# Development of Bottle Gourd Tutti Frutti Infused with Jamun Peel Colour

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*Abstract* - **Tutti Frutti, a typical combination of candied fruits, is a common ingredient in baked goods, ice creams, and other confections. However, its manufacture frequently uses artificial colours and flavours, and it may occasionally employ less sustainable fruit sources. This study investigates a novel method for producing Tutti Frutti using bottle gourd (Lagenaria siceraria) rind, a typically discarded agricultural by-product, as the principal substrate. The work focusses on infusing natural colour into this rind using a natural extract produced from the Jamun (Syzygium cumini) fruit peel, another underutilised resource. The procedure involves preparing the bottle gourd rind, extracting anthocyanins from Jamun peel, and adjusting the infusion parameters (temperature, duration, and concentration) to produce the required colour intensity and sensory characteristics. The resulting Tutti Frutti was tested for physicochemical characteristics, colour stability, and sensory acceptance. Preliminary findings indicate that bottle gourd rind can be successfully turned into a visually appealing and tasty Tutti Frutti utilising natural Jamun peel extract, providing a sustainable and economically feasible alternative to traditional methods while also decreasing food waste. This study indicates the viability of developing a new product that uses agricultural by products, encourages sustainable practices, and offers a healthy and natural alternative to commercially available Tutti Frutti.**

***Keywords*** **- Tutti Frutti, Bottle Gourd Rind, Jamun Peel, Anthocyanins, Natural Colour, Food Waste Reduction, Sustainable Development, Agricultural By product, Value-Added Product, Infusion, Sensory Evaluation, Physicochemical Properties**

## I. INTRODUCTION

This research project investigates a fresh technique to Tutti Frutti manufacture that uses bottle gourd (Lagenaria siceraria) as a base. Bottle gourd presents a viable alternative to papaya, its bland flavour necessitates careful processing and flavour enhancement. Existing methods for Tutti Frutti production often rely on artificial colours, raising concerns about consumer health and preferences for natural alternatives. Tutti Frutti, or "all fruits" in Italian, is a bright and versatile confectionery ingredient that is commonly used in baked goods, ice cream, and other desserts. Commercially available Tutti Frutti is primarily made from papaya, which is sugared and often contains artificial colours and flavours. Bottle gourd is an easily available, inexpensive, and frequently underutilised vegetable with a mild flavour, making it an excellent option for absorbing desired flavours and hues. This research aims to convert bottle gourd into a Tutti Frutti counterpart, providing a possibly more sustainable and cost-effective alternative to typical papaya-based products. *(Dhivya S, et.al 2025). (Indian Institute of Food Processing Technology ,2020).*

### A. Tutti Frutti using Bottle gourd and Jamun Peel as a Potential Base:

The bottle gourd and jamun peel-based Tutti Frutti differs significantly from the typical version in numerous crucial ways, making it a standout alternative. First and foremost, bottle gourd substitutes the previously utilised papaya, providing a more cost-effective, easily available, and sustainable foundation material. This change resolves the risks associated with relying only on papaya, which is prone to crop illnesses and seasonal availability concerns. Second, and perhaps most importantly, our approach eliminates the need for artificial colours, which are a prevalent component in commercially available Tutti Frutti and cause health concerns among consumers. Instead, we use the natural colouring strength of jamun peel, a by-product of jamun fruit manufacturing that is frequently discarded. The extraction and inclusion of anthocyanins from jamun peel not only gives the Tutti Frutti a brilliant, appealing hue, but they also add to its nutritional profile, potentially providing antioxidant advantages. This dual functioning - colour enhancement and nutrient enrichment - is a key distinguishing feature. Furthermore, the mild tasting profile of bottle gourd allows for more control and customisation of the end product's taste, potentially opening the door to a broader range of flavour combinations and catering to various consumer preferences. *(Puspita Das,et al 2019)*

