RESEARCH PAPER

Nutritional Characterization and Sensory Evaluation of a Fermented Fig-Pear-Honey Probiotic Beverage for Gastrointestinal Health Applications

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ABSTRACT
This study provides a detailed nutritional characterization and sensory evaluation of a novel fermented fig (Ficus carica)–pear (Pyrus communis)–honey probiotic beverage, developed using Lactococcus lactis isolate LA-C1 as a functional carrier for gastrointestinal health applications, including dysbiosis and irritable bowel syndrome (IBS) management. Proximate nutritional analysis performed by an ISO/IEC 17025-accredited laboratory (Choksi Laboratories Ltd., Panchkula, India) established an energy content of 100 kcal per 100 mL, with total carbohydrate (54 g/100 mL), free sugar (2 g/100 mL), protein (0.40 g/100 mL), and fat (0.1 g/100 mL). The pronounced disparity between total carbohydrate and free sugar content reflects substantial contributions of dietary fiber and prebiotic oligosaccharides from fig, pear, and honey, accounting for 96.3% of the total carbohydrate fraction and suggesting a low-glycemic-potential, functionally synbiotic beverage profile. A pilot consumer sensory evaluation was conducted with 35 semi-trained panelists (19 to 58 years; 23 female, 65.7%; 12 male, 34.3%; mean age 30.2 ± 10.0 years) using a standardized nine-point hedonic scale, assessing five attributes, appearance, aroma, taste, texture, and overall acceptability, on Day 0 and Day 7 of refrigerated storage. Paired t-test analysis demonstrated statistically significant improvements in aroma, taste, and overall acceptability by Day 7, while appearance and texture remained stable. Score frequency distribution analysis showed that 88.6% of panelists assigned the maximum overall acceptability score of 9 by Day 7, compared to 37.1% at Day 0. Together these findings collectively establish the beverage as nutritionally credible, prebiotic-rich, and sensorially well-accepted functional food, with potential relevance as a delivery vehicle for probiotic-based gastrointestinal support, showing fermentation-driven organoleptic improvement during early refrigerated storage.
Keywords: probiotic beverage; Ficus carica; Pyrus communis; nutritional profiling; sensory evaluation; nine-point hedonic scale; paired t-test; Lactococcus lactis; prebiotic fiber
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INTRODUCTION

Consumer demand for functional food products with demonstrable health-promoting properties has intensified considerably over the past decade, driving research interest in plant-based fermented matrices as delivery vehicles for probiotic microorganisms (Granato et al., 2020). Traditional probiotic carriers have been predominantly dairy-based; however, increasing prevalence of lactose intolerance, milk-protein allergy, and consumer preference for vegan and plant-derived products has necessitated exploration of non-dairy fermentation substrates (Zare et al., 2020). Fruit-based beverages represent a promising alternative, offering inherent nutritional value, including natural sugars, dietary fiber, vitamins, and polyphenolic phytochemicals, alongside fermentable carbohydrate profiles suitable for lactic acid bacterial growth and probiotic delivery (Abbasi et al., 2025). Fig (Ficus carica L.) and pear (Pyrus communis L.) are nutritionally rich fruits with well-documented functional properties (Kolniak-Ostek et al., 2020; Sandhu et al., 2023). Figs are recognized as significant sources of dietary fiber, phenolic compounds, and minerals, while pears are particularly abundant in soluble pectin fiber and catechin-class flavonoids, both of which contribute to gastrointestinal health and prebiotic functionality (Malanik et al., 2025; Singh et al., 2022). The incorporation of natural honey as a fermentable carbohydrate source and prebiotic adjunct further enriches the nutritional and functional profile of the beverage matrix, contributing fructooligosaccharides (FOS), natural antimicrobial compounds, and antioxidant flavonoids (Hajam, 2024). Together, these three ingredients provide a synergistic nutritional and functional foundation for a non-dairy probiotic beverage formulation.

The microbiological, physicochemical, and gastrointestinal tolerance properties of this fermented fig-pear-honey beverage, inoculated with Lactococcus lactis isolate LA-C1, have been characterized in a companion study. However, the nutritional composition and consumer sensory acceptability of the finalized product remain unestablished constitute the focus of the present study. Nutritional profiling anchors the product within dietary and regulatory frameworks, providing the compositional data required for labeling, health claim assessment, and dietary recommendation. Sensory evaluation, supported by rigorous statistical analysis, is likewise indispensable for product development, as consumer acceptance ultimately determines the practical

utility and commercial viability of a functional food product. The present study therefore addresses two primary objectives: (i) to provide a comprehensive, methodologically detailed account of the proximate nutritional composition of the fermented fig-pear-honey beverage as determined by an ISO/IEC 17025-accredited laboratory using validated AOAC and BIS standard methods; and (ii) to conduct a rigorous pilot consumer sensory evaluation with a demographically characterized semi-trained panel, subjecting the resulting hedonic data to statistical analysis, including paired t-tests and score frequency distribution analysis, in order to quantify the consumer acceptability of the beverage and characterize its sensory evolution during early refrigerated storage. This paper presents these findings under a matched structural framework, aligning each methodological protocol directly with its empirical result and interpretive discussion.

2. MATERIALS AND METHODS

2.1 Beverage Preparation and Formulation Protocol

The fermented probiotic beverage was prepared from fresh, fully ripened pear (Pyrus communis) and desiccated fig (Ficus carica) procured from a local market in Hamirpur, Himachal Pradesh, India, combined with locally sourced raw natural honey in a formulation ratio of 40:50:10 (fig juice : pear juice : honey, v/v/w). This ratio was selected on the basis of preliminary sensory and fermentability screening trials in which multiple formulation ratios were evaluated. Fruits were washed, deseeded, and blended, and the juice was filtered through sterile muslin cloth. The resulting juice mixture was pasteurized at 80 °C for 10 minutes, aseptically cooled to 37 °C, and inoculated with Lactococcus lactis isolate to achieve an initial viable count of approximately 10^7 CFU/mL. Fermentation was conducted at 37 °C for 24-48 hours under static conditions, followed by refrigerated storage at 4 °C. Complete procedural details of strain isolation, molecular identification by 16S rRNA gene sequencing, fermentation protocol, probiotic viability monitoring, and physicochemical parameters were done and are reported in the companion paper.

2.2 Proximate Nutritional Analysis and Caloric Calculation

Proximate nutritional composition of the fermented beverage was determined by Choksi Laboratories Ltd. (Panchkula, Haryana, India), an ISO/IEC 17025-accredited analytical testing laboratory (Certificate No. 16848/2024–2025). All analyses were conducted on the finalized fermented product following standardized AOAC and BIS protocols. Results were expressed per 100 mL of beverage. The methodology for each of the five nutritional parameters is described below.

