Design and Development of a Tangy Twist Functional Pineapple Jelly

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ABSTRACT:
Development of innovative functional confectionery products has gained significant attention due to increasing consumer demand for unique flavors and added health benefits. This study focuses on the formulation and evaluation of pineapple–black salt jelly, a novel product combining the natural sweetness and nutritional properties of pineapple with the distinctive flavor and digestive benefits of black salt. Pineapple, rich in vitamin C and bromelain enzyme, contributes to improved digestion and antioxidant activity, while black salt enhances taste and supports gastrointestinal health. The jelly was prepared using fruit juice, sweeteners, gelling agents, and controlled acidity to achieve the desired texture, clarity, and shelf stability. Physicochemical parameters such as pH, total soluble solids, and sensory attributes including taste, aroma, color, and overall acceptability were evaluated. The results indicated that the incorporation of black salt provided a unique sweet–salty flavor profile, improving consumer acceptability while maintaining product quality. This study highlights the potential of pineapple–black salt jelly as a functional and cost-effective confectionery product with enhanced sensory appeal and health benefits

Keywords: Pineapple jelly, black salt, functional confectionery, fruit-based jelly, physicochemical Properties, bromelain, digestive benefits, natural flavor enhancement total soluble solids (TSS),

1. INTRODUCTION

Pineapple jelly is a popular fruit-based confectionery product known for its refreshing taste, appealing texture, and consumer acceptability. Fruit-based processed products like jellies have gained significant attention due to their extended shelf life and wide consumer preference (Mahajan and Dhillon, 2020). With increasing demand for functional foods, there is a growing interest in developing value-added jelly products that not only satisfy taste but also provide health benefits (Corbo et al., 2020).Incorporating innovative ingredients such as black salt and fructo-oligosaccharides (FOS) can enhance both the sensory profile and nutritional value of the product. FOS is a prebiotic dietary fiber that promotes gut health by supporting beneficial intestinal microflora (Robertfroid, 2020), while black salt imparts a unique flavor and aids digestion. The addition of potassium sorbate as a preservative helps in extending the shelf life by inhibiting microbial growth (Rao et al., 2023).Therefore, this study focuses on the development and optimization of pineapple jelly with varying concentrations of black salt and FOS to evaluate its sensory attributes, quality, and overall acceptability.

2. MATERIALS:

Pineapple juice – Fresh and ripe pineapple was selected, washed, peeled, and extracted to obtain clear juice. It serves as the main raw material providing flavor, color, and nutrient

Sugar (Sucrose) – Used as a sweetening agent and for gel formation. It also helps in preservation by reducing water activity.

Pectin – A natural gelling agent responsible for forming the jelly structure and providing the desired consistency.

Black salt – Added to enhance flavor and provide digestive benefits, giving a unique taste to the jelly.

Citric acid – Used to adjust pH, which is essential for proper gel formation and to improve flavor stability.

Fructo-oligosaccharides (FOS) – A functional ingredient added as a prebiotic fiber to improve nutritional value and support gut health.

Potassium sorbate – Used as a preservative to inhibit the growth of molds and yeasts, thereby extending shelf life.

Water – Used for dilution and to adjust the consistency of the jelly mixture.


Pineapple juice

Sugar

Fig-1 Materials

3. METHODS:

Preparation of Pineapple Juice:

Pineapple fruits were washed thoroughly, peeled and cut into small pieces. The pulp was extracted using a blender and filtered through a muslin cloth to obtain clear juice. The extracted juice was used immediately for jelly preparation.

Preparation of jelly:

The preparation of pineapple jelly begins with the careful selection of raw materials, ensuring the quality of pineapple and other ingredients used (Mahajan and Dhillon, 2020). The selected fruits are then thoroughly washed and cleaned to remove any dirt and contaminants, followed by cutting and juice extraction. The extracted pineapple juice is filtered to obtain a clear liquid free from pulp and impurities (Corbo et al., 2020).Next, all ingredients such as sugar or fructo-oligosaccharides (FOS), gelling agent, and acid are accurately weighed. The pineapple juice is then heated, and the gelling agent is added along with sugar to facilitate proper gel formation. The mixture is cooked until the desired °Brix is achieved, which is essential for attaining the correct consistency and preservation of the jelly (Feng et al., 2023).After reaching the required concentration, the stove is turned off and citric acid is added to adjust the pH, ensuring gel stability and microbial safety. Black salt is then incorporated to enhance flavor and provide digestive benefits, followed by thorough mixing to achieve uniform distribution (Verma et al., 2024).The prepared jelly is then poured into molds and allowed to cool for proper setting. Once cooled, the jelly is packaged under hygienic conditions and stored appropriately. Finally, the product undergoes storage and evaluation for physicochemical properties and sensory attributes to determine its quality and overall acceptability (Rao et al., 2023).

