International Journal of Food and Fermentation Technology
Citation: *Int. J. Food Ferment. Technol.*, **15**(02): 275-284, December 2025
DOI: 10.30954/2277-9396.02.2025.2

ASSOCIATION FOR AGRICULTURE ENVIRONMENT AND BIOTECHNOLOGY

RESEARCH PAPER

Quality Attributes of Avocado, Pumpkin Seeds and Lemon Fortified Lactose-Hydrolyzed Curd and Yogurt

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Paper No.: 325 **Received:** 13-09-2025 **Revised:** 22-11-2025 **Accepted:** 04-12-2025

ABSTRACT

The present study focuses on developing lactose-hydrolyzed curd and yoghurt enriched with avocado pulp powder, pumpkin seed powder, and lemon juice, and evaluating their physico-chemical and sensory characteristics. Compared to the control (non-hydrolyzed samples), the lactose-hydrolyzed variants exhibited higher acidity, greater syneresis, and reduced setting time. Incorporation of avocado pulp powder (0.25%, 0.50%, 0.75%), pumpkin seed powder (0.50%, 0.75%, 1.00%), and lemon juice (0.50%, 0.75%, 1.00%) into the hydrolyzed curd and yoghurt resulted in increased titratable acidity, decreased syneresis, and shorter setting time, except for lemon juice which caused a rise in syneresis. The optimized formulations demonstrated improved physico-chemical properties, with syneresis reduced by 1.8 ml, setting time shortened by 115 minutes, and acidity increased by 0.16% LA. Sensory evaluation revealed that samples containing 0.50% avocado pulp powder, 0.75% pumpkin seed powder, and 0.75% lemon juice achieved the highest scores for colour and appearance, body and texture, flavour, and overall acceptability on the 9-point Hedonic scale. The enriched lactose-hydrolyzed curd and yoghurt showed enhanced physicochemical characteristics and superior sensory quality when compared with both lactose-hydrolyzed and non-hydrolyzed control samples.

Keywords: Lactose hydrolysis, Avocado, Pumpkin seeds, Lemon, Curd, Yoghurt

Lactose is a disaccharide found in milk that can be hydrolysed by the enzyme lactase (β-galactosidase). Lactase, located in the brush border epithelial cells of the small intestine, breaks lactose into its monosaccharide components—glucose and galactose. It is estimated that about 68% of the global population and around 65% of the Indian population are lactose intolerant due to insufficient lactase activity in the intestine. Individuals with lactose intolerance often experience gastrointestinal symptoms such as bloating, diarrhoea, flatulence, abdominal pain, nausea, and loss of appetite (Nagrala *et al.* 2019).

At present, low-lactose (<1.0%) and lactose-free (<0.1%) milk products are gaining popularity due to their improved digestibility. These products can be produced either through membrane filtration or enzyme-based lactose hydrolysis. Several microbial sources—including *Kluyveromyces lactis*, *Aspergillus oryzae*, and *Escherichia coli*—can produce lactase, which after purification is used to hydrolyse lactose in milk. In the dairy industry, β-galactosidase has multiple applications, such as preventing lactose crystallisation, increasing sweetness, producing low-lactose foods, and utilising cheese whey (Kaur *et al.* 2017; Skryplonek *et al.* 2017; Joon *et al.* 2018). Studies indicate that starter cultures grow more rapidly when

How to cite this article: Anjana, M. Pushpa, B.P., Shashi Kumar, C.S. and Anjum. (2025). Quality Attributes of Avocado, Pumpkin Seeds and Lemon Fortified Lactose-Hydrolyzed Curd and Yogurt. *Int. J. Food Ferment. Technol.*, **15**(02): 275-284.

Source of Support: None; **Conflict of Interest:** None

monosaccharides are available as carbon sources, reducing the setting time needed to achieve the desired acidity in fermented products (Skryplonek *et al.* 2017; Sharanagouda *et al.* 2022).

Fermented milk products are often recommended for lactose-intolerant individuals, as curd and yoghurt naturally have about 30% lower lactose content. In this study, lactose-hydrolysed milk was used for preparing curd and yoghurt, further reducing lactose levels to below 1.0% through the combined effects of enzymatic hydrolysis (conversion of lactose to glucose and galactose) and fermentation (conversion of lactose to lactic acid). Since complete hydrolysis by enzymes alone requires a longer time, the objective was to apply partial hydrolysis followed by fermentation to develop low-lactose products.