In contrast, papaya's intrinsic flavour can limit the flexibility of classic Tutti Frutti. The extraction and inclusion of anthocyanins from jamun peel not only gives the Tutti Frutti a brilliant, appealing hue, but they also add to its nutritional profile, potentially providing antioxidant advantages. This dual functioning - colour enhancement and nutrient enrichment - is a key distinguishing feature. Furthermore, the mild tasting profile of bottle gourd allows for more control and customisation of the end product's taste, potentially opening the door to a broader range of flavour combinations and catering to various consumer preferences. In contrast, papaya's intrinsic flavour can limit the flexibility of classic Tutti Frutti. Bottle gourd has various advantages, including a bland flavour profile that allows for the addition of desired flavours and colours, a hard texture that can tolerate processing, and year-round availability. Using bottle gourd not only addresses the constraints of traditional papaya-based Tutti Frutti, but it also helps to reduce food waste and promote agricultural crop diversity. *(Upaganlawar&Balaraman, 2009) (Thakur & Thakur, 2023)*.

In addition to bottle gourd as a basis, this study uses jamun (Syzygium cumini) peel as a natural colourant. Jamun peel contains a high concentration of anthocyanins, natural colours with antioxidant characteristics, and is frequently thrown as agricultural waste. Incorporating jamun peel extract not only adds brilliant colour to the Tutti Frutti, but it also has the ability to increase the nutritional value of the product, giving it a considerable edge over products tinted with chemical dyes. When compared to organic solvents such as ethanol or methanol, water is commonly available, very affordable, non-toxic, and generally suitable for food applications. Residual organic solvents in food products are a worry, thus utilising water solves this problem. *(Nejeliski & Duarte, 2017) (Rana, et al.2024).*

## II. METHODOLOGY

Fresh bottle gourds were thoroughly washed and peeled, leaving only the rinds for candy-making and removing the flesh. The green outer layer of the rinds was removed, and the white inside component was cut into pieces 2 cm long and 1 cm wide. The rind pieces were blanched in boiling water for 1 minute before being immersed in sugar syrup, which saturated the tissues with sugar at a high concentration to avoid microbiological decay. The method began with a sugar concentration of 40°Brix, which was gradually increased by 5 °Brix every day until a final concentration of 60 °Brix was achieved. Each time the syrup concentration was adjusted, it was drained, boiled, and sugar was added to get the appropriate level. Natural food colouring from the jamun peel is added and tastes like vanilla essence were added. The syrup was chilled to 60 degrees Celsius before reintroducing the rinds. The rinds were soaked in the final concentration for three days and then drained. Approximately 200 g of the produced rind samples were placed on perforated stainless-steel trays and dried in a cabinet drier at 70°C for 2 hours.

Three different treatment methods are used to make Tutti Frutti with bottle gourd.

### *1. Treatment 1(T1): Traditional Sugar Syrup Method (60% Sugar):*

Bottle Gourd is diced and cooked in a sugar syrup until tender. This method creates a sweet and sticky texture through the heating of the rind in a mixture of sugar and water.

**Osmotic Dehydration Steps**:

TABLE I
OSMOTIC DEHYDRATION

| Step | Sugar Syrup Concentration (% w/w) | Temperature (°C) | Time (hours) | Approximate Brix of Bottle Gourd | Remarks |
|---|---|---|---|---|---|
| Initial State | _ | _ | 0 | 2–4°Brix | Fresh bottle gourd cubes, initial low solid content. |
| Stage 1 (Early Absorption) | 50% | 55–60°C | 2-2.5 | 10–18°Brix | Rapid water removal begins; high osmotic gradient drives early absorption. |
| Stage 2 (Intermediate Absorption) | 60% | 60–65°C | 3-4 | 25–32°Brix | Increased syrup strength accelerates sugar uptake, moisture loss continues. |
| Stage 3 (Near Final Absorption) | 70% | 65–70°C | 5-6 | 42–50°Brix | Maximum absorption occurs; nearing target solids, requires close monitoring. |
| Jamun Peel Extract Infusion | (After draining) | Room Temp (20–25°C) | Half-1 | 50–55°Brix | Add 1–10 ml Jamun peel extract. Slight moisture introduced reduces Brix slightly (by ~2–5°). |

| | | | | | |
|---|---|---|---|---|---|
| Stabilization Step (Post-Infusion Drying) | Mild air drying / resting | 35-40°C | 6-8 | 60°Brix | Final dehydration at low temp to regain and stabilize to 60°Brix. Prevents microbial spoilage and improves shelf stability. |
| Final State (After Complete Drainage & Rest) | _ | Room Temp | 12-24 (resting) | 60°Brix | Final homogeneous product ready. Jamun flavour infused with balanced moisture and sugar content. |