4. FORMULATION OF JELLY:

Ingredients(g)	Trial 1	Trial 2	Trail 3	Trial 4
Pineapple juice	48.5	48.5	48.5	47.5
Sugar	43.0	41.0	39.0	38.5
Pectin	1.0	1.0	1.0	1.5
Black salt	0.5	1.0	1.5	2.5
Citric acid	0.5	0.5	0.5	0.5

FOS	4.0	5.0	6.0	6.0
Potassium sorbate	0.05	0.05	0.05	0.05
Water	2.45	3.0	3.45	3.45
Total	100 g	100 g	100g	100 g

Table 1 Sample Formulation

PHYSICO-CHEMICAL ANALYSIS:

The developed jelly samples were analyzed for various physico-chemical parameters including moisture content, ash content, pH, reducing sugars, and titratable acidity using standard analytical procedures (AOAC, 2020).

MOISTURE CONTENT:

Moisture content of the sample was determined by the hot air oven method, which is based on the principle of weight loss upon drying. A known quantity of the sample was accurately weighed in a clean, dry, and pre-weighed moisture dish. (Ranganna, 2010).The sample was then placed in a hot air oven maintained at 105 ± 2°C and dried for a specified period, usually until a constant weight was obtained. After drying, the dish was transferred to a desiccator to cool to room temperature and then reweighed. The loss in weight represented the moisture content present in the sample. The moisture percentage was calculated using the difference between the initial and final weights and expressed as grams per 100 grams of the sample. This method is widely used due to its simplicity, reliability, and suitability for determining moisture content in food products such as jelly.

Moisture (%) = $((W_2-W_3)\div(W_2-W_1))\times100$

Where:

W1= Weight of empty dish

W2= Weight of dish + sample before drying

W3 = Weight of dish + sample after drying

ASH CONTENT:

The ash content of the sample was determined using a muffle furnace method, which is based on the principle of complete oxidation of organic matter, leaving behind inorganic mineral residues. A clean, dry, and pre-weighed crucible was taken, and a known quantity of the sample was accurately weighed into it. The sample was first charred gently over a low flame or hot plate to avoid losses due to spattering. The crucible was then placed in a muffle furnace maintained at 550 ± 25°C and incinerated for several hours until a light gray or white ash was obtained, indicating complete combustion of organic matter. After ashing, the crucible was carefully removed and cooled in a desiccator to room temperature, and then weighed. The difference in weight was used to calculate the total ash content, which represents the mineral content of the sample. This method is widely used for determining total ash in food products such as jelly. (Ranganna, 2010).

Ash(%) = $(W_2-W_1)\div W\times100$

Where:

W1= Weight of empty dish

W2 = Weight of crucible + ash

W= Weight of sample taken (g)

pH VALUE:

The pH of the sample was determined using a digital pH meter based on the principle of electrometric measurement. Initially, the pH meter was calibrated using standard buffer solutions of known pH (commonly pH 4.0, 7.0, and 9.2) to ensure accuracy. A small quantity of the sample was prepared, and if necessary, diluted with distilled water to obtain a uniform solution. The electrode of the pH meter was then immersed into the sample, ensuring proper contact without trapping air bubbles. The reading was allowed to stabilize, and the pH value was recorded directly from the display. After each measurement, the electrode was rinsed with distilled water to avoid contamination. This method provides a rapid and accurate determination of the acidity or alkalinity of the sample (Feng et al., 2023)

REDUCING SUGARS

The reducing sugar content of the sample was determined by the Lane and Eynon method, which is based on the reduction of Fehling's solution by reducing sugars present in the sample. In this method, a known volume of Fehling's solution (mixture of Fehling's A and Fehling's B) was taken and heated to boiling. The sample solution was prepared by appropriate dilution and added from a burette to the boiling Fehling's solution until the blue color of copper ions was reduced to a brick-red precipitate of cuprous oxide, indicating the endpoint. To improve accuracy, an internal indicator such as methylene blue was used, which loses its color at the endpoint. The volume of sample required for complete reduction was noted, and the reducing sugar content was calculated using standard tables or factors. This method is widely used for estimating reducing sugars in food products like jelly due to its simplicity and reliability (Rao et al., 2023).