The study also aimed to enhance the nutritional profile of the products by fortifying them with micronutrient-rich plant sources, which may additionally support starter culture growth. Avocado pulp powder, pumpkin seed powder, and lemon juice serve as excellent sources of vitamins and minerals. Avocado (*Persea americana*) is rich in vitamins such as β-carotene, tocopherol, retinol, ascorbic acid, thiamine, riboflavin, niacin, pyridoxine, and folic acid, along with minerals like potassium, magnesium, calcium, sodium, phosphorus, zinc, and iron. It is one of the rare fruits that contains both water- and fat-soluble vitamins, along with phyto-compounds such as omega fatty acids, phytosterols, tocopherols, and squalene, which contribute to its therapeutic benefits (Duarte *et al.* 2016).

Pumpkin seeds are rich in amino acids, phytosterols, unsaturated fatty acids, phenolic compounds, tocopherols, cucurbitacins, carotenoids, and essential minerals such as iron, zinc, calcium, phosphorus, and manganese. Their known health benefits include regulation of blood glucose and cholesterol levels, and support for liver, prostate, and bladder health. They also possess immunomodulatory, antioxidant, anti-diabetic, anti-inflammatory, anti-fungal, and anti-bacterial properties (Amin *et al.* 2019).

Lemon juice contributes flavour and provides ascorbic acid, an antioxidant that prevents enzymatic browning in products containing fruits or vegetables. It is also known for its medicinal properties, including benefits for blood pressure regulation, immunity, and treatment of conditions like scurvy and sore throat (Klimek *et al.* 2020).

This study therefore examines lactose hydrolysis in milk and the effect of incorporating micronutrient-rich plant sources into curd and yoghurt. The influence of avocado pulp powder, pumpkin seed powder, and lemon juice on the physico-chemical characteristics and sensory qualities of lactose-hydrolysed curd and yoghurt is discussed, focusing on parameters such as setting time, titratable acidity, syneresis, and overall acceptability.

MATERIALS AND METHODS

Preparation of lactose hydrolysed Milk

Homogenized cow's milk containing 3.5% fat and 8.5% SNF was heated at 90 °C for 10 minutes, then cooled to 40 °C. Lactase enzyme (DSM Food Specialities, Heerlen, Netherlands) was added at a concentration of 0.30%, and the mixture was incubated at 40 °C for 1 hour to obtain lactose-hydrolyzed milk.

Preparation of lactose hydrolysed curd and yoghurt

A curd starter culture comprising *Lactococcus lactis* ssp. *lactis* was incorporated into lactose-hydrolysed milk at a concentration of 1.5%. In parallel, a yoghurt starter culture consisting of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus* (YO-MIX, Danisco) was inoculated at a 1:1 ratio, also at 1.5%. The inoculated mixtures were dispensed into polypropylene cups and subjected to incubation under controlled conditions: 37 ± 1 °C for 5–6 h for curd production, and 42 ± 1 °C for 4–5 h for yoghurt production. Following incubation, the products were stored at 5 °C.

Preparation of micronutrients rich curd and yoghurt using lactose hydrolysed milk

Lactose-hydrolysed curd and yoghurt formulations were developed by incorporating avocado fruit powder, pumpkin seed powder, and fresh lemon

juice at varying levels, as illustrated in Fig. 1 (flow chart). The blended ingredients were homogenized at 1000 rpm using a laboratory homogenizer, followed by pasteurization at 90 °C for 10 minutes. Subsequently, the mixture was cooled to 37 °C for curd preparation and 42 °C for yoghurt preparation. The cooled samples were inoculated with respective starter cultures, packaged in polypropylene cups, and stored at 5 °C until further analysis.

Physico-chemical analysis

The influence of incorporating avocado fruit powder, pumpkin seed powder, and fresh lemon juice, along with the characteristics of the final formulated product, was investigated in lactose-hydrolysed curd and yoghurt. The physico-chemical attributes, namely titratable acidity (IS: SP 18, Part XI, 1981), syneresis (Nagaraj *et al*. 2009), and setting time (minutes), were systematically evaluated for the prepared samples.

Sensory evaluation

Lactose-hydrolysed curd and yoghurt fortified with avocado fruit powder, pumpkin seed powder, and fresh lemon juice were subjected to sensory evaluation for product optimization. Semi-trained judges assessed the samples, and grading was performed by panellists based on sensory attributes including colour and appearance, body and texture, flavour, and overall acceptability, using a 9-point hedonic scale.