2.2.1 Energy Determination

The gross energy content of the fermented beverage was determined by calculation using the Atwater general factor system, following the method prescribed by the Association of Official Analytical Chemists (AOAC International, 2012). The Atwater system developed by Wilbur Atwater in the late 1800s, is the standard method used to calculate the energy (caloric) value of a food based on its macronutrient composition. It is the most widely accepted approach for estimating the metabolizable energy of food products from their proximate macronutrient composition, and has been adopted as the standard calculation method by food regulatory agencies globally, including the Food Safety and Standards Authority of India (FSSAI) and the Food and Agriculture Organization of the United Nations (FAO, 2003). The method is based on the principle that each macronutrient class yields a characteristic and reproducible quantity of metabolizable energy upon digestion and absorption in the human body. These quantities, established through extensive human calorimetric studies by Atwater and colleagues, are expressed as empirically derived conversion coefficients: protein yields 4 kcal per gram, carbohydrate yields 4 kcal per gram, and fat yields 9 kcal per gram (Atwater and Bryant, 1900; FAO, 2003). The higher energy coefficient for fat reflects its greater degree of chemical reduction compared to carbohydrates and proteins, resulting in a larger quantity of energy released per unit mass upon complete oxidative metabolism. Energy content was calculated by multiplying the experimentally determined mass of each macronutrient per 100 mL of beverage by its respective Atwater conversion coefficient and summing the three contributions:

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

Because the total carbohydrate fraction of this beverage contains a substantial proportion of non-digestible dietary fiber and prebiotic oligosaccharides derived from fig, pear, and honey, which are not metabolized as free energy in the human body, the accredited laboratory adjusted this calculation to isolate the digestible carbohydrate fraction from the non-digestible fiber fraction before applying the Atwater coefficients. Results were expressed as kilocalories (kcal) per 100 mL of beverage.

2.2.2 Total Fat Determination

Total fat content was determined by the Soxhlet continuous solvent extraction method using petroleum ether (boiling range 40–60 °C) as the extraction solvent, following AOAC method 948.04 (AOAC International, 2012). This gravimetric method is widely employed for the quantification of total lipids in food matrices, as it enables exhaustive and reproducible extraction of all ether-soluble fat fractions from the sample (Hewavitharana et al., 2020). Prior to extraction, a measured aliquot of the fermented beverage was transferred into a pre-dried and pre-weighed evaporating dish and dried in a hot air oven at 100–105 °C until a constant weight was achieved, ensuring complete removal of moisture that could otherwise interfere with accurate fat quantification. A 2 to 5 g portion of the dried sample was then accurately weighed and packed into a pre-weighed cellulose extraction thimble, which serves as a porous container allowing solvent to penetrate and extract fat while retaining the solid sample matrix (Hewavitharana et al., 2020). The loaded thimble was placed inside the Soxhlet extractor, connected at its lower end to a pre-dried and pre-weighed round-bottom flask containing approximately 250 mL of petroleum ether, and at its upper end to a water-cooled reflux condenser. The assembly was mounted on a heating mantle and heated to 70–80 °C; as petroleum ether vaporized, condensed, and dripped back through the sample, it dissolved and carried lipophilic compounds, primarily triglycerides and other ether-soluble lipids, into the boiling flask below, with automatic siphoning repeating the cycle. This process was continued for 4 to 6 hours to ensure exhaustive extraction. Following extraction, the petroleum ether was recovered and evaporated using a rotary evaporator at 40 °C under reduced pressure (or

alternatively a hot air oven) to obtain the crude fat residue, which was then dried at 100 °C for 30 minutes to remove residual solvent, cooled in a desiccator, and weighed. The difference in flask weight before and after extraction represented the mass of extracted fat:

Total Fat (%) = (Weight of extracted fat, g / Weight of sample, g) × 100

Results were expressed as grams (g) of fat per 100 mL of the fermented beverage.

2.2.3 Crude Protein Determination

Crude protein content was determined by the macro-Kjeldahl method, following Indian Standard IS:7219:1993 (Bureau of Indian Standards, 1993), the most widely accepted and internationally validated procedure for quantifying total organic nitrogen in food samples, from which crude protein is estimated using a standard nitrogen-to-protein conversion factor (Horwitz and Latimer, 2006). The method proceeds through three sequential stages.

Acid digestion: A measured aliquot of the beverage was transferred into a Kjeldahl digestion flask with anhydrous potassium sulphate (K_2SO_4, raises the boiling point to accelerate digestion), copper sulphate pentahydrate ($CuSO_4 \cdot 5H_2O$, catalyst), and concentrated sulphuric acid (H_2SO_4, 98% w/v, the primary oxidizing agent) (Nielsen, 2017). The flask was heated progressively to 370 to 420 °C, oxidatively converting organic nitrogen to ammonium sulphate through complete mineralization; digestion was complete when the digest turned colorless or pale yellow, typically after 60 to 90 minutes, after which it was cooled and diluted with distilled water.

Alkalinization and steam distillation: 40% (w/v) sodium hydroxide was added to render the digest strongly alkaline, converting ammonium ions to free ammonia gas (AOAC International, 2012). The flask was connected to a Kjeldahl steam distillation unit, and ammonia gas was steam-distilled into a receiving flask containing a measured volume of standardized 0.1 N hydrochloric acid combined with methyl red-methylene blue mixed indicator, continuing until approximately 150 mL of distillate had been collected (Bureau of Indian Standards, 1993).

Back-titration and calculation: The excess unreacted HCl in the receiving flask was back-titrated with standardized 0.1 N sodium hydroxide until the indicator changed to blue-green, with a blank determination run in parallel to correct for background nitrogen (Bureau of Indian Standards, 1993):

Nitrogen (g) = [(V1 × N1) - (V2 × N2)] × 0.014

where V1 is the volume of HCl used, N1 is the normality of HCl, V2 is the volume of NaOH used in back-titration, N2 is the normality of NaOH, and 0.014 is the milliequivalent weight of nitrogen. Crude protein was then calculated by multiplying the nitrogen value by the standard Jones conversion factor of 6.25, which assumes an average nitrogen content of 16% in food proteins (Jones, 1931; FAO, 2003):

Protein (g/100 mL) = Nitrogen (g) × 6.25 × (100 / sample volume in mL)

All determinations were performed in triplicate with a blank correction applied, and results were expressed as grams (g) per 100 mL of the fermented beverage.