Reducing sugars(%) = Factor × Dilution × 100÷Titrate Value × Weight of Sample

MICROBIAL ANALYSIS:

The microbial quality of the developed jelly samples was evaluated to ensure safety and shelf stability. Total Plate Count (TPC), coliform count, and yeast and mold count were determined using standard microbiological methods (APHA, 2015). These analyses are essential for assessing the hygienic quality and microbial safety of food products during processing and storage (Rao et al., 2023).

Total Plate Count (TPC):

Total viable bacterial load was determined using the standard plate count method. One gram of the sample was aseptically homogenized in 9 mL of sterile diluent to obtain a 10^{-1} dilution, followed by serial dilutions up to 10^{-5}. One milliliter of the selected dilution was poured into sterile Petri plates, and molten Plate Count Agar (PCA) was added. After solidification, plates were incubated at 37°C for 24–48 hours, and colonies were counted. Only plates containing 30–300 colonies were considered for enumeration.

The TPC method is widely used for assessing microbial load in food products and provides an estimate of viable aerobic microorganisms (Ilham et al., 2025; Tamiru et al., 2024).

CFU/g = Number of Colonies × Dilution Factor÷Volume plated(ml) Coliform

Coliform Count:

Coliform bacteria were enumerated using Violet Red Bile Agar (VRBA) following standard pour plate techniques. Serial dilutions were prepared, and 1 mL aliquots were inoculated into sterile plates, followed by addition of molten VRBA. After incubation at 37°C for 24 hours, characteristic pink to red colonies with bile precipitation were counted as coliforms.

Coliform analysis serves as an indicator of sanitary quality and potential contamination in food systems and is widely used in food safety evaluation (Tamiru et al., 2024; Neyaz et al., 2024).

CFU/g = Number of Colonies × Dilution Factor Yeast

Yeast and Mold Count:

Yeast and mold counts were determined using the spread plate method. Appropriate dilutions were prepared, and 0.1 mL aliquots were spread onto Potato Dextrose Agar (PDA) acidified to pH 3.5 to suppress bacterial growth. Plates were incubated at 25–28°C for 3–5 days. Yeast colonies appeared smooth and creamy, while mold colonies were filamentous and fuzzy.

Yeast and mold enumeration is essential for evaluating spoilage and shelf-life stability of food products, particularly fruit-based products such as jelly (Ilham et al., 2025; Selvaraj et al., 2024).

CFU/g = (Number of Colonies × Dilution Factor)÷0.1

SENSORY EVALUATION:

Sensory evaluation was conducted using a 9-point hedonic scale, where 1 = dislike extremely and 9 = like extremely (Peryam D. R. And Pilgrim F. J., 1957).

SHELF-LIFE OBSERVATION:

The developed jelly samples were subjected to accelerated storage studies using a stability chamber, where one day is equivalent to one month of real-time storage. The samples were analyzed over a period of 3 to 4 days, corresponding to approximately 3 to 4 months of shelf life under normal storage conditions (Mahajan and Dhillon, 2020).During the storage period, the samples were evaluated for changes in appearance, color, texture, aroma, and overall acceptability. No significant changes were observed in the initial days, while slight variations in texture and aroma were noticed towards the end of the study. However, all parameters remained within acceptable limits (Feng et al., 2023).

The use of potassium sorbate effectively prevented microbial growth and helped maintain product quality (Rao et al., 2023). Among all the formulations, Trial 3 showed better stability, with minimal changes in physicochemical and sensory properties throughout the storage period (Corbo et al., 2020).

Based on the accelerated storage study, the developed jelly was found to be stable and acceptable for up to 3–4 months under normal storage conditions.

5. RESULTS AND DISCUSSIONS:

Among the three trials conducted for pineapple jelly preparation, Trial 3 showed the best overall performance. The physicochemical analysis indicated that Trial 3 had optimum pH (3.1), higher titratable acidity (0.77%), and increased moisture content, which contributed to better gel consistency and product stability (Feng et al., 2023). The higher ash content also reflects the increased mineral contribution due to black salt (Verma et al., 2024).

