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Standardization and Nutritional Evaluation of A Fortified Mango Gulkand Milk Beverage

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Abstract:
This research aims to standardize, physically and chemically characterize, evaluate sensory, microbiologically assess, and nutritionally analyse a Mango-Gulkand Milk Beverage. This Fortified milk beverage combines the nutrients of pasteurized milk with spray-dried mango powder and gulkand (rose petal preserve) Rich in vital minerals and bioactive substances, gulkand has Medicinal advantages include the cooling impacts, antioxidant capabilities, and gastrointestinal Support. The primary objective is to optimize the formulation to achieve an ideal balance of flavour and texture. Three experimental trials are conducted to refine the blend, enhance stability, and Reduce phase separation. A comprehensive physical and chemical analysis, including pH, total Soluble solids (TSS), viscosity, and acidity, is performed. Sensory evaluations assess consumer Acceptance based on texture, flavour, and overall appeal. The study also investigates the impact of Natural preservatives and thermal processing on product stability. The findings will contribute to the development of a cost-effective, shelf-stable, and nutritionally enriched mango-flavoured Milk beverage with enhanced sensory properties.

Keywords: Fortified Beverage, Flavoured Dairy Beverage, Gulkand, Milk-Based Drink.

INTRODUCTION

Increased consumption of functional drinks among consumers has created space for novel milk. drinks with decent nutritional quality and reasonable sensory attributes. Mango-Gulkand Milk Drink was designed to fill such space by synergistically uniting milk's creaminess with that of mango and gulkand's antioxidant and gut health benefits. Milk is the most widespread source of excellent protein, calcium, and useful vitamins, and therefore a natural component of human nutrition. Mango, the most widely eaten tropical fruit, is a good source of vitamins A and C. polyphenols, and dietary fibre for its antioxidant and anti-inflammatory activity (Sharma et al., 2020). Gulkand, an Ayurvedic sugar preparation of rose petals, was utilized ages ago because of its cooling and carminative effect and thus proves to be beneficial for the digestive system (Patel & Mehta, 2019). It is backed by the requirement for value-added dairy beverages that address the nutrient gap and improve total well-being. Introduction of fruit-derived components into milk beverages has been noted to enhance their bioactive functionality and appeal among consumers (Singh et al., 2021). Further, the functionality of gulkand has not yet been utilized to its full potential in

dairy applications. And the present study is a step towards functional beverage production. This research aims for scientific evidence of its feasibility as a milk beverage working drink by establishing the physical, chemical, sensory, microbiological, and nutritional characteristics of the Mango-Gulkand Milk Beverage. This research also investigates low-cost preservation techniques like pasteurization (Kumar et al., 2022).

Scope of Study:

Production, standardization, and testing of a fortified Mango-Gulkand Milk Drink are studied here. It covers various important topics like selection of ingredients, operation of process, sensory evaluation, microbial safety, and nutrition studies. Formulation and Standardization of product, the ratio of milk, mango pulp, and gulkand with the best sensory and nutritional quality is studied here. Multiple trials are set to standardize the formula and determine the maximum ingredient ratio. Physicochemical Analysis like pH, total soluble solids (TSS), viscosity, and acidity are tested for Product quality and stability tests. These are significant in determining product shelf life and Consumer acceptability (Singh et al., 2021) Sensory analysis is employed to determine acceptability of Mango-Gulkand Milk Beverage, whereby the trained panellists notice attributes like flavour, texture, aroma, and Preference (Sharma et al., 2020). Microbial stability of the drink upon storage Is performed in the study through measurement of pasteurization effectiveness testing and Inhibitory effect of potassium sorbate against microbial growth. Microbial stability of the drink during storage is carried out in the study by Determining pasteurization effectiveness testing and potassium sorbate inhibitory action to Microbial growth (Kumar et al., 2022). And finally Nutritional Evaluation Macronutrients and micronutrients, such as vitamins, minerals, and Bioactive compounds, are quantified in the test drink to determine its impact on health after Repeated intake (Patel & Mehta, 2019).

Flavoured Milk:

Flavoured milk is a treat that can be had without consuming excess sugar. Not only is flavoured milk a delicious treat, but it is also a healthy one that can be had by individuals of all ages. Its controversy about its sugar content serves as a reminder that everyone should eat well and be moderate. Instead of judging the flavoured milk, we should commend its role in having a balanced diet and move on to educate and provide them with alternatives. Flavoured milk can still make our taste buds tingle without risking our lives if done correctly. After all, a subtle flavour may be just what we need in order to inspire us to eat and appreciate the necessary nutrients. (Reddy, 2023)

Materials and Methods:

Toned Milk, Spray dried Mango powder, Gulkand (rose petal preserve), Sugar Powder, Water.