2.2.4 Total Carbohydrate Determination

Total carbohydrate content of the fermented beverage was determined by the indirect calculation method, commonly referred to as the carbohydrate-by-difference method, in accordance with AOAC guidelines (AOAC International, 2012). This method derives the total carbohydrate fraction by subtracting the sum of all directly measured proximate components from the total sample mass, on the assumption that the remainder constitutes carbohydrate; it is the most widely applied method for total carbohydrate estimation in food labeling and nutritional analysis owing to its simplicity and compatibility with standard proximate analysis frameworks (FAO, 2003). The formula applied was:

Total Carbohydrate (g/100 mL) = 100 - [Protein (g) + Fat (g) + Moisture (g) + Ash (g) + Fiber (g)]

Each subtracted component was determined independently prior to the calculation. Moisture was determined gravimetrically by drying a measured sample aliquot in a hot air oven at 105 °C until a constant weight was achieved, with the loss in weight representing moisture content (AOAC International, 2012). Ash was determined by incinerating the dried sample residue in a muffle furnace at 550 °C for 5 to 6 hours until a constant-weight white or greyish-white ash was obtained, representing total mineral content after complete combustion of organic matter (AOAC International, 2012). Crude protein was determined by the macro-Kjeldahl method described above, total fat by Soxhlet extraction as described above, and dietary fiber by the standard enzymatic-gravimetric method. The resulting total carbohydrate value is an inclusive figure encompassing all carbohydrate fractions in the beverage matrix, including free monosaccharides and disaccharides, complex polysaccharides, dietary fiber (soluble pectin and insoluble cellulose and hemicellulose from fig and pear), and prebiotic fructooligosaccharides (FOS) contributed by honey (Hajam, 2024; Singh et al., 2022), and is therefore analytically and nutritionally distinct from the free sugar fraction determined independently below. Results were expressed as grams (g) per 100 mL of the fermented beverage.

2.2.5 Free Sugar Determination

Free sugar content was determined by the Lane-Eynon titrimetric method following acid hydrolysis, in accordance with Indian Standard IS:15279:2003 (Bureau of Indian Standards, 2003), a well-established volumetric procedure based on the principle that reducing sugars chemically reduce cupric ions (Cu^{2+}) in alkaline Fehling solution to cuprous oxide (Cu_2O), which precipitates as a brick-red solid (AOAC International, 2012). The method was applied in two stages: direct determination of reducing sugars, and total free sugars following acid hydrolysis of non-reducing disaccharides such as sucrose.

Sample preparation: A measured aliquot of homogenized beverage was diluted with distilled water to bring sugar concentration within the working range. For total free sugar determination, dilute hydrochloric acid was added to convert non-reducing disaccharides, primarily sucrose, into glucose and fructose (Lane and Eynon, 1923), with the flask heated in a water bath at 70 °C for 10 minutes to ensure complete hydrolysis. The solution was cooled, neutralized to approximately pH 7.0 with 40% (w/v) NaOH, and made up to final volume for titration.

Fehling solution preparation: Fehling solution was freshly prepared by combining equal volumes of Solution A (copper sulphate pentahydrate in distilled water, providing the cupric oxidizing ions) and Solution B (sodium potassium tartrate and sodium hydroxide in distilled water, which stabilizes the Cu^{2+} complex and prevents premature precipitation)

(Nielsen, 2017), then heated to 50 to 65 °C.

Titration: The sample solution was added dropwise from a burette to the hot Fehling solution with continuous swirling; reducing sugars reduced Cu^{2+} to Cu_2O, forming a brick-red precipitate. Methylene blue indicator was added near the endpoint; its blue color persists in the presence of excess unreacted Fehling reagent but is discharged once all Cu^{2+} has been reduced, signaling the endpoint (Lane and Eynon, 1923; Bureau of Indian Standards, 2003). A parallel blank determination corrected for background reagent reduction.

Calculation:

Free Sugar (g/100 mL) = (Titre value × Dilution factor × 100) / Sample volume (mL)

Or using the Fehling factor:

Free Sugar (g/100 mL) = [(V_sample - V_blank) × F × D] / V_original

where V_sample is the volume of sample solution used at the endpoint, V_blank is the volume consumed in the blank titration, F is the Fehling factor (mg glucose equivalent reduced per mL of Fehling reagent), and D is the dilution factor. All determinations were performed in triplicate with a blank correction applied, and results were expressed as grams (g) of free sugar per 100 mL of the fermented beverage.

2.3 Sensory Evaluation

2.3.1 Consumer Panel Recruitment and Demographic Characterization

A panel of 35 semi-trained evaluators was recruited from among postgraduate students and academic staff at Career Point University, Hamirpur, Himachal Pradesh, India. Semi-trained panel status was defined in accordance with ISO 11136:2014 (ISO, 2014), indicating that panelists had received prior orientation to hedonic scale methodology and the evaluation process before commencing formal evaluation sessions, but had not undergone the extensive training characteristic of trained analytical panels. This level of training is considered appropriate for hedonic acceptability studies aimed at assessing consumer preference in a controlled laboratory setting. Informed verbal consent was obtained from all participants prior to the evaluation sessions. Potential panelists reporting known food allergies, dietary restrictions, or medical conditions affecting gustatory or olfactory perception were excluded from participation. Gender, age, and academic background were recorded for all panelists at recruitment to construct the consumer demographic profile reported in Section 3.3.

2.3.2 Sensory Evaluation Design and Mean Attribute Evaluation (Paired t-Test)

Sensory evaluation was conducted using a within-subjects repeated measures design, in which the same cohort of 35 panelists evaluated the fermented beverage at two time points: Day 0 (immediately following 48-hour fermentation, prior to refrigerated storage) and Day 7 of refrigerated storage at 4 °C. This within-subjects design was selected because it maximizes statistical power for detecting within-subject differences over time by controlling for inter-individual variability in absolute hedonic scaling behavior, which would otherwise inflate error variance in a between-subjects design.

Five organoleptic attributes were evaluated at each time point: appearance (visual clarity, color uniformity, and overall visual appeal), aroma (overall olfactory character, pleasantness, and intensity), taste (overall flavor profile, balance of sweetness and sourness, and aftertaste), texture (mouthfeel, viscosity, and body), and overall acceptability (integrated holistic judgment of the beverage). Each attribute was scored independently on a standardized nine-point hedonic scale with verbal anchors as described by Lim (2011): 1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much, and 9 = like extremely. Panelists were instructed to score each attribute independently without reference to other attributes.

Beverage samples were served chilled at approximately 4 °C in identical, standardized glass vessels labeled with three-digit randomized codes to prevent identification bias and order effects. Evaluations were conducted individually in partitioned evaluation booths under standardized fluorescent lighting conditions in a dedicated sensory evaluation room to eliminate inter-panelist communication and environmental bias. Room-temperature bottled water and unsalted crackers were provided between samples for palate cleansing and expectoration. Panelists were asked to allow at least 60 seconds between attribute evaluations and between samples. Evaluation sessions were separated by a minimum of 7 days corresponding to the storage interval. Panelists were additionally invited to record open qualitative comments regarding each sample on the hedonic score sheet.