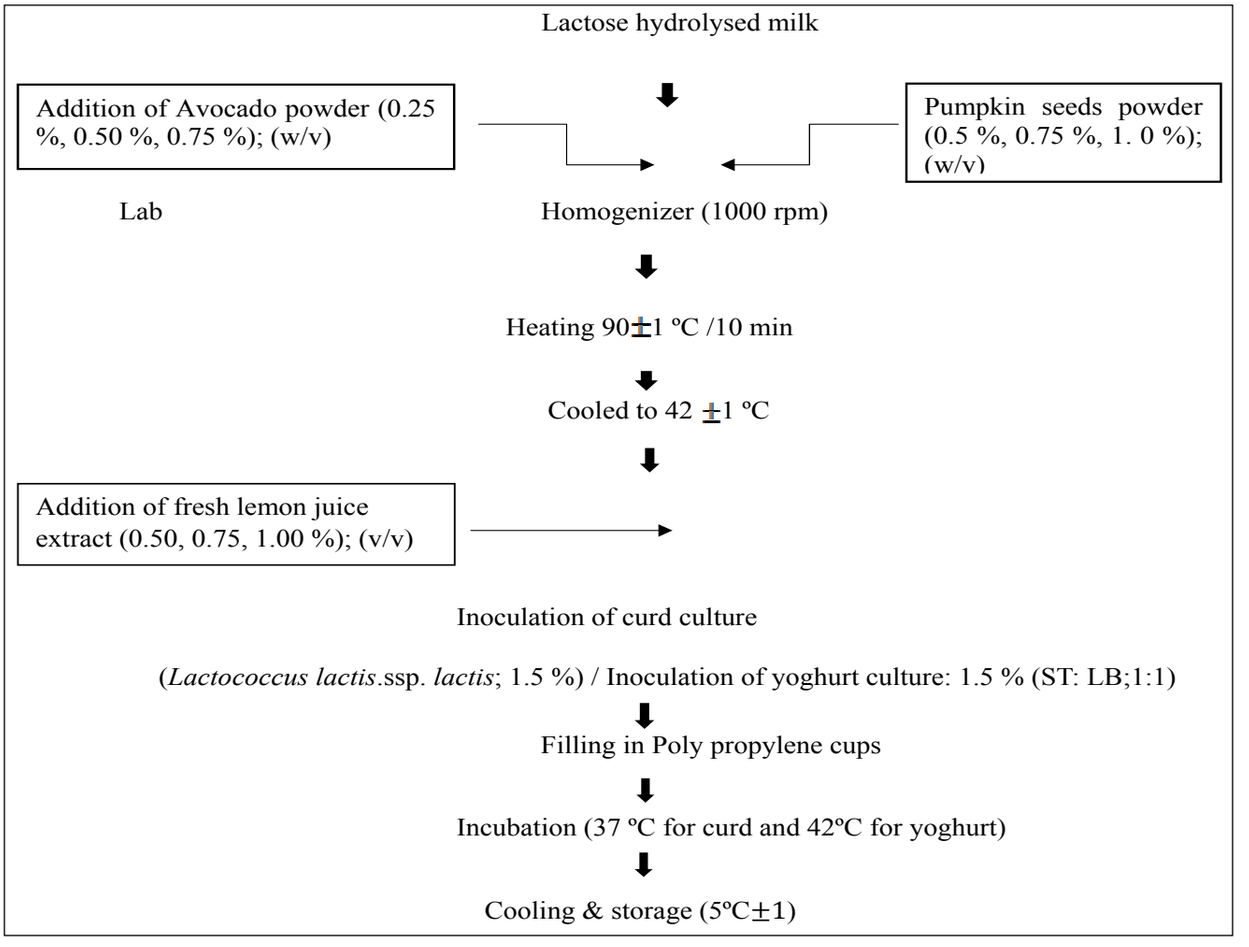

Fig. 1: Preparation of micronutrient rich yoghurt using lactose hydrolysed milk

RESULTS AND DISCUSSION

The influence of avocado fruit powder on the physico-chemical properties of lactose-hydrolysed curd and yoghurt is summarized in Table 1. The powder was incorporated at concentrations of 0.25, 0.50, and 0.75%, and the resulting products were evaluated in comparison with two controls: unhydrolyzed samples (Control 1) and lactose-hydrolysed samples without avocado powder (Control 2).

Table 1: Effect of avocado fruit powder on physico-chemical characteristics in lactose hydrolysed curd and yoghurt

Samples	Setting time (min)	Titratable acidity (%LA)	Syneresis (ml/100 g)
Curd			
Control 1	333^{e}	0.66^{a}	28.80^{d}
Control 2	288^{d}	0.76^{b}	30.76^{e}
0.25 %	265^{c}	0.79^{b}	27.70^{c}
0.50 %	241^{b}	0.82^{b}	26.90^{b}
0.75 %	218^{a}	0.84^{b}	24.96^{a}
CD(P≤0.05)	10.95	0.04	0.42
Yoghurt			
Control 1	225^{d}	0.62^{a}	27.46^{d}
Control 2	201^{c}	0.66^{a}	29.50^{e}
0.25 %	187^{bc}	0.71^{ab}	26.70^{c}
0.50 %	178^{ab}	0.79^{b}	25.90^{b}
0.75 %	163^{a}	0.80^{b}	24.96^{a}
CD(P≤0.05)	9.72	0.06	0.55

Note: *All values are average of three trials; Similar superscripts indicate non-significant at the corresponding critical difference.*

Control 1: *Lactose unhydrolyzed;* ***Control 2:*** *Lactose hydrolysed*

Setting time

The setting times for short-set curd and yoghurt in the unhydrolyzed samples (Control 1) were 333 and 224 minutes, respectively. Hydrolysis reduced the setting time by 45 minutes in curd and 24 minutes in yoghurt. Further supplementation with avocado powder at concentrations of 0.25, 0.50, and 0.75% resulted in additional reductions of 23, 47, and 70 minutes in curd, and 14, 23, and 38 minutes in yoghurt, respectively, when compared with hydrolyzed samples without avocado powder (Control 2). Statistical analysis confirmed that the incorporation of avocado fruit powder at varying levels exerted a significant effect on the setting time of both curd and yoghurt (P≤0.05).

A pronounced reduction in setting time was observed in hydrolysed curd samples, with the incorporation of avocado powder further accelerating coagulation relative to the unhydrolyzed control (Control 1). The magnitude of reduction was nearly double that observed in yoghurt samples. These findings indicate that lactose hydrolysis, in combination with avocado-derived nutrients, exerts a significant stimulatory effect on mesophilic starter cultures in curd, whereas thermoduric cultures in yoghurt were comparatively less influenced.

Titratable acidity

Titratable acidity (expressed as % lactic acid) in hydrolysed curd and yoghurt (control 2) was 0.76 and 0.67% LA, respectively, compared to 0.66 and 0.62% LA in the corresponding unhydrolyzed samples. A statistically significant difference (P ≤ 0.05) was observed only in the curd samples. Fortification with avocado at levels of 0.25, 0.50, and 0.75% resulted in a further increase in acidity; however, these changes were not statistically significant among the fortified treatments themselves, though they differed significantly from the unhydrolyzed curd and yoghurt controls. The slightly higher acidity in treated curd samples may be attributed to longer setting times and the more rapid proliferation of mesophilic cultures compared to yoghurt. The marked reduction in setting time observed in avocado-fortified curd further supports the increase in acidity.

Syneresis

Lactose hydrolysis resulted in an increase in syneresis, reaching 30.76 and 29.50 ml/100 g in curd and yoghurt, respectively, compared to the non-hydrolyzed samples (28.80 and 27.46 ml/100 g, v/m, respectively). The difference between hydrolyzed and non-hydrolyzed samples was statistically significant (P ≤ 0.05), with curd exhibiting slightly higher syneresis than yoghurt. Incorporation of

avocado powder at concentrations of 0.25, 0.50, and 0.75% progressively reduced syneresis to 27.70, 26.90, and 24.96% in curd, and to 26.70, 25.90, and 24.96% in yoghurt, respectively. These reductions were statistically significant ($P \leq 0.05$) when compared with the control. The presence of starch, fiber, fat, and protein in avocado likely contributed to enhanced water retention within the gel matrix, thereby mitigating syneresis in the final product.

Effect of pumpkin seeds powder on physico-chemical characteristics in lactose hydrolysed curd and yoghurt

Lactose-hydrolysed curd and yoghurt were formulated with pumpkin seed powder at concentrations of 0.50, 0.75, and 1.00%. These samples were evaluated for their physico-chemical properties and compared against two controls: unhydrolyzed (Control 1) and hydrolysed (Control 2). The experimental results, including setting time (min), titratable acidity (% LA), and syneresis (mL/100 g), are summarized in Table 2.

Table 2: Effect of pumpkin seeds powder on physico-chemical characteristics in lactose hydrolysed curd and yoghurt

Samples	Setting time (min)	Titratable acidity (%LA)	Syneresis (ml/100 g)
Curd			
Control 1	333^{d}	0.66^{a}	28.80^{d}
Control 2	288^{c}	0.76^{b}	30.76^{e}
0.50 %	263^{b}	0.77^{b}	27.50^{c}
0.75 %	238^{ab}	0.81^{b}	26.66^{b}
1.00 %	215^{a}	0.82^{b}	24.86^{a}
CD(P≤0.05)	13.56	0.05	0.41
Yoghurt			
Control 1	225^{d}	0.62^{a}	27.46^{c}
Control 2	201^{c}	0.66^{a}	29.50^{d}
0.50 %	184^{b}	0.70^{ab}	27.70^{c}
0.75 %	175^{ab}	0.78^{b}	26.06^{b}
1.00 %	158^{a}	0.79^{b}	25.13^{a}
CD(P≤0.05)	11.84	0.19	0.58

Note: *All values are average of three trials; Similar superscripts indicate non-significant at the corresponding critical difference.*

Control 1: *Lactose unhydrolyzed;* ***Control 2:*** *Lactose hydrolysed*

Setting time

The incorporation of pumpkin seed powder at concentrations of 0.50, 0.75, and 1.00% resulted in a reduction in setting time of 25, 50, and 73 minutes for curd, and 17, 26, and 43 minutes for yoghurt, respectively, when compared with hydrolyzed samples lacking pumpkin seed powder (control 2). Statistical analysis confirmed that the variations in setting time across different supplementation levels were significant ($P \leq 0.05$).

A pronounced reduction in setting time was observed in hydrolysed curd samples, with the incorporation of pumpkin seed powder further accelerating coagulation relative to the unhydrolyzed control. The magnitude of reduction was nearly twofold compared to that observed in yoghurt samples. These findings indicate that lactose hydrolysis, in combination with the nutritional constituents of pumpkin seeds, exerts a significant stimulatory effect on mesophilic starter cultures in curd, whereas thermoduric cultures in yoghurt were comparatively less influenced.

Titratable acidity

The titratable acidity of hydrolysed curd and yoghurt samples was found to be 0.76% and 0.66% lactic acid (LA), respectively, with curd exhibiting a statistically significant difference ($P \leq 0.05$). Incorporation of pumpkin seeds at concentrations of 0.50, 0.75, and 1.00% resulted in a progressive increase in acidity, reaching maximum values of 0.82% LA in curd and 0.70% LA in yoghurt at 1.00% supplementation. However, the differences in acidity among the treatments were statistically non-significant ($P \leq 0.05$). In contrast, significant variation was observed when compared with unhydrolyzed samples. Factors such as curd setting time, microbial growth in lactose-hydrolysed milk, and fortification with nutrient-rich ingredients may collectively influence the acidity profile of milk-based products.

Syneresis

The incorporation of pumpkin seed powder into curd resulted in a reduction of syneresis (ml/100

g) to 27.50, 26.66, and 24.86%, and in yoghurt to 27.70, 26.06, and 25.13% at supplementation levels of 0.50, 0.75, and 1.00%, respectively. All treated samples exhibited a statistically significant decrease in syneresis compared with both un-hydrolysed and hydrolysed control groups.

Effect of lemon juice on physico-chemical characteristics in lactose hydrolysed curd and yoghurt

Lactose-hydrolysed curd and yoghurt were prepared with the addition of lemon juice at concentrations of 0.50, 0.75, and 1.00%. These samples were evaluated for their physico-chemical properties and compared against two controls: unhydrolyzed (Control 1) and hydrolysed (Control 2). The results pertaining to setting time (min), titratable acidity (% LA), and syneresis (mL/100 g) are summarized in Table 3.

Table 3: Effect of lemon juice on physico-chemical characteristics in lactose hydrolysed curd and yoghurt

Samples	Setting time (min)	Titratable acidity (%LA)	Syneresis (ml/100 g)
Curd			
Control 1	333^{d}	0.66^{a}	28.80^{b}
Control 2	288^{c}	0.76^{b}	30.76^{c}
0.50 %	239^{b}	0.79^{bc}	27.86^{a}
0.75 %	218^{a}	0.82^{bc}	28.63^{b}
1.00 %	205^{a}	0.86^{c}	31.33^{d}
CD(P≤0.05)	10.87	0.04	0.96
Yoghurt			
Control 1	225^{d}	0.62^{a}	27.46^{b}
Control 2	201^{c}	0.66^{ab}	29.50^{c}
0.50 %	144^{b}	0.72^{b}	26.06^{a}
0.75 %	127^{a}	0.82^{c}	26.23^{a}
1.00 %	113^{a}	0.85^{c}	29.50^{c}
CD(P≤0.05)	8.65	0.04	0.80

Note: *All values are average of three trials; Similar superscripts indicate non-significant at the corresponding critical difference.*

Control 1: *Lactose unhydrolyzed;* ***Control 2:*** *Lactose hydrolysed.*

Setting time

The incorporation of lemon juice at concentrations of 0.50, 0.75, and 1.00% resulted in a reduction of setting time by 49, 70, and 83 minutes in curd, and by 57, 74, and 88 minutes in yoghurt, respectively, when compared with hydrolysed samples without lemon juice (Control 2). Statistical analysis indicated that the effects of lemon juice addition on curd and yoghurt setting times were significant ($P \leq 0.05$) relative to the control, with the exception of the difference observed between the 0.75% and 1.00% levels, which was not statistically significant.