Methods:

Preparation of the product is very simple, before preparing the Fortified Mango-Gulkand Milk Beverage, pasteurize the milk first. Pasteurize the milk by heating it to 80–85°C and holding for 5–10 minutes at the same temperature as an attempt to completely inactivate pathogenic microorganisms and to improve the shelf life of the final product. During heating of the milk, prepare the mango solution by dispersing spray dried mango powder in a little amount of hot water. This move allows for effortless dissolution of the mango powder and thus no lumps are formed and it will also blend easily with the milk. Once the mango solution has been prepared, add the solution to the hot milk and stir well to have an equal mixture. Finally,

let the milk-mango cool below 50°C. Chill the mixture since addition of ingredients such as Gulkand and sugar powder at temperature can ruin their taste and nutritional value. Once the mixture is cooled, add the Gulkand and sugar powder and mix well in a manner that they become evenly distributed. To give the drink an acceptable appearance for the texture and consistency, puree the entire mixture for 1–2 minutes until smooth and consistent. Pour the beverage into pre-sterilized packaging material such as glass or food-grade plastic bottles once shaking with the drink being hot. Seal the bottles at the same time and hold the bottles inverted for about one or two minutes—this will sterilize the inside of the cap and minimize chances of contamination. Sealed bottles are finally stored in a dry, cold area away from sunlight to enhance quality of the beverage.

Figure 1: Ingredients

Table 1: Three Formulations of Mango Gulkand Milk Beverage

Ingredients	Formulation 1 (100 ml)	Formulation 2 (200 ml)	Formulation 3 (300 ml)
Spray-Dried Mango Powder	10 g	12 g	22 g
Hot Water	20 ml	60 ml	100 ml
Milk (Toned)	60 ml	112 ml	150 ml
Gulkand	5 g	4 g	10 g
Sugar	2 g	12 g	18 g

Determination of Energy Value:

The energy value of the formulated product was calculated as per the method given in IS 13285:1992 (RA 2022) – Energy Foods – Specification. The energy (calorific) value was derived using the Atwater general factors, which estimate the metabolizable energy provided by macronutrients. Protein, fat, and carbohydrate contents are expressed in grams per 100 grams of the product. The constants 4, 9, and 4 represent the energy values (in kcal/g) of protein, fat, and carbohydrates, respectively. This method provides an estimate of the energy content in kilocalories per 100 grams of the product.

Calculation:

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

Determination of Carbohydrate (IS 1656:2022):
Determine moisture, protein, fat, and ash content of the sample using standard methods Like Calculate carbohydrate content by subtracting the sum of these components from 100.
Carbohydrate (%) = 100 – (Moisture + Protein + Fat + Ash)

Determination of Protein (IS 7219:1973, RA 2020) (Kjeldahl Method):
Weigh the sample accurately (usually 1g) and digest it with strong sulfuric acid and catalyst to convert nitrogen to ammonium sulphate. Neutralize the digest using sodium hydroxide and distil the ammonia released over a boric acid solution, Titrate the distillate against a standard acid (usually HCl or H2SO4) to determine the nitrogen content. To calculate crude protein content, multiply the result for nitrogen by a conversion factor (usually 6.38 for dairy products).

Calculation:
Protein (%) = Nitrogen (%) × 6.38 Where 6.38 is the nitrogen-to-protein conversion factor for milk and milk-based products.

Determination of Total Sugars (Based on IS Method):
To find the total sugar content, the known weight of the sample was initially diluted with distilled water. The solution was then hydrolysed using dilute hydrochloric acid to transform all the non-reducing sugars into reducing sugars. The solution was then neutralized cautiously and filtered to eliminate any solid impurities after the hydrolysis. The resulting filtrate was titrated against Fehling's solution to approximate the overall amount of reducing sugars, which now indicates the total sugar content of the sample.

Calculation:
Total Sugar (%) = Volume of sample used × Factor / Weight of sample × 100

Determination of Fat by Gerber Method (FSSAI Manual):
In order to estimate the total fat content, the sample was first acidified and subjected to sulfuric acid to hydrolyse proteins and liberate fat. Amyl alcohol was then added to aid in the separation of fat. The contents were transferred to a butyrometer and tightly capped. The butyrometer was centrifuged to cause the fat to separate, rising to the calibrated neck of the butyrometer. Finally, the fat layer was taken directly from the graduated scale. This method, the Gerber method, is officially recognized by FSSAI for estimating fat in milk and milk products.