To assess temporal change in mean attribute scores, paired two-tailed Student's t-tests were applied comparing Day 0 and Day 7 scores for each of the five attributes separately. The paired design is statistically appropriate because each panelist evaluated the same beverage at both time points, making their Day 0 and Day 7 scores naturally paired observations; this pairing allows within-subject score differences to be estimated with greater precision by removing between-subject variability from the error term, increasing sensitivity to detect genuine temporal change. Degrees of freedom for each paired t-test were $n - 1 = 34$.

2.3.3 Score Frequency Distribution Analysis

Score frequency distributions were tabulated by counting the number of panelists, and the corresponding percentage of the total panel, assigning each integer score from 1 to 9 on the hedonic scale for each attribute at each time point. This analysis supplements mean comparisons by revealing the shape of the score distribution, including ceiling effects, skewness, and the proportion of panelists assigning maximum or minimum scores, none of which is visible from means and standard deviations alone.

2.4 Statistical Validation and Analysis Quality Controls

All sensory scoresheet data were entered into Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) and verified by double-entry cross-checking to eliminate transcription errors. Statistical analyses were performed using GraphPad Prism version 5.0 (GraphPad Software, San Diego, CA, USA). Statistical significance for all tests was set at $\alpha = 0.05$, and all results are expressed as mean ± standard deviation (SD) unless otherwise stated. Rigorous data-collection quality control was additionally maintained through the standardized, bias-controlled evaluation environment as described earlier.

3. RESULTS

3.1 Beverage Preparation and Physical Characteristics

The optimized preparation protocol consistently yielded a homogeneous, moderately viscous beverage. Physically, the

finalized product was classified as a 'granulated brown liquid', exhibiting excellent suspension stability during early storage without phase separation, which is attributed to the pectin-rich pear substrate (Kolniak-Ostek et al., 2020; Sharma & Sogi, 2024).

3.2 Proximate Nutritional Composition

The proximate nutritional composition of the fermented fig–pear–honey probiotic beverage, as certified by Choksi Laboratories Ltd. under ISO/IEC 17025 accreditation, is presented in Table 1.

Table 1. Proximate nutritional composition of the fermented fig–pear–honey probiotic beverage per 100 mL, as determined by ISO/IEC 17025-accredited analysis (Choksi Laboratories Ltd., Panchkula; Certificate No. 16848/2024–2025).

Nutritional Parameters	Value per 100 mL	Standard Method	Unit
Energy	100	AOAC (Atwater factors, by calculation)	kcal
Fat	0.1	AOAC 948.04 (Soxhlet extraction)	g
Protein	0.40	IS:7219:1993 (Kjeldahl method, N × 6.25)	g
Total Carbohydrate	54	AOAC (by difference)	g
Free Sugar	2	IS:15279:2003 (Lane–Eynon method)	g

3.2.1 Energy Content

The macronutrient values determined by accredited proximate analysis were: protein 0.40 g/100 mL, fat 0.1 g/100 mL, and total carbohydrate 54 g/100 mL. Applying the Atwater conversion coefficients (Atwater & Bryant, 1899), the calculated contributions were protein 1.6 kcal, fat 0.9 kcal, and carbohydrate 216 kcal, giving a theoretical total of approximately 218.5 kcal/100 mL. The certified energy value of 100 kcal/100 mL reported by the accredited laboratory reflects the fact that a large proportion of the carbohydrate fraction consists of non-digestible dietary fiber and prebiotic oligosaccharides, and the laboratory applied the Atwater calculation to the digestible carbohydrate fraction rather than the total carbohydrate value determined by the by-difference method (FAO, 2003). This adjustment is consistent with internationally recommended practice, whereby dietary fiber is assigned a substantially lower energy conversion factor (approximately 2 kcal/g for fermentable fiber, compared with 4 kcal/g for available carbohydrate) to better approximate its true metabolizable energy contribution, since fiber is only partially fermented in the colon rather than fully digested and absorbed in the small intestine (FAO, 2003; Livesey, 2001). This 100 kcal/100 mL value represents a moderate energy density appropriate for a functional beverage category product.

3.2.2 Total Fat Content

Total fat content of the beverage was 0.1 g/100 mL, a negligible level consistent with a low-fat product profile and reflective of the inherently low lipid content characteristic of fruit-derived fermentation substrates such as fig and pear, neither of which contributes appreciable amounts of fat to the matrix (Sandhu et al., 2023; Kolniak-Ostek et al., 2020). This value is well below the regulatory threshold required for a "low fat" nutrient content claim under the FSSAI Food Safety and Standards (Advertising and Claims) Regulations, 2018, which permits such a claim for liquid foods containing no more than 1.5 g of fat per 100 mL (FSSAI, 2018), as well as below comparable international thresholds such as the EU's 1.5 g/100 mL limit for liquids (Regulation (EC) No 1924/2006). The near-absence of fat further reinforces the beverage's positioning as a carbohydrate- and fiber-dominant functional product rather than an energy-dense formulation, distinguishing it from many commercially available flavored or creamer-based probiotic beverages that rely on added oils or dairy fat for mouthfeel.

3.2.3 Crude Protein Content

Crude protein content of the beverage was 0.40 g/100 mL, representing a modest protein contribution to the overall nutritional profile, consistent with expectations for a fruit-based fermentation matrix, since fig and pear are characteristically low in protein compared to cereal-, legume-, or dairy-based substrates (Sandhu et al., 2023; Kolniak-Ostek et al., 2020). This value is comparable to protein levels reported for other non-dairy, fruit-based probiotic beverages, which typically range from 0.2 to 0.6 g/100 mL depending on the fruit substrate used and the extent of microbial protein synthesis during fermentation (Abbasi et al., 2025). Although Lactococcus lactis fermentation can marginally increase free amino acid and small peptide content through proteolytic activity during growth, this effect is generally limited in fruit-based matrices with low initial protein substrate availability, and is therefore not expected to substantially elevate the beverage's protein value beyond that contributed by the raw fruit ingredients themselves (Zare et al., 2020). While the beverage is not positioned as a significant protein source, its low protein content is consistent with its classification as a carbohydrate- and fiber-dominant functional beverage rather than a nutritionally complete supplement.

3.2.4 Total Carbohydrate Content

The directly determined proximate values per 100 mL were: moisture 44.8 g, protein 0.40 g, fat 0.1 g, and ash 0.7 g. Total carbohydrate content was calculated using the carbohydrate-by-difference method, a standard approach in food composition analysis whereby total carbohydrate is estimated by subtracting the sum of moisture, protein, fat, and ash from 100 g (or 100 mL) of sample, rather than through direct analytical quantification (AOAC International, 2012; FAO, 2003). Substituting these values into the by-difference formula:

Total Carbohydrate = 100 − (0.40 + 0.1 + 44.8 + 0.7) = 54 g per 100 mL

This carbohydrate fraction was the dominant macronutrient component of the beverage.