Mild drying removes only water and Sugar content per unit mass increases and therefore the Brix goes up**.**

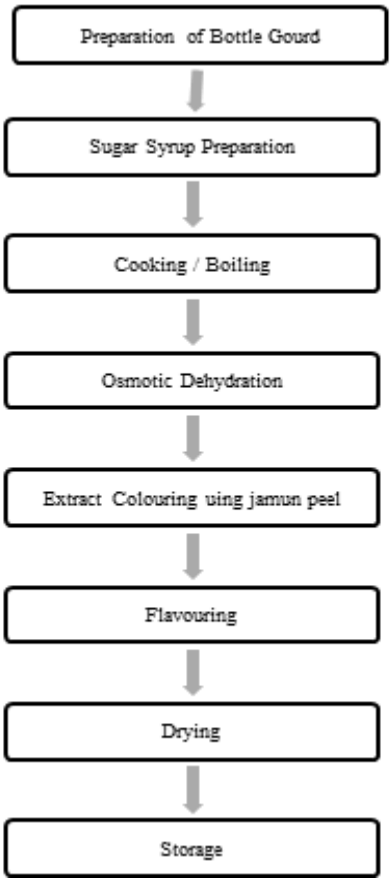
### *2. 1% Citric Acid Powder and 60% Sugar Preservation Method:*

The Bottle gourd is blanched briefly and mixed with a sugar-citric acid powder solution, enhancing its flavour and preservation while creating a slightly tangy tutti frutti.

### *3. Treatment 3 (T3): Natural Colorants Method:*

This variation involves adding natural colourants *i.e.* 10% jamun peel extract to enhance the visual appeal of the tutti frutti without using artificial dyes, maintaining a natural ingredient profile.

## B. PROCESSING STEPS




There are 2 major factors that are important in Tutti Frutti

## C. DETERMINATION OF MOISTURE CONTENT

A known weight of the Bottle Gourd Tutti Frutti sample is spread thinly in a pre-weighed and dried dish. This initial weight is recorded. The sample is placed in a hot air oven set at 70°C. It is dried until a constant weight is achieved, which usually takes about 1-2 hours. The key is to remove all moisture without burning the sample. After drying, the sample is transferred to a desiccator to cool to room temperature and then weighed again.

**Moisture Content (dry basis) % = $\frac{W1-W2}{W1}$ x 100**

Where,

$W_1$ is the initial weight (weight before drying) in grams.
$W_2$ is the weight (weight after drying) in grams.

### D. DETERMINATION OF BRIX

Brix, or the soluble solids content of a liquid, is measured using a refractometer, which provides a quick and accurate method to assess the sugar concentration in food samples. The refractometer is first calibrated with distilled water to ensure accuracy. The device should read 0 Brix with distilled water. A small drop of the syrup extracted from the cooked tutti frutti is placed on the refractometer prism. The cover is closed to spread the drop across the prism. The Brix value is read directly from the scale through the eyepiece. The reading reflects the refractive index of light passing through the sample, which increases with higher sugar concentration. The Brix value is reported directly as the percentage of sugar by weight in the solution:

**Brix (%) = Refractometer Reading (%)**

Fig.1 Bottle gourd Tutti frutti (Final Product)

### E. RESPONSE SURFACE METHODOLOGY

Response Surface Methodology (RSM) is a set of mathematical and statistical methods for developing empirical models. The goal of carefully designing experiments is to optimise a response (output variable) that is impacted by numerous independent variables (input variables). It includes sequence of tests, or runs, in which modifications are made to the input variables in order to determine the cause of changes in the output response.