Estimation of cholesterol (FSSAI Manual of Methods of Analysis of Foods – Oils and Fats (2021):
For analysis of the cholesterol content, a definite amount of the fat or oil sample was saponified with alcoholic potassium hydroxide to release the unsaponifiable material, i.e., cholesterol. The unsaponifiable fraction was then dissolved out with a suitable organic solvent such as ether or hexane. The solvent on evaporation left behind the residue with cholesterol, which was then purified if necessary. Cholesterol was then measured by a colorimetric assay based on reaction with Liebermann-Burchard reagent, which gave a colour that was read spectrophotometrically at a particular wavelength (most often 620 nm) and had the cholesterol concentration calculated from a standard curve calibration.

Determination of Calcium:
In order to obtain the calcium content, a specified volume of the sample solution prepared was taken and taken to around pH 12 with a suitable buffer solution such that titration conditions were optimal. Suitable indicator like Patton and Reeder's was added to the solution so that visual detection of endpoint could be made. The sample was titrated against a standard edta solution. As it is titrated, EDTA binds to the calcium ions of the sample. Endpoint was signalled by a distinctive change in colour that guaranteed complete titration of all the calcium ions with EDTA. By then, the amount of EDTA taken during the endpoint had been noted down. Calcium content of the sample was then calculated from the amount of EDTA solution taken, its molarity, and the weight or volume of the sample, whichever is applicable.

Estimation of Moisture content by IS 12711:1989 (RA 2020):
For determining the moisture content, an accurately weighed known quantity of the sample was taken in a clean, dry, and pre-weighed dish for moisture. The sample was dried in a hot air oven at 105 ± 1°C for 4 to 6 hours or until constant weight is obtained. After drying, the dish was cooled in a desiccator and reweighed. The weight loss was measured as the moisture content of the sample.

Determination of ash content procedure based on IS 12711:1989 (RA 2020):
For an estimation of the ash content, a definite quantity of the sample was accurately weighed and put in a pre-ignited and tared silica crucible. The sample was then burned gently over a mild flame so that it would not be lost by spattering. After initial charring, the crucible was placed in a muffle furnace and subjected to firing at 550 ± 25°C for 5 to 6 hours, or until the ash coloured white or light grey, which indicates total ashing. The crucible was cooled in a desiccator and weighed. The difference in weight before and after ashing was recorded as the total ash content of the sample.

Determination of Total Soluble Solids (Brix):
Calibrate the refractometer using distilled water (should read 0 °Brix), then mix the beverage sample thoroughly place 1-2 drops of the sample on the refractometer prism and close the cover and wait for a stable reading read and record the value as °Brix.

Determination of Titratable Acidity:
Pipette 10 mL of the sample into a conical flask and add ~50 mL distilled water sequentially adds 2–3 drops of phenolphthalein indicator and titrate with 0.1 N NaOH until a faint pink colour persists for 30 seconds note the titre value.
Calculation: Acidity (%) = (Titre value × Normality of NaOH × Eq. wt. of acid × 100) / Volume of sample taken. For citric acid, Eq. wt. = 64.04.

Determination of pH:
Calibrate the pH meter using pH 7.0 and pH 4.0 buffer solutions then rinse the electrode with distilled water and blot dry, now immerse the electrode in the beverage sample and wait for the reading to stabilize and record the ph.

Total Plate Count (TPC):
The TPC of the milkshake was calculated using the pour plate technique and Plate Count Agar. One

millilitre of the adequately diluted material was added to sterile Petri dishes, followed by molten agar. Plates were incubated at 35 ± 2°C for 48 h. Following incubation, all visible colonies were enumerated and reported as cfu/mL to determine the overall microbial load in the product.

Coliform test:

Coliform count was determined by Violet Red Bile Agar (VRBA) and the pour plate method. One millilitre of the diluted sample was seeded in sterile Petri plates with the addition of VRBA. Plates were incubated at 35 ± 2°C for 24 h. Colonies with a colour of red and a precipitated zone of bile were considered as presumptive coliforms, and the results were reported in CFU/ml.

Yeast and Mold (Y&M) Count:

Yeast and Mold were counted on Potato Dextrose Agar (PDA) that was acidified to pH 3.5 using tartaric acid. Dilution sample one millilitre was plated by applying the pour plate technique and incubated at 25 ± 2°C for 120 hours. During incubation, yeasts in the form of wet creamy colonies and Molds as dry filamentous colonies, result being stated as cfu/ml.

Results:

The mango-gulkand milk beverage was analysed using sensory, physicochemical, nutritional, and microbiological testing. The optimised product was nice to taste and mouthfeel, improved in the nutrition aspect, and microbiologically safe on storage. These confirm its utility as a healthy dairy beverage drink.