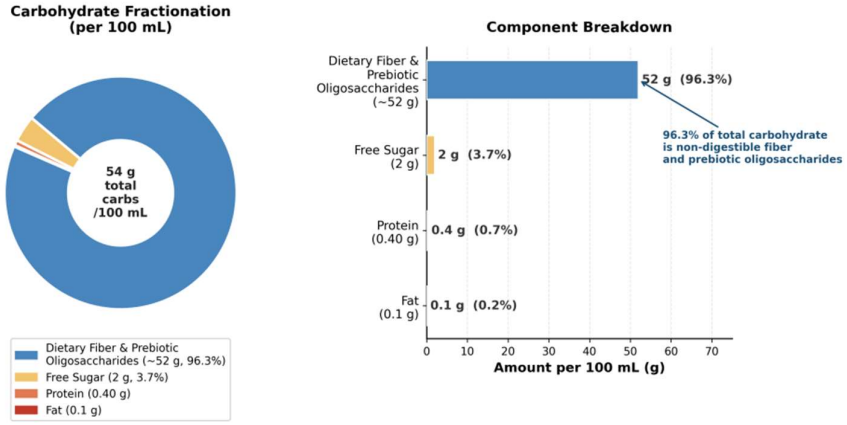

Figure 1: Carbohydrate fractionation of the fermented fig–pear–honey probiotic beverage per 100 mL. (Left) Donut chart showing proportional composition of total carbohydrate (54 g/100 mL). (Right) Horizontal bar chart showing gram quantities and percentage contribution of each component. The dietary fiber and prebiotic oligosaccharide fraction (~52 g) accounts for 96.3% of total carbohydrate, reflecting the low glycemic potential of the beverage.

3.2.5 Free Sugar Content

Free sugar content, determined by the Lane–Eynon method (AOAC International, 2012; Lane & Eynon, 1923), was 2 g/100 mL. The pronounced difference between total carbohydrate (54 g/100 mL) and free sugar (2 g/100 mL) confirms the dominant contribution of dietary fiber and prebiotic oligosaccharides to the carbohydrate composition of this beverage. Free sugars constituted only 3.7% of the total carbohydrate fraction; the remaining 96.3% (approximately 52 g/100 mL) is accounted for by the combined contribution of (a) dietary fiber from pear (primarily soluble pectin, insoluble cellulose, and hemicellulose) and from fig (Sandhu et al., 2023; Kolniak-Ostek et al., 2020), (b) prebiotic fructooligosaccharides contributed by honey (Hajam, 2024), and (c) complex polysaccharide fractions, none of which are hydrolyzed or detected by the Lane–Eynon method, since this titrimetric technique is selective for reducing sugars and does not measure non-reducing oligosaccharides or polysaccharide fiber fractions (Lane & Eynon, 1923; AOAC International, 2012). The low free sugar content relative to total carbohydrate implies a low glycemic potential, a nutritionally advantageous characteristic for health-conscious consumers and individuals monitoring dietary sugar intake (Giuntini et al., 2022)

3.3 Sensory Panelist

3.3.1 Panelist Demographic Profile

The panel was demographically heterogeneous, comprising 23 female (65.7%) and 12 male (34.3%) participants ranging in age from 19 to 58 years (mean age: 30.2 ± 10.0 years), with a positively skewed distribution toward younger participants: 20 panelists (57.1%) were under 30 years of age, 12 panelists (34.3%) were aged 30–44 years, and 3 panelists (8.6%) were 45 years or older. The age range of 19–58 years ensured representation across multiple life stages, capturing variation in sensory sensitivity, dietary habits, and flavor preferences that are known to differ across age cohorts (Methven et al., 2012). This demographic composition reflects a young adult consumer profile representative of the primary target market for functional probiotic beverages, as younger consumers have been consistently identified as the most frequent adopters of novel functional food and beverage products in both global and Indian market contexts (Granato et al., 2020; IFIC, 2023). The panel gender composition (65.7% female) reflects the recruitment pool of postgraduate students and faculty, which is typical of academic consumer panels in India.Female overrepresentation in sensory panels drawn from academic settings has been widely reported and is generally considered acceptable in pilot hedonic studies, provided that results are interpreted within the context of the recruitment pool rather than as population-representative data (Lim, 2011; Lawless and Heymann, 2010). Demographic details are summarized in Table 2.

Table 2. Demographic profile of the sensory evaluation panel (n = 35).

Demographic Variable	Category	n (%)
Gender	Female	23 (65.7%)
	Male	12 (34.3%)
Age group	< 30 years	20 (57.1%)
	30–44 years	12 (34.3%)
	≥ 45 years	3 (8.6%)

Age (years)	Range	19–58
	Mean ± SD	30.2 ± 10.0
Background	Postgraduate students and faculty	35 (100%)

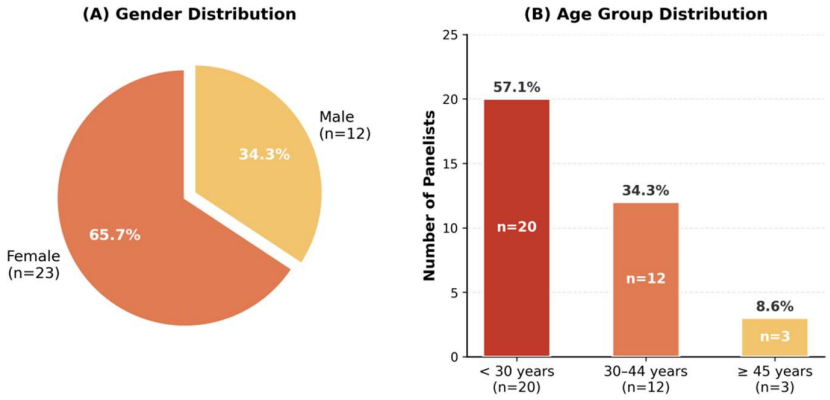

Figure 2: Demographic profile of the sensory evaluation panel (n = 35). (A) Gender distribution. (B) Age group distribution. Percentage values are displayed on each chart.

3.3.2 Paired t-Test Analysis of Mean Sensory Attribute Scores

Results of paired t-test comparisons between Day 0 and Day 7 mean hedonic scores are presented in Table 3. Of the five evaluated attributes, three showed statistically significant improvements between Day 0 and Day 7. The paired t-test was selected as the appropriate inferential test because each panelist evaluated the same beverage at both time points, making Day 0 and Day 7 scores naturally paired observations within subjects; this design controls for inter-individual differences in absolute hedonic scaling and increases statistical sensitivity to genuine temporal changes (Lawless and Heymann, 2010).