A reduction in setting time was observed in hydrolysed curd samples, with the incorporation of lemon juice further decreasing the time up to the 0.75% level compared to the unhydrolyzed control (Control 1). The magnitude of reduction was comparable in both curd and yoghurt samples. These findings indicate that the addition of lemon juice, owing to its citric acid content, lowered the pH and thereby facilitated faster coagulation, independent of the microbial cultures employed in curd and yoghurt.

Titratable acidity

The incorporation of lemon juice resulted in a marked increase in titratable acidity (% LA), rising from 0.66% and 0.62% in the respective controls to peak values of 0.86% and 0.85% at 1.00% lemon juice concentration in curd and yoghurt. The variation in lemon juice levels exerted a statistically significant effect ($P \leq 0.05$) on the acidity of both products relative to the controls. This enhancement in acidity can be attributed to the citric acid content of lemon juice (5–8%) and its inherently low pH (2–3).

Syneresis

The incorporation of lemon juice at concentrations of 0.50% and 0.75% into curd and yoghurt resulted in a reduction of syneresis, with values of 27.86% and 28.63% for curd, and 26.06% and 26.23% for yoghurt, respectively, compared to the unhydrolyzed control (Control 1). In contrast, the addition of lemon juice at 1.00% led to a significant increase in syneresis in both curd and yoghurt, comparable to that observed in the hydrolysed control (Control 2). The elevated syneresis at higher lemon juice concentrations may be attributed to increased acidity levels in the samples.

Effect of avocado fruit powder, pumpkin seeds and lemon juice on sensory attributes in lactose hydrolysed curd and yoghurt

Lactose-hydrolysed curd and yoghurt supplemented with avocado fruit powder (0.25, 0.50, and 0.75%), pumpkin seed powder (0.50, 0.75, and 1.00%), and lemon juice (0.50, 0.75, and 1.00%) were subjected to sensory evaluation using a 9-point Hedonic scale by semi-trained panelists. The influence of varying levels of plant-derived ingredients on sensory attributes of curd and yoghurt is presented in Fig. 2. Among the controls, lactose-hydrolysed samples (Control 2) consistently achieved higher scores across all sensory parameters—colour and appearance (7.82 and 7.71), body and texture (8.30 and 8.21), flavour (8.05 and 8.12), and overall acceptability (8.04 and 8.10)—

