

# Technological Optimization of Instant *Phalahari Gulabjamun*

काशी हिन्दू  
विश्वविद्यालय



BANARAS HINDU  
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## THESIS

submitted in partial fulfillment of the requirements  
for the award of the degree of

**Master of Technology**

in

**Dairy Technology**

Supervisor

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Submitted By

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Dedicated to: Our Founder Sir



**HON'BLE BHARAT RATNA PANDIT MADAN MOHAN  
MALVIYA JI AND HIS PHILOSOPHY OF**

॥ गायत्री गीता ॥



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Dear Sir,

I have great pleasure in forwarding the thesis entitled **“Technological Optimization of Instant Phalahari Gulabjamun”** submitted by **Mr. Shubham Jaysurya, I.D. No. 20412MDT012, Enrolment No. 433981**, in partial fulfilment of the requirement for the degree of **Master of Technology in Dairy Technology**, Department of Dairy Science & Food Technology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi.

This is to certify that the work has been carried out solely by **Mr. Shubham Jaysurya** under my supervision and guidance and his findings and data presented herein are genuine and original to the best of my knowledge and belief and no part of the work has been submitted for any other degree or institution.

Thanking you,

**Forwarded by**

Yours faithfully

**(Dr. Arvind)**  
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# Technological Optimization of Instant Phalahari *Gulabjamun*



By  
*Shubham Jaysurya*

Thesis submitted in partial fulfilment of the requirements for degree of  
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**Date:**

**Place:** Varanasi

(Shubham Jaysurya)

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# **ABBREVIATIONS AND SYMBOLS**

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<b>°C</b>	Degree Centigrade
<b>AMF</b>	Anhydrous Milk Fat
<b>AOAC</b>	Association of Official Agricultural Chemists
<b>B°</b>	Brix
<b>BIS</b>	Bureau of Indian Standard
<b>CC</b>	Coliform Count
<b>CNF</b>	Chestnut Flour
<b>CuSO<sub>4</sub></b>	Copper Sulfate
<b>g</b>	Gram
<b>gm</b>	Gram
<b>H</b>	Hour
<b>H<sub>2</sub>SO<sub>4</sub></b>	Sulphuric Acid
<b>HMF</b>	Hydroxyl Methyl Furfural
<b>INR</b>	Indian Rupee
<b>K<sub>2</sub>SO<sub>4</sub></b>	Potassium sulfate
<b>Kg</b>	Kilogram
<b>M</b>	Meter
<b>mg</b>	Miligram
<b>mL</b>	Mililitre
<b>NaOH</b>	Sodium Hydroxide
<b>OD</b>	Optical Density
<b>QDA</b>	Quantity Descriptive Approach
<b>SD</b>	Standard Deviation
<b>SMP</b>	Skim Milk Powder
<b>TBA</b>	Thibarbutaric Acid
<b>TCA</b>	Tri-chloroacetic acid
<b>TDS</b>	Traditional Dairy Products
<b>TPC</b>	Total Plate Count
<b>US \$</b>	United State dollar
<b>UV</b>	Ultra Violet
<b>WMP</b>	Whole Milk Powder
<b>WPC</b>	Whey Protein Concentrate

## **INTRODUCTION**

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India has overtaken the United States as the world's top milk producer, and milk availability has developed during the flush season, combined with insufficient facilities to keep liquid milk fresh during transit from countryside production areas to city markets, has resulted in milk being enhanced into traditional milk products. These items are significant in terms of societal, religious, cultural, medical, and economic importance in Indian culture. They were created throughout time with the help of homemakers' cooking skills and Halwais (**Veni et al., 2016**).

In fiscal year 2020, India would produce almost 198 million metric tonnes of milk. 44.5 percent of milk is used as fluid milk, while 55.5 percent is used in the production of sweets. Because of its social, economic, religious, medical, and cultural value, traditional milk products such as rasogolla, *Gulabjamun*, sandesh, and misti dahi have been manufactured in our country since ancient times. *Gulabjamun*, among these, holds a special place in the world of Indian sweets **Thakur and Chandra (2015)**.

