extracts into yoghurt formulations can enhance sensory attributes, particularly body and texture, leading to improved overall acceptability compared to control samples. For instance, Joung *et al.* [29] found that the addition of leaf extract of Korean traditional plants *Diospyros kaki* and *Nelumbo nucifera* increased scores related to flavor, taste, and texture, resulting in higher overall preference ratings compared to control yoghurt without any leaf extracts. Similarly, a study investigating the enrichment of yoghurt with olive leaf powder (OLP) and its extract (OLE) reported that concentrations lower than 1.5 mg/ml of OLP and 5 mg/ml of OLE were acceptable in terms of sensory characteristics. The enriched yoghurts also exhibited improved microbiological, physicochemical, and antioxidant properties during 21 days of storage at 4 °C [30]. These findings align with the observed improvements in body and texture in yoghurt samples incorporated with curry leaves extract, suggesting that the addition of certain plant extracts can positively influence sensory attributes and overall acceptability of yoghurts.

Conclusion

This study demonstrates that curry leaves extract can effectively enhance the antimicrobial and antioxidant properties of probiotic yoghurt while maintaining good sensory acceptability. The extract exhibited significant antibacterial activity against *S. aureus* and *Salmonella* sp. and showed promising antioxidant potential, as indicated by the DPPH radical scavenging assay. The incorporation of curry leaves extract in probiotic yoghurt improved its functional properties without compromising consumer acceptance, making it a viable natural additive for functional dairy products. These findings support the potential application of curry leaves extract in the development of healthier and more sustainable probiotic yoghurt with enhanced therapeutic benefits.

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