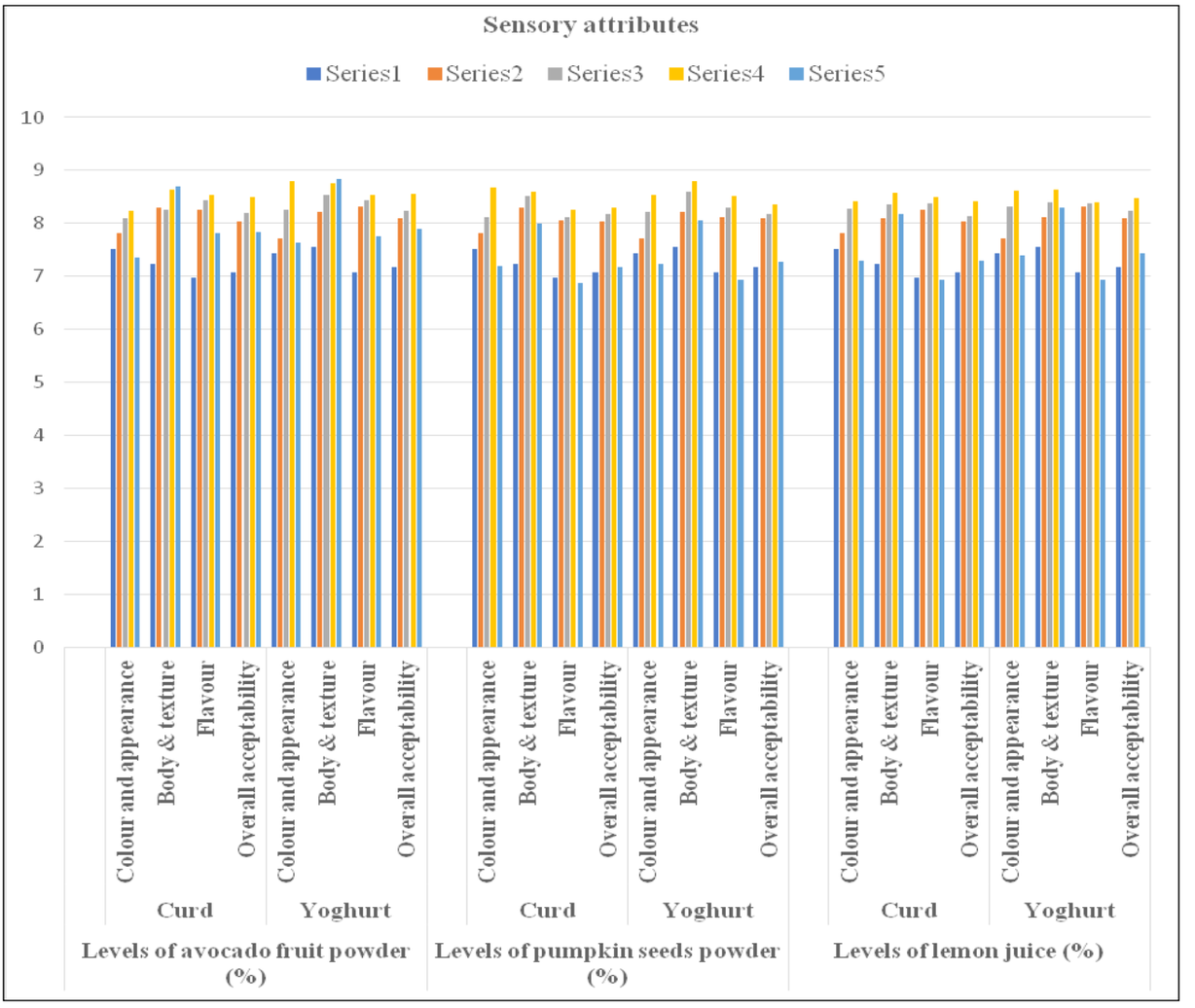

Fig. 2: Sensory Attributes of lactose hydrolysed curd and yoghurt fortified with avocado powder, pumpkin seeds powder and lemon juice

Series 1: *Lactose unhydrolyzed;* ***Series 2:*** *Lactose hydrolysed;* ***Series 3:*** *0.25 % Avocado: 0.50 % Pumpkin seeds and lemon juice addition;* ***Series 4:*** *0.50 % Avocado: 0.75 % Pumpkin seeds and lemon juice addition;* ***Series 5:*** *0.75 % Avocado: 1.00 % Pumpkin seeds and lemon juice addition.*

compared with unhydrolyzed controls (Control 1), which recorded lower values (7.51 and 7.43; 7.25 and 7.55; 6.98 and 7.07; and 7.08 and 7.18, respectively). Differences between the two control groups were statistically significant ($P \leq 0.05$).

The lactose-hydrolysed curd and yoghurt samples exhibited a glossy surface and a distinctly creamy appearance. Consistent with the present findings, Nagaraj *et al.* (2009) and Skryplonek *et al.* (2017) reported that hydrolysed samples achieved higher sensory scores compared to their unhydrolyzed counterparts. This enhancement has been attributed to the increased concentration of monosaccharides, which are more soluble and contribute to a softer body, creamier texture, and greater flavour development. The elevated glucose content in hydrolysed samples facilitates faster lactic acid production, thereby intensifying flavour compound formation relative to the control. Similarly, Popescu *et al.* (2022) and Ahmed *et al.* (2020) observed that lactose-hydrolysed yoghurt demonstrated superior creaminess and flavour quality compared to unhydrolyzed yoghurt. Wolf *et al.* (2015) further identified 22 volatile compounds, including acetaldehyde and diketones, in significantly higher concentrations in hydrolysed yoghurt, a result linked to the greater availability of glucose. In addition, Sharanagouda *et al.* (2022) investigated the effect of varying lactase enzyme levels on sensory attributes. Their study revealed that yoghurt prepared with 0.24% enzyme achieved the highest sensory score (8.50), whereas samples produced with 0.40% enzyme received the lowest score (6.25). The latter were characterised by weak body and texture, accompanied by a harsh fruity flavour, in contrast to the control.