**RSM – CCD MODEL FOR BOTTLE GUARD TUTTI FRUTTI**

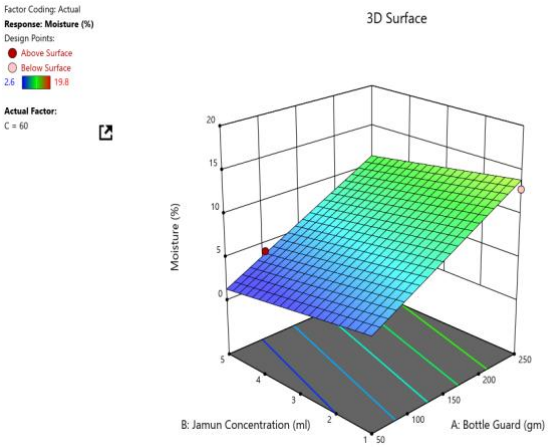



Fig.2 RSM 3D Model

## III. RESULTS AND DISCUSSIONS

### F. DETERMINATION OF MOISTURE CONTENT

The moisture content of the bottle gourd Tutti frutti was determined by placing single batch of produced tutti frutti which weights 300gm. Sample is placed in the hot air oven at 105 °C for 1 hr (AOAC, 2000)

TABLE II

MOISTURE CONTENT

| Sample | Initial Weight of the Sample (g) | Final Weight of the Sample (g) | Moisture Content (%) |
|---|---|---|---|
| Bottle Gourd Tutti Frutti | 350 | 304.85 | 12.9% |

This successful reduction in moisture content showcases the efficiency of the drying technology employed, indicating that the operational parameters are well-optimized for achieving the desired dryness without compromising the sensory qualities of the bottle gourd tutti frutti.

### G. OPTIMISATION USING RESPONSE SURFACE METHODOLOGY

The RSM is run through Stat-Ease 360, a DoE Software. The results from this experimental setup provide insights into the optimal levels of each ingredient that lead to the desired product quality. Through detailed analysis using ANOVA and 3D surface plots, the individual and combined effects of the factors on moisture content were analyzed. The upper limit and lower limit of each ingredient and the experimental run table are mentioned as follows

TABLE III

EXPERIMENTAL FACTOR VALUES – UPPER LIMIT AND LOWER LIMIT

| **Name of the factor** | **Upper limit** | **Lower limit** |
|---|---|---|
| Bottle gourd (gm) | 100 | 250 |
| Jamun concentration (ml) | 1 | 5 |
| Sugar concentration (%) | 10 | 60 |

TABLE IV
EXPERIMENTAL RUN DETAILS
DoE – (Factor and Response Run Values)

| | **Factor 1** | **Factor 2** | **Factor 3** | **Response 1** |
|---|---|---|---|---|
| **Run No.** | **Bottle Gourd (g)** | **Jamun Concentration (ml)** | **Sugar Concentration (%)** | **Moisture Reduction (%)** |
| 1 | 250 | 2 | 10 | 19.8 |
| 12 | 250 | 1 | 20 | 17.4 |
| 13 | 250 | 2 | 30 | 16.8 |
| 6 | 250 | 1 | 40 | 15.6 |
| 4 | 250 | 2 | 50 | 14 |
| 3 | 250 | 1 | 60 | 12.9 |
| 11 | 100 | 3 | 10 | 6.8 |
| 5 | 100 | 2 | 20 | 9.8 |
| 8 | 75 | 4 | 30 | 7.4 |
| 10 | 100 | 3 | 40 | 6.8 |
| 2 | 50 | 2 | 50 | 5.6 |
| 9 | 100 | 5 | 60 | 4 |
| 7 | 90 | 5 | 60 | 2.6 |

## H. DETERMINATION OF SENSORY ANALYSIS RESULT:

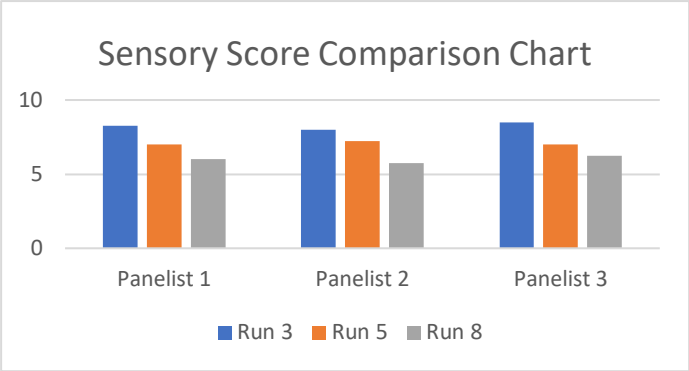



Fig.3 Sensory Score Comparison Chart

From the sensory score comparison chart, it is evident that Run No. 3, with a moisture content of 12.9%, offers the best overall sensory experience. This moisture level effectively balances the product's dryness with sufficient residual moisture to enhance aroma, texture, and taste, leading to higher overall acceptability. Both higher and lower moisture contents (14.0% and 7.4%) did not perform as well, indicating that a slight reduction in moisture from the standard drying process (without going too low) could be optimal for producing a sensorially appealing bottle gourd tutti frutti. This insight is crucial for optimizing production parameters to enhance consumer satisfaction.