Aroma scores increased from 7.69 ± 0.93 on Day 0 to 8.20 ± 0.68 on Day 7 (mean difference: +0.51), yielding a significant t-statistic of 2.850 ($p = 0.007$) and a small-to-medium Cohen's d effect size of 0.482. This aromatic improvement is consistent with the progressive accumulation of volatile aroma compounds, including diacetyl, acetaldehyde, and acetoin, generated by residual metabolic activity of Lactococcus lactis during cold storage at 4 °C, which are well-established contributors to the characteristic sour-fruity aroma of lactic acid bacteria-fermented fruit beverages (Filannino et al., 2014). Taste scores increased from 8.03 ± 1.04 on Day 0 to 8.69 ± 0.53 on Day 7 (mean difference: +0.66), with $t = 3.422$, $p = 0.002$, and a medium effect size of $d = 0.578$. The improvement in taste scores between Day 0 and Day 7 is attributable to the progressive mild acidification of the beverage during refrigerated storage, which sharpens and balances the overall flavor profile by introducing a cleaner sourness that complements the residual sweetness of fig, pear, and honey substrates; this pattern of taste improvement during early cold storage has been consistently reported in lactic acid bacteria-fermented fruit and vegetable beverage studies (Ngouenam et al., 2021; Sahrawat et al., 2023). Overall acceptability showed the strongest improvement, increasing from 8.11 ± 0.87 to 8.80 ± 0.58 (mean difference: +0.69), with the highest t-statistic ($t = 3.968$, $p = 0.0004$) and a medium Cohen's d of 0.671.

Appearance scores showed a negligible, non-significant change from 7.80 ± 0.80 to 7.94 ± 0.87 ($t = 0.961$, $p = 0.343$). Similarly, texture scores changed marginally from 8.00 ± 0.97 to 8.14 ± 0.91, with no statistically significant difference ($t = 0.695$, $p = 0.492$). These non-significant results are expected and appropriate: appearance is primarily governed by the pigmentation, turbidity, and color uniformity of the beverage matrix, which are determined at formulation by the phenolic and carotenoid composition of fig and pear substrates and are not substantially altered by the low-level biochemical activity occurring during cold storage (Malanik et al., 2025; Singh et al., 2022). Texture, reflecting mouthfeel, viscosity, and body, is similarly governed by the structural polysaccharide and pectin content of the beverage, which remains stable during short-term refrigerated storage in the absence of enzymatic degradation (Ngouenam et al., 2021).

Table 3. Paired t-test results comparing mean sensory attribute scores between Day 0 and Day 7 of refrigerated storage (n = 35, nine-point hedonic scale).

Attribute	Day 0 Mean ± SD	Day 7 Mean ± SD	Δ	t	p-value	Significance	Effect magnitude
Appearance	7.80 ± 0.80	7.94 ± 0.87	+0.14	0.961	0.343	ns	Negligible

Aroma	7.69 ± 0.93	8.20 ± 0.68	+0.51	2.850	0.007**	p < 0.01	Small–Medium
Taste	8.03 ± 1.04	8.69 ± 0.53	+0.66	3.422	0.002**	p < 0.01	Medium
Texture	8.00 ± 0.97	8.14 ± 0.91	+0.14	0.695	0.492	ns	Negligible
Overall	8.11 ± 0.87	8.80 ± 0.58	+0.69	3.968	0.0004***	p < 0.001	Medium

Note: Δ = mean difference (Day 7 − Day 0). ns = not significant. ** p < 0.01; *** p < 0.001. Cohen's d effect size benchmarks (Cohen, 1988): negligible < 0.20; small 0.20–0.49; medium 0.50–0.79; large ≥ 0.80. SD = standard deviation.

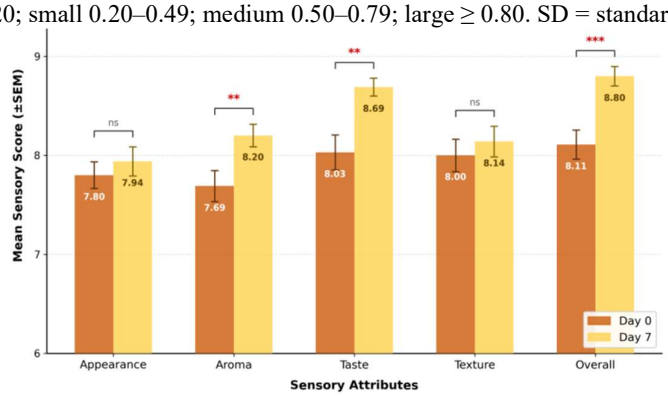

Figure 3: Mean sensory scores (±SEM) of the fermented fig–pear–honey probiotic beverage for five organoleptic attributes evaluated by a semi-trained panel (n = 35) on Day 0 and Day 7 of refrigerated storage at 4 °C using a nine-point hedonic scale. ** p < 0.01; *** p < 0.001; ns = not significant (paired t-test).

3.4 Score Frequency Distribution Analysis

Frequency distribution analysis of individual hedonic scores (Tables 4 and 5) reveals the distribution and shift of panelist responses across the full 1–9 scale for all five attributes, providing distributional context that mean comparisons alone cannot convey (Lim, 2011; Lawless and Heymann, 2010).

For appearance (Table 4), the score distribution was similar at both time points, with scores concentrated in the 7–9 range at both Day 0 and Day 7, consistent with the non-significant paired t-test result. At Day 0, the majority of panelists scored appearance as 8 (n = 14; 40.0%) or 9 (n = 10; 28.6%), while at Day 7 the distribution remained centered on 7 (n = 13; 37.1%) and 8–9 combined (n = 18; 51.4%), indicating stability with a minor redistribution.

For aroma (Table 4), Day 0 scores were distributed across 5–9, with a mode at 8 (n = 12; 34.3%). By Day 7, scores concentrated more strongly at 8–9, with 21 panelists (60.0%) scoring 9 and 13 (37.1%) scoring 8, with no scores below 7. This upward compression of the distribution reflects the significant aromatic improvement detected by the paired t-test (Filannino et al., 2014).

For taste (Table 4), Day 0 scores ranged from 4 to 9, with the mode at 8 (n = 16; 45.7%) and 12 panelists (34.3%) scoring 9. By Day 7, scores shifted decisively to 9, with 25 panelists (71.4%) assigning the maximum score, and only 1 panelist scoring 7. The proportion of panelists scoring 7 or below fell from 20.0% (n = 7) to just 2.9% (n = 1) (Sahrawat et al., 2023).

For texture (Table 4), the distribution remained stable between time points with scores concentrated at 8–9, consistent with the non-significant t-test result (Ngouenam et al., 2021). For overall acceptability (Table 5), Day 0 showed 13 panelists (37.1%) scoring 9 and 15 (42.9%) scoring 8. By Day 7, 31 panelists (88.6%) assigned the maximum score of 9, with only 3 scoring 7 and 1 scoring 8. This near-ceiling distribution at Day 7 represents a near-universal maximum consumer approval of the beverage after one week of fermentation-driven maturation.

Table 4. Score frequency distribution for all five sensory attributes at Day 0 and Day 7 (n = 35).