Avocado pulp powder

The mean sensory scores for lactose-hydrolysed curd and yoghurt fortified with 0.25% and 0.50% avocado fruit powder were significantly higher across all sensory attributes compared to Control 1, whereas no significant differences were observed relative to Control 2. Specifically, the sensory evaluation of products containing 0.50% avocado powder yielded scores of 7.82 and 7.71 for colour and appearance, 8.30 and 8.21 for body and texture, 8.05 and 8.12 for flavour, and 8.04 and 8.10 for overall acceptability in curd and yoghurt, respectively. The enhanced sensory quality may be attributed to the increased solids content—comprising fat, protein, and soluble fibres—which imparted a glossier, creamier appearance and a more pleasing flavour profile.

The elevated sensory scores for colour, appearance, and flavour in avocado-enriched yoghurt are consistent with the observations of Atmanaji *et al.* (2019), who reported that the incorporation of 7.5% avocado fruit pulp yielded significantly higher ratings (6.73 and 6.63) compared to the control (5.80 and 5.93, respectively). Similarly, Gangaraju (2020) documented enhanced scores across all sensory attributes in yoghurt supplemented with avocado pulp relative to the control. Furthermore, the superior overall acceptability score (7.68) aligns with the findings of Reddy and Marid (2022), who demonstrated that stirred yoghurt fortified with 10% avocado achieved higher consumer preference compared to plain drinking yoghurt (6.64).

Pumpkin seeds powder

The incorporation of 0.75% pumpkin seed powder into lactose-hydrolysed curd and yoghurt resulted in significantly higher mean sensory scores across all evaluated attributes compared to both unhydrolyzed and hydrolysed controls. The respective scores for colour and appearance (8.67 and 8.53), body and texture (8.60 and 8.80), flavour (8.26 and 8.51), and overall acceptability (8.30 and 8.36) demonstrated marked improvement. The enhanced sensory perception of the fortified products may be attributed to their shiny, firm gel structure and pleasant nutty flavour. Furthermore, the improved body and texture are likely due to the increased total solids and soluble fibre content contributed by the pumpkin seed powder.

The present findings are consistent with those reported by Pooja (2021), who observed that paneer kheer incorporated with 2% pumpkin seeds achieved the highest scores across all sensory attributes when

compared to the control. Similarly, the results pertaining to overall acceptability align with the observations of Robert (2018), wherein yoghurt fortified with 10% pumpkin seeds attained a superior acceptability score (4.06) relative to the control sample (3.93).

Lemon juice

The incorporation of 0.75% lemon juice into lactose-hydrolysed curd and yoghurt resulted in significantly higher mean sensory scores across all evaluated attributes compared to both hydrolysed and unhydrolyzed controls. The scores for colour and appearance (8.41 and 8.61), body and texture (8.58 and 8.63), flavour (8.50 and 8.40), and overall acceptability (8.41 and 8.47) demonstrated marked improvement. The enhanced colour and appearance may be attributed to the shiny, firm gel structure imparted by lemon juice addition. Improvements in body and texture likely stem from reduced product acidity, which facilitated faster curd setting relative to the controls. Furthermore, the inclusion of 0.75% lemon juice contributed a pleasant tangy flavour, attributable to the presence of citric acid, thereby enhancing the overall sensory acceptability of the product.

The findings of the present investigation are consistent with those reported by Bhat *et al.* (2016), who evaluated the effect of lemon juice addition to curd at concentrations of 2.50, 5.00, and 7.50%. Their study demonstrated that supplementation at the 5% level yielded significantly higher sensory scores for colour and appearance (7.83), flavour (7.32), body and texture (7.96), and overall acceptability (7.84), compared with the control (7.67, 6.58, 7.89, and 7.49, respectively). Similarly, Sobczak *et al.* (2022) investigated the incorporation of vitamin C (18 mg/100 g) into cow milk yoghurt. They observed no differences in colour and appearance (5.00) or flavour (4.50) between control and treated samples. However, the fortified yoghurt achieved superior scores for body and texture (4.90) and overall acceptability (4.70), relative to the control (4.70 and 4.58, respectively).

CONCLUSION

The lactose-hydrolysed curd and yoghurt formulations were optimized with the incorporation of 0.50% avocado fruit powder, 0.75% pumpkin seed powder, and 0.75% lemon juice. The fortified products exhibited a marked improvement in processing and quality attributes. Specifically, the curd and yoghurt demonstrated reductions in setting time of 108.33 minutes and 70.34 minutes, respectively; decreases in syneresis of 4.97 mL and 6.03 mL; and increases in titratable acidity of 0.14% and 0.10% lactic acid, respectively. Overall, the enriched lactose-hydrolysed curd and yoghurt showed enhanced physicochemical characteristics and superior sensory quality when compared with both lactose-hydrolyzed and non-hydrolyzed control samples.

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