Khoa occupies a place of prominence among traditional Indian milk products. In spite of limitations, India's high-value, high-volume market for traditional dairy products and delicacies is set to boom under the technology of mass production. This market is the largest in value after liquid milk and is estimated at US \$3 billion in India and US \$1 billion overseas. Khoa is one of the most well-known traditional Indian milk products. According to a rough estimate, khoa industry in India, utilized about 7 per cent of the total milk production (Dairy India 2007). Despite its limits, the high-value, high-volume market for traditional dairy products and delicacies in India is likely to expand because to mass-production technologies. After liquid milk, this sector is predicted to be worth \$3 billion in India and \$1 billion internationally. In the country, 900,000 tonnes of khoa worth Rs 45,000 million are produced. The value of khoa and chhana produced is likely to be twice that of all milk handled by the

country's organised sector. Sweets made from khoa and chhana might be worth more than Rs 130,000 million (**Rao et al., 2014**)

*Gulabjamun* is a popular Indian delicacy that can be found all throughout the country. *Gulabjamun*, like other sweets, is prepared in India, is mostly in the hands of halwais who use a small-scale batch method. Though sensory quality of *Gulabjamun* varies greatly, the most popular product should have a brown colour, a smooth and spherical shape, a soft and slightly spongy body free of both lumps and a hard central core, a uniform granular texture, a mildly cooked and oily flavour free of doughy feel, and be fully succulent by Sugar syrup. It is typically made from cow or buffalo milk khoa by kneading a smooth dough with wheat flour (Maida) and baking powder, portioning the dough, flattening it into spherical balls, deep frying the balls in oil till golden brown in colour, and soaking them in sugar syrup overnight (**Vasava et al., 2018**).

Low-calorie foods and beverages are becoming increasingly popular. The majority of the world's population is aware of the negative effects of sugar on health. Today's health-conscious consumer seeks conventional dairy products that are low in sugar or sugar free. Non-communicable diseases such as obesity, diabetes, cardiovascular disease, and cancer have become serious health problems worldwide as a result of changing lifestyles and eating patterns (**Saraiva et al., 2020**)

*Gulabjamun* is an Indian sweetmeat made from a combination of khoa, wheat flour (maida), and baking powder. *Gulabjamun's* main dairy ingredient, khoa, produces considerable variances in the chemical and sensory properties of the fruit. Because khoa has a short shelf life and is not available all year, attempts were made to find a substitute for it in the manufacture of *Gulabjamun* (**Patil et al., 2017**).

Over the years, a variety of milk powders have been researched for use in dairy products. Among these are whole milk powders (WMP), highfat powders, buttermilk powders, whey powders, and skim milk powder sprayed with anhydrous milk fat (AMF) or cream. Despite the fact that they may have a similar composition,

these powders have vastly different properties. The two most significant stages in the production of milk powder are evaporation and drying (**Kelly et al., 2016**).

Both operations' scientific underpinnings are detailed in length in the literature. A roller or a spray drier are typically used to dry milk. Spray drying is the process of turning concentrated liquid milk into dried powder by spraying it into a regulated flow of hot air within a drying chamber. The large surface area of the spray droplets contributes to the rapid evaporation rate. In the roller drying method, pre-concentrated milk is dried on the surface of a hot drum. As the water evaporates, a scraper remove the thin, dehydrated milk layer from the drum (**Amaladhas et al., 2017**)

Roller dried skimmed milk (SMP), butterfat, maida, suji, and baking powder were used to create a *Gulabjamun* mix powder (GMP) **Ranganadham et al. (2016)**. This composition was widely accepted for commercial *Gulabjamun* manufacturing. In India, there are only a few small dairies that produce roller SMP. Spray-dried SMP, on the other hand, is widely available. As a result, GMP was created using spray dried SMP and other ingredients (**Wang et al., 2018**).

Water chestnut (*Trapa natans*), also known as "Singhara" in India **Gani et al. (2010)**, is an effective substitute for wheat flour (WF) in the case of Celiac illness caused by gluten dyspepsia (wheat protein) (**Gul et al., 2014; Mir et al., 2014b**). Water chestnut fruits can be boiled or roasted, or dried and crushed into flour, which is occasionally used as an arrowroot flour substitute. With 16 percent carbohydrates and 2% protein, the fruit is a significant source of nourishment. The fruits are luscious and crisp while raw; when cooked, the flesh softens but remains crunchy. Minerals, vitamins, carbohydrates, calcium, phosphate, iron, copper, manganese, magnesium, sodium, and potassium are all abundant in the kernel **Bhatiwal and Jain (2012)**

The 'Phalahar vrat' is a variant of this fast (or falahar). People who practise this do not eat any cereal grains and instead eat fruits, milk and milk products, nuts and seeds for their daily meals. There is a group of folks that include potatoes to their

phalahar vrat meals, but it is entirely up to you. The vrat meals are sattvic and include very few seasonings. For cooking, most people use sendha namak or rock salt. The most popular beverages are fruit juices, fresh chaas (butter milk), and coconut water. Milk and milk products are essential ingredients in phalahar meals. Dairy products offer our bodies with essential nutrients. The following are some of the health benefits of drinking milk and milk products during the phalahar Navratri fast. They are high in essential minerals such as calcium and phosphorus. Calcium is not only important for bone and tooth health, but it is also necessary for muscles to move, For nerves to convey information, To aid the movement of blood through blood vessels, To cause the release of hormones and enzymes, which affect a variety of bodily activities.