Score	App. D0	App. D7	Aroma D0	Aroma D7	Taste D0	Taste D7	Tex. D0	Tex. D7	Overall D0	Overall D7
4	0	0	0	0	1	0	0	0	0	0
5	0	0	1	0	0	0	0	0	0	0
6	2	1	1	0	1	0	1	1	2	0
7	7	13	4	0	5	1	4	3	5	3
8	14	13	12	13	16	9	14	14	15	1

9	10	5	17	21	12	25	16	17	13	31

App. = Appearance; Tex. = Texture; D0 = Day 0; D7 = Day 7. Scores 1–3 were not assigned by any panelist at either time point and are omitted from this table.

Table 5. Percentage frequency distribution for Taste and Overall Acceptability at Day 0 and Day 7 (n = 35).

Score	Taste D0 (n)	Taste D7 (n)	Taste D0 (%)	Taste D7 (%)	Overall D0 (n)	Overall D7 (n)
4	1	0	2.9	0.0	0	0
5	0	0	0.0	0.0	0	0
6	1	0	2.9	0.0	2	0
7	5	1	14.3	2.9	5	3
8	16	9	45.7	25.7	15	1
9	12	25	34.3	71.4	13	31

4. DISCUSSION

4.1 Beverage Formulation, Bio-Chemical Stability, and Physical Characteristics

The physical stabilization of the fig-pear-honey composite juice is a direct consequence of the structural matrix. The'granulated brown liquid' texture is supported by soluble dietary fiber, specifically pectins from pear (Pyrus communis)and mucilaginous compounds from dried fig (Ficus carica). These act as natural hydrocolloids that stabilize the suspension, preventing Phase separation (Singh et al., 2022). This structural integrity is critical during early refrigerated storage, preserving the homogeneous distribution of the active probiotic culture throughout the matrix.

4.2 Nutritional Profile and Functional Food Positioning

The proximate nutritional composition of the fermented fig–pear–honey beverage positions it within the category of carbohydrate-rich, low-fat functional beverages, comparable to other plant-based probiotic drinks reported in the literature (Hidalgo-Fuentes et al., 2024; Granato et al., 2020). The energy content of 100 kcal/100 mL represents a moderate energy density suitable for a functional beverage — sufficient to contribute meaningfully to daily caloric intake without exceeding the energy ceiling appropriate for a health-promoting drink.

The most significant and nutritionally informative finding is the pronounced carbohydrate-to-free-sugar differential: 54 g versus 2 g per 100 mL. This nearly 27-fold difference between total carbohydrate and free sugar content has several important nutritional implications. Pear (Pyrus communis) is among the richest fruit sources of dietary fiber, contributing both soluble pectin, which forms viscous gels in the intestinal lumen, slowing glucose absorption and promoting satiety, and insoluble cellulose and hemicellulose, which add bulk and promote intestinal motility (Singh et al., 2022). Ficus carica similarly contributes soluble dietary fiber and mucilaginous polysaccharides. Together, these fruit-derived fiber components constitute a substantial proportion of the total carbohydrate fraction.

In addition to fruit-derived fiber, honey contributes fructooligosaccharides (FOS) - short-chain oligosaccharides composed of fructose units linked to a terminal glucose - that are classified as prebiotic compounds because they resist digestion by human gastrointestinal enzymes and reach the colon intact, where they have been reported in the literature to selectively stimulate the growth and metabolic activity of beneficial gut bacteria including Bifidobacterium and Lactobacillus species (Hajam, 2024). On this basis, the beverage represents a synbiotic formulation, combining viable Lactococcus lactis with prebiotic components that are expected, on the basis of their established mechanism of action, to support colonic microbiota modulation (Granato et al., 2020); this synbiotic potential is inferred from compositional data and existing literature and was not directly assessed in the present study. The combination of high dietary fiber and prebiotic oligosaccharide content in a single beverage matrix is nutritionally distinctive and represents a key functional attribute of this formulation beyond simple probiotic delivery.

The low free sugar content (2 g/100 mL) is nutritionally advantageous for several reasons. First, the high proportion of fiber relative to free sugar is consistent with a low glycemic response, as viscous soluble fiber has been shown to slow gastric emptying and moderate postprandial glucose absorption even in carbohydrate-rich matrices (Giuntini et al., 2022), suggesting the beverage would not generate a rapid postprandial glucose spike despite its high total carbohydrate content, making it a plausible candidate for individuals with impaired glucose tolerance or those monitoring dietary sugar intake, pending direct glycemic testing.

Second, from a regulatory perspective, a beverage with only 2 g free sugar per 100 mL would qualify for 'low sugar' labeling under many international regulatory frameworks including FSSAI guidelines in India. The low free sugar also reflects the fermentation process itself, during which

Lactococcus lactis consumed simple sugars as fermentable substrates for growth and lactic acid production.

The low protein (0.40 g/100 mL) and negligible fat (0.1 g/100 mL) contents are consistent with expectations for a fruit juice-based fermented product and confirm this beverage as a carbohydrate- and fiber-dominant functional food rather than a complete nutritional supplement. Future nutritional characterization should include quantification of total dietary fiber by the AOAC 991.43 enzymatic-gravimetric method, micronutrient profiling (vitamin C, potassium, magnesium), and amino acid profiling, to generate a full nutritional dataset supportive of regulatory health claim assessment.

4.3 Sensory Evaluation: Panel Demographics and temporal acceptability

4.3.1 Sensory Panel Demographics and Target Market Alignment

The demographic distribution of the panel, with a mean age of 30.2 years and 57.1% of panelists under 30, aligns with a plausible prime consumer target for functional and non-dairy probiotic beverages (Zare et al., 2020). This alignment is a reasonable interpretive framing rather than a tested market claim, since no comparative consumer-segment data was collected. The high percentage of female panelists (65.7%) is typical for academic sensory evaluations in India.

However, a panel of 35 semi-trained evaluators drawn from a single institutional setting does not constitute a full consumer panel in the strict ISO 11136:2014 sense, which typically recommends 100 or more untrained consumers for generalizable hedonic data. The demographic concentration around a young, female-skewed, academically affiliated population further constrains generalizability: the strong acceptability scores reported here should not be extrapolated to older consumers, male consumers, or non-academic populations without further validation. The results of this pilot panel should therefore be interpreted as robust evidence of strong preliminary sensory acceptability within a defined demographic segment, rather than a population-level estimate of consumer preference.

4.3.2 Temporal Sensory Evolution (Paired t-Test Findings)

The sensory evaluation results demonstrate clearly that the fermented fig-pear-honey probiotic beverage was well-accepted at both Day 0 and Day 7, with all five attributes consistently scoring above 7.6 on the nine-point hedonic scale throughout the evaluation period. High baseline acceptability at Day 0, with overall acceptability already at 8.11 ± 0.87, validates the formulation optimization process in which the 40:50:10 ratio was selected on the basis of maximizing sensory quality alongside fermentability. Acceptability improved further and significantly by Day 7 for three attributes, indicating that the beverage undergoes spontaneous, fermentation-driven sensory maturation during early refrigerated storage.

The statistically significant improvements in aroma, taste, and overall acceptability are most plausibly explained by fermentation-driven biochemical changes that continue at a reduced rate during cold storage. Even at 4 °C, residual metabolic activity of Lactococcus lactis generates low-molecular-weight volatile aroma compounds, including diacetyl, acetaldehyde, acetoin, and short-chain fatty acids, that are characteristic contributors to the pleasant sour-fruity aromatic profiles of LAB-fermented beverages (Filannino et al., 2014). Mild acidification occurring during this period, as documented in the companion study, likely introduces a sharper, cleaner sourness to the flavor profile that most panelists perceived as an improvement in taste, consistent with consumer preference patterns for mildly acidic functional beverages (Sahrawat et al., 2023).

The stability of appearance and texture scores is expected and appropriate: these attributes are primarily determined by the physical characteristics of the beverage matrix, pigmentation, turbidity, viscosity, and pectin-derived body, which are established at formulation and not substantially altered by the low-level biochemical activity occurring during cold storage.

Qualitative comments recorded from panelists provide corroborating context. At Day 0, several panelists explicitly noted suggestions to "improve aroma," "improve aroma and appearance," and "improve aroma and taste," consistent with the lower mean scores for these attributes at baseline. By Day 7, qualitative feedback shifted markedly toward positive descriptors: panelists noted "nice fragrance and texture," "liked the aroma," "nice taste and texture," and "very nice," with several assigning qualitative "excellent" ratings consistent with their numerical scores of 9. The occasional notation of "sour taste" at Day 7, primarily by three to four panelists, reflects awareness of the progressive acidification of the beverage but was evidently not perceived negatively by the majority, given the strong overall acceptability scores at this time point.

4.4 Consumer Acceptability Distribution and Ceiling Effects

Frequency distribution analysis adds a layer of analytical depth that mean comparisons alone cannot convey. The shift in taste scores from a mode of 8 (45.7% of panelists) at Day 0 to a mode of 9 (71.4%) at Day 7 represents not merely an increase in the mean but a fundamental redistribution of consumer responses toward maximum liking. The near-ceiling distribution for overall acceptability at Day 7, with 88.6% of panelists assigning the maximum score of 9, is a particularly strong outcome for a novel functional product formulation, indicating that fermentation-driven sensory maturation within the first week of storage brings the beverage to an organoleptic optimum that approaches universal consumer approval within this panel. This pattern is consistent

with consumer behavior in LAB-fermented fruit beverage studies, where acidification and flavor development during early storage are typically perceived as organoleptic improvements by acceptability panels (Ngouenam et al., 2021). The shift from a distributed scoring pattern at Day 0 to a concentrated maximum-approval pattern at Day 7 supports the conclusion that a period of cold maturation is necessary to reach peak organoleptic quality in this formulation.

4.5 Limitations and Future Directions

Several limitations of the present study should be acknowledged. The nutritional analysis was conducted exclusively on the fermented product and was limited to proximate macronutrient composition. A fully comprehensive nutritional profile would additionally include total dietary fiber quantification by the AOAC 991.43 enzymatic-gravimetric method, water-soluble vitamins (particularly vitamin C, thiamine, riboflavin), mineral content (potassium, calcium, magnesium, iron), and individual amino acid profiling, to support regulatory nutrition labeling and health claim assessment under Indian and international frameworks. Comparative analysis of nutritional composition between unfermented and fermented samples would additionally clarify the specific contribution of the fermentation process to the nutritional profile.

Critically, the present study did not include any direct assessment of gastrointestinal tolerance, digestive effects, gut microbiota modulation, or clinical outcomes related to irritable bowel syndrome (IBS) or dysbiosis. All statements regarding prebiotic potential, synbiotic functionality, and gastrointestinal relevance in this discussion are inferences drawn from the beverage's compositional profile and from established literature on similar dietary fiber and oligosaccharide compounds, rather than findings demonstrated experimentally in this study. Substantiation of any gastrointestinal health claim would require dedicated in vitro digestion modeling, gut microbiota assays, and/or controlled clinical trials in target populations.

Beyond the demographic and panel-composition considerations discussed in Section 4.3.1, sensory evaluation at only two time points (Day 0 and Day 7) limits the resolution of the sensory maturation trajectory; future studies should evaluate multiple time points across the full shelf life, for example extending to 21 or 28 days of storage, to characterize the kinetics of fermentation-driven sensory development and identify the precise time point of maximum sensory quality. The possible carry-over effects inherent to within-subjects repeated measures designs, while minimized by the 7-day separation between evaluation sessions and individual booth evaluations, cannot be entirely excluded without counterbalanced designs. Future sensory studies should employ larger, demographically diverse consumer panels of untrained evaluators ($n > 100$, per ISO 11136:2014) recruited from the general population to support generalizable, population-level conclusions.

5. CONCLUSION

This study presents a structurally aligned nutritional characterization and pilot sensory evaluation of a novel fermented fig-pear-honey probiotic beverage produced by Lactococcus lactis, with methodology (Section 2), results (Section 3), and discussion (Section 4) matched sequentially across each analytical axis. Accredited proximate nutritional analysis established a carbohydrate-rich (54 g/100 mL), low-fat (0.1 g/100 mL), low-free-sugar (2 g/100 mL) profile delivering 100 kcal/100 mL. The pronounced carbohydrate-to-free-sugar differential reflects the substantial dietary fiber and prebiotic oligosaccharide contributions of fig, pear, and honey, suggesting a nutritional profile with low glycemic potential and synbiotic functional attributes.

Pilot consumer sensory evaluation with 35 semi-trained panelists using a nine-point hedonic scale confirmed high baseline acceptability and demonstrated statistically significant improvements in aroma, taste, and overall acceptability between Day 0 and Day 7 of refrigerated storage, attributed to fermentation-driven aromatic compound generation and mild progressive acidification. Appearance and texture remained stable across the same period. Frequency distribution analysis showed a marked upward shift in scores by Day 7, with 88.6% of panelists assigning the maximum overall acceptability score, indicating a near-ceiling level of consumer approval.

These findings collectively establish the fermented fig-pear-honey beverage as a nutritionally credible, prebiotic-enriched, and sensorially well-accepted novel functional product, supporting its viability as a functional, non-dairy probiotic beverage. Gastrointestinal health relevance, including potential application to dysbiosis and IBS management, is supported by the beverage's compositional profile and by existing literature on similar prebiotic compounds, but remains to be experimentally validated. Further work should include full consumer panel validation with a larger, more demographically diverse cohort, extended shelf-life sensory monitoring, expanded micronutrient and dietary fiber profiling, and clinical evaluation of its probiotic health effects.

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