In terms of sensory evaluation, Trial 3 exhibited good scores in color, aroma, taste, and texture, indicating acceptable consumer preference (Peryam and Pilgrim, 1957). Although Trial 2 showed slightly higher sensory scores and better microbial stability, Trial 3 was considered superior due to its improved functional properties, enhanced nutritional value (higher FOS content), and balanced physicochemical characteristics (Robertfroid, 2020).

Therefore, Trial 3 was selected as the best formulation based on its overall quality, functional benefits, and acceptable sensory attributes (Corbo et al., 2020).

Parameter	**Trial 1**	**Trail 2**	**Trial 3**	**Trial 4**
Moisture (%)	30.5	36	31.2	32.0
pH	3.3	3.6	3.2	3.1
Ash (%)	0.6	0.3	0.8	1.0
Reducing Sugars (%)	17	15	18	20
Titratable Acidity (%)	0.68	1.3	0.65	0.77

Table 2- Physico-chemical analysis

Parameter	**Trial 1**	**Trail 2**	**Trial 3**	**Trial 3**
Total Plate Count (TPC)	3.2×10^3	2.5×10^3	1.5×10^3	2.8×10^3
Yeast & Mold Count	2.5×10^2	2.0×10^3	1.0×10^2	2.2×10^2
Coliform Count	Absent	Absent	Absent	Absent

Table 3- Microbial Analysis

Parameter	**Trail 1**	**Trial 2**	**Trial 3**	**Trial 4**
Color & Appearance	7.5	8.5	9.5	7.8
Aroma	7.2	8.3	9.0	7.5
Taste	7.0	8.8	9.5	7.2
Texture	7.3	8.6	9.5	7.6
Overall Acceptability	7.7	8.5	9.5	7.5

Table 4 – Sensory Evaluation

The development of pineapple jelly with the incorporation of fructo-oligosaccharides (FOS), black salt, and potassium sorbate showed significant variations in physicochemical, sensory, and microbiological properties among the three trials (Corbo et al., 2020).
From the physicochemical analysis, Trial 3 exhibited the lowest pH (3.1) and highest titratable acidity (0.77%), which are ideal conditions for effective gel formation and improved shelf stability (Feng et al., 2023). The higher moisture content in Trial 3 can be attributed to increased FOS levels, as FOS has good water-binding properties (Robertfroid, 2020). The ash content was also highest in Trial 3 due to the increased addition of black salt, contributing to mineral content (Verma et al., 2024). The increase in reducing sugars may be due to sucrose inversion and the presence of FOS (Patel et al., 2023). In terms of sensory evaluation, Trial 3 showed the highest scores in color, aroma, taste, texture, and overall acceptability, indicating superior consumer preference (Peryam and Pilgrim, 1957). The balanced

combination of sweetness, saltiness, and improved mouthfeel due to FOS contributed to enhanced sensory quality (Singh et al., 2023).
Microbiological analysis revealed that Trial 3 had the lowest microbial counts, indicating better microbial stability and safety. This may be due to its lower pH, higher acidity, and the presence of potassium sorbate, which effectively inhibited the growth of microorganisms such as yeast and molds (Rao et al., 2023).
Overall, Trial 3 demonstrated the best performance across all parameters, including physicochemical properties, sensory attributes, and microbial safety. Additionally, the higher FOS content enhances the functional and nutritional value of the product by providing prebiotic benefits (Robertfroid, 2020). Thus, Trial 3 is considered the most optimized formulation, offering improved quality, safety, and health benefits compared to the other trials.

Fig 2 – Final product- jelly

6. CONCLUSION:

The study successfully developed pineapple jelly with the incorporation of fructo-oligosaccharides (FOS) and potassium sorbate. Among the three trials, **Trial 3 was found to be the best formulation**. It showed **better physicochemical properties**, including suitable pH and acidity for good gel formation and stability. Trial 3 also obtained the **highest sensory scores**, indicating better color, taste, texture, and overall acceptability. In addition, it recorded the **lowest microbial load**, confirming good product safety and shelf life.
Therefore, **Trial 3 can be considered the most optimized formulation**, as it provides a good balance of quality, safety, and enhanced nutritional benefits due to the presence of FOS.

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