Table 2: Sensory Evaluation

Parameters	Control	F1	F2	F3
Colour	9	7	8	8
Appearance	9	7	9	8
Taste	9	6	9	7
Texture	9	8	8	7
Overall acceptability	9	7	9	8

Sensory Evaluation:

Sensory scores have shown that F2 formulation was superior in appearance, taste, and general acceptability, almost at control level. Reasonable scores were given to all the formulations for colour and texture. Results are in Favor of F2 as the best acceptable form for consumer preference.

Table 3: Physicochemical Analysis

Parameters	Product value	Control
Brix (°Brix)	15.36	14-20
Acidity	0.126	0.10-0.30

pH	6.7	6.2-6.8
Viscosity (cp)	27	20-100

Physicochemical Analysis:

This table reflects the physicochemical properties of the end drink against standard ranges. The end sample measures 15.36 °Brix, 0.126% acidity, 6.7 pH, and 27 cp viscosity, all of which are within standards. This improves mouthfeel as well as customer acceptability through having flow able texture suitable for packaging as well as consumption. Overall, physicochemical testing was done so that the designed beverage retains such important quality attributes as functional milk-based beverages should. All the parameters are consumer acceptable values, and therefore it is found to be consumer acceptable as well as display shelf stability. These measures reflect a balanced composition with even consistency and flavour.

Table 4: Nutritional Information of Developed Product

Parameters	Control value	Product value	Unit
Energy	69	80.45	Kcal
Total Fat	1.5	2.49	g
Cholesterol	5.0	7.5	mg
Carbohydrates	11.0	11.09	g
Sugars	11	7.68	g
Protein	2.7	3.42	g
Calcium	110	78.0	mg
Ash	0.61	0.64	g
Moisture	88.67	82.36	g

Nutritional Information:

The nutritional content shown in table brings to fore the superior profile of the Fortified Mango-Gulkand Milk Beverage developed compared to the control sample. The beverage contained 80.45 kcal of energy content, which is more than the control's 69 kcal energy, reflective of a superior energy-dense product for those consumers that need an immediate energy source. Besides, the overall fat and protein content of the product were raised to 2.49 g and 3.42 g respectively, indicating a better macronutrient balance that would yield satiety and muscle retention. Lastly, the product indicated some decrease in sugar content (7.68 g) compared to the control (11 g), which would make it healthier for consumers who want to reduce sugar consumption. Carbohydrates were essentially the same in the two samples, demonstrating that the product had maintained the anticipated energy-delivering nutrients. The calcium content in the product (78 mg) was a bit lower than in the control (110 mg), but nonetheless a contribution towards a day's intake for bone function. Ash and water contents between the two were similar to one another, indicating consistency in water activity and mineral composition which may impact shelf life and microbial growth.

Test Parameter	Incubation Temperature	Media Used	Specification Limit	Results (cfu/2ml)

Coliform	35 ± 2°C at 24 hrs.	Violet Red Bile Agar	Beverage: 1cfu/2ml	<1 (at 24, 48, 72, 96, 120 hrs.)
Total Plate Count (TPC)	35 ± 2°C at 48 hrs.	Plate Count Agar	Beverage: 1cfu/2ml	<1 (at 24, 48, 72, 96, 120 hrs.)
Yeast & Mold (Y&M)	25 ± 2°C at 120 hrs.	Potato Dextrose Agar	Beverage: 1cfu/2ml	<1 (at 24, 48, 72, 96, 120 hrs.)

Table 5: Microbial Analysis

Microbial Analysis:
Microbial results guarantee safe drinking as all tested parameters (Coliform, TPC, Yeast & Mold) were below 1 cfu/2ml for five-time intervals. This guarantees the stability of the drink to microbes when stored for a short time. Proper incubation and selective media allowed proper detection.

Conclusion:
The Mango-Gulkand Milk Drink formulated in this project is a functional, fortified dairy-based beverage that provides a novel blend of nutrition, taste, and health benefits. Its composition forms a refreshing and nutrient-rich product. The addition of mango powder offers vital vitamins A and C, antioxidants, and dietary fibre, making a contribution to immune function, enhanced digestion, and antioxidant defences. Gulkand, which is cooling and digestively beneficial, not only contributes a natural floral sweetness but also some therapeutic qualities in the form of relieving acidity, lowering oxidative stress, and promoting gut health. The milk base adds creaminess and nutritional value to the product by providing necessary calcium, protein, and healthy fats, making it a healthy drink choice. The end-product shows excellent sensory attributes, comprising an ideal combination of sweetness, tartness, and creaminess, which renders it extremely palatable and acceptable to consumers.

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