**In light of the foregoing, the current project work “Technological Optimization of Instant Phalahari *Gulabjamun*” was undertaken with the following objectives:**

- 1) To optimize the process of Instant Phalahari dry *Gulabjamun* balls.
- 2) To study the shelf life of Instant Phalahari *Gulabjamun*.



## **REVIEW OF LITERATURE**

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India would generate over 198 million metric tonnes of milk in fiscal year 2020. Milk is used to make fluid milk in 44.5 percent of the time, and sweets in 55.5 percent of the time. Rasogolla, *Gulabjamun*, Sandesh, and Misti Dahi are traditional milk products that have been produced in our country since ancient times for social, economic, religious, medical, and cultural reasons. *Gulabjamun*, among these, holds a special place in the world of Indian sweets. *Gulabjamun* is a popular Indian sweetmeat. Is made with a combination of khoa, maida, and baking powder. *Gulabjamun's* main dairy ingredient, khoa, produces considerable variances in the chemical and sensory properties of the fruit.

### **2.1 Traditional dairy products**

TDP stands for "Traditional Dairy Products," which are milk products that originated in undivided India. Since Vedic times, the value of these milk products has been acknowledged. The range of ways to create traditional milk products is almost an art form. Traditional milk products provide the organised dairy sector a one-of-a-kind potential since they have a large popular appeal and a market that considerably exceeds that of western dairy products. Traditional dairy product consumption is increasing at a pace of more than 20% per year, but western dairy product consumption is expanding at a far slower rate (5-10 percent).

Traditional Indian milk products have been an essential component of India's socio-cultural life from time immemorial. Milk sweets are always presented at childbirth, weddings, job interviews, house inaugurations, feasts, festivals, social or religious events. In the light of the current globalisation strategy, international business executives are attempting to discover huge unknown areas of Indian traditional sweet food products acquired from Indian heritage and culture since the Vedic era. Huge opportunities are waiting to be tapped by combining our traditional riches of science and technology knowledge with our people's art and culture. The fact

that roughly half of India's milk production is used to make local sweets demonstrates their widespread appeal (**Malik et al., 2015**).

Traditional milk products offer a one-of-a-kind opportunity for India's organised dairy sector, as they appeal to a broad audience and have a significantly larger market than western-style dairy products. Traditional dairy product consumption is increasing at a pace of more than 20% per year, but western dairy product consumption is expanding at a far slower rate (5-10 percent ) **Patil et al. (2009)**. Traditional Indian dairy products offer roughly 200 percent value to milk, whereas western dairy products (with the exception of malted milk and milk chocolates) provide about 50 percent value to milk (**Aggarwal et al., 2018**).

Traditional sweets like *Gulabjamun*, *peda*, and *burfi* have already made significant progress in industrial manufacture. This development is nothing short of a revolution in the manufacturing and marketing of long-cherished traditional milk products that were formerly the sole property of small-scale *halwais* (sweetmeat producers). In India alone, the market for ethnic milk products is expected to be worth more than 1000 billion INR, with an annual growth rate of 50 billion INR (**Aggarwal et al., 2007; Rasane et al., 2015**).

Traditional Indian dairy products offer roughly 200 percent value to milk, whereas western dairy products (with the exception of malted milk and milk chocolates) provide about 50 percent value to milk. *Shrikhand*, *rasogolla*, *Gulabjamun*, *khoa*-based sweets (*peda*, *burfi*, *kalakand*), *sandesh*, and *paneer*, for example, cost 29, 33, 34, 35, and 65 percent of the selling price, respectively (**Aggarwal et al., 2018**).

## **2.2 GULABJAMUN**

*Gulabjamun* is a highly nutritious *Khoa*-based sweet food. It's made using a combination of *Khoa*, *maida* (refined wheat flour), and baking powder. *Gulabjamun* can be made with *Dhap Khoa*, which has a moisture content of 40-45 percent. *Gulabjamun* is the name of an Indian dairy product. Dipping *Gulabjamuns* in sugar

syrup is a crucial unit operation in the production of *Gulabjamuns* (Singh *et al.*, 2015).