## I. DETERMINATION OF NUTRIENT CONTENT:

The nutrient analysis has been performed in the external food analysis laboratory. The results are as follows:

TABLE V
NUTRIENT CONTENT

| S. No. | Parameters | Result | Unit |
|---|---|---|---|
| 1 | Energy | 212 | Kcal |
| 2 | Fat | 0.1 | g/100g |
| 3 | Carbohydrate | 52 | g/100g |
| 4 | Protein | 0.9 | g/100g |
| 5 | Total Sugar | 15.2 | g/100g |
| 6 | Fiber | 1.4 | g/100g |
| 7 | Calcium | 16 | mg/100g |
| 8 | Iron | 0.3 | mg/100g |
| 9 | Potassium | 72 | mg/100g |
| 10 | Sodium | 4 | mg/100g |
| 11 | Vitamin C | 1.2 | mg/100g |
| 12 | Vitamin A | Negligible | mg/100g |

## J. SHELF LIFE STUDY OF TUTTI FRUTTI

TABLE VI
SHELF LIFE STUDY

After one month of storing Tutti frutti

| S.No | Parameters | Unit | RESULT |
|---|---|---|---|
| 1 | Total coliforms | CFU/g | 5.5×10^2 |
| 2 | Escherichia coli | CFU/g | Absent |
| 3 | Staphylococcus aureus | CFU/g | Absent |
| 4 | Yeast & Mould | CFU/g | <10 |
| 5 | Salmonella | /25g | Absent |

After 3 months of storing the product

| S.No | Parameters | Unit | RESULT |
|---|---|---|---|
| 1 | Total coliforms | CFU/g | 5.5×10^2 |
| 2 | Escherichia coli | CFU/g | Absent |
| 3 | Staphylococcus aureus | CFU/g | Absent |
| 4 | Yeast & Mould | CFU/g | 5×10^2 |
| 5 | Salmonella | /25g | Absent |

## IV. CONCLUSION:

This project successfully demonstrated the potential of utilizing bottle gourd rind waste for value-added applications. By using low-cost agricultural waste, we addressed environmental challenges associated with food processing waste while promoting sustainable practices. Our findings confirmed that both fresh and fermented bottle gourd peels possess rich nutritional and antioxidant properties, with fermentation significantly enhancing their quality. Our findings emphasize not only the environmental benefits of waste utilization but also the potential for developing profitable, health-promoting products. The addition of jamun extracts further improved the visual properties of the developed tutti frutti, maintaining high antioxidant activity. Overall, this work emphasizes a practical, eco-friendly approach to waste and the creation of health-promoting food and beverage products.

Response Surface Methodology (RSM) was applied to optimize the production parameters, maximizing enzyme yields and enhancing product quality efficiently. This statistical approach helped fine-tune key factors, ensuring better process control and scalability. Overall, our findings emphasize the environmental, nutritional benefits of the tutti frutti.This work offers a sustainable model for industries to reduce waste disposal costs, promote health-oriented food products, and adopt eco-friendly practices. Tests such as microbial and shelf life study has also has given the result that the tutti frutti lasts for almost a month without spoilage in room temperature and later on vacuum packaging the product and refrigerating the product for 3 months the product still stays fresh and when the product only refrigerated without vacuum packaging there may be a little amount of yeast and mould growth in 3 three months.The final product exhibited a moisture content of 12.9%, deemed ideal for retaining the desirable chewy texture and consistency typical of tutti frutti, without compromising shelf life. Overall, this study demonstrated the potential for bottle gourd-based tutti frutti to serve as a sustainable, nutrient-rich, and visually appealing confectionery ingredient, offering a promising avenue for commercial production and contributing to food waste reduction and value addition in the agro-processing sector.

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