*Gulabjamun* sensory quality varies greatly, the most popular product should be brown in colour, smooth and sphere-shaped in shape, soft and a little spongy body free of both lumps and hard central core, uniform granular texture, mildly cooked and oily flavour, free of doughy feel, and fully succulent by Sugar syrup. Cashew nut chunk may or may not be present in the centre (Banupriya *et al.*, 2020).

Khoa is a traditional milk product made by concentrating milk that is commonly used in India and adjacent countries as a base for a variety of traditional dairy products. Pindi, Dhap, and Danedar are the three categories that BIS (IS: 4883-1980) uses to classify khoa based on its texture and composition. Dhap khoa is preferred by *Gulabjamun* over the other two varieties. This variety's body has a loose, sticky texture with a smooth smoothness. It is usually pre-pindi and so has more moisture, allowing for the creation of smooth-surfaced balls by Kant and Broadwayb (2017).

This department has recently been working on preparing and characterization of khoa made from camel milk. Some preliminary research was conducted to determine the suitability of camel milk khoa in the preparation of *Gulabjamun* and Burfi. Camel milk khoa is not ideal for the preparation of Burfi, although it has showed potential in the preparation of *Gulabjamun*. However, the results showed that more effort is needed to improve the rheological qualities and sensory attributes of *Gulabjamun* made using camel milk khoa. The inadequate porosity of the *Gulabjamun* affected the desired penetration of the sugar syrup inside the product, and another issue was the typical flavour of the *Gulabjamun* linked with camel milk.

*Gulabjamun* is a popular dairy sweet made by frying portioned dough made by combining and kneading desiccated milk solids (khoa), refined wheat flour, and a suitable leavening agent (optional) in measured amounts of water; the fried balls are then immersed in a sweetening syrup at moderate temperatures for extended periods of time (> 3 hours) to impart the product's characteristic succulence and sweetness.

Several research have looked into the different technology advances and process optimizations that have occurred throughout the frying and soaking of this beloved dish **Chetana et al. (2004)**. However, there is little information about *Gulabjamun* sub-baric processing in the public domain. A brief report on changes in the product's fat and moisture content during vacuum impregnation was noted in (**Sharanabasava et al., 2018**).

**Chetana et al. (2004)** by optimising several parameters, a technology for producing sugar-free *Gulabjamun* was devised. It was found that soaking fried *Gulabjamun* balls in 54° Brix strength sorbital syrup with 0.25 percent aspartame for 3 hours at 65°C produced a decent grade result.

**Kushwaha et al. (2018)** looked at the technique of making *Gulabjamun* mix using Spray and Drum dried Skim milk powder, which may be used in both the home and the workplace. The benefits of dried milk products include improved quality.

### 2.3 Technology of *Gulabjamun* production

**Eswara et al. (2013)** 300 gm Khoa, 35 gm maida, half tea spoon baking powder, 1 kg sugar, 1 kilogramme water, and 12 kg ghee are used in this recipe for producing *Gulabjamun* on a small scale. They suggested dipping the balls in sugar syrup for a few minutes before letting them float at room temperature for 10-12 hours. There were no details about process control, such as frying temperature or syrup content, provided. According to them, the balls should be cooked until a deep brown colour develops, which contradicts the conventional *Gulabjamun* preparation procedure. As a result, before commercialization, the procedure must be standardised.

**Shendurse et al. (2020)** *Gulabjamuns* were also made using preserved cow and buffalo milk khoa powder (roller dried). *Gulabjamun* made with cow milk khoa powder had a soft and spongy texture, whilst those made with buffalo milk khoa powder were hard and compact.

**Patil et al. (2017)** The effect of homogenising milk in the manufacture of khoa on the quality of the final *Gulabjamun* was investigated. Baking powder was

added at quantities of 0, 0.02, 0.05, 0.08, and 0.11 percent to khoa prepared from unhomogenized and homogenised milk in a 3:1 ratio. The most acceptable product was *Gulabjamun* made from unhomogenized milk khoa and 0.08 percent baking powder. *Gulabjamun's* quality was not improved by homogenization of milk.

#### **2.4 *Gulabjamun* is made using a traditional manner**

*Gulabjamun* is traditionally cooked with khoa, but **Kant et al. (2015)** standardised the recipe. They said that they made the dough with 80% khoa and 20% refined flour, adjusted the moisture content to 40%, and added 0.25 percent baking powder to the raw mix. Consumers did not like *Gulabjamun* made with cow milk, according to the same workers, because of its harsh texture.

#### **2.5 *Gulabjamun* mix powder formulation**

Light brown colour, spherical shape, soft and spongy body with penetration value of around 150 (precision cone penetrometer, 300 AOCS cone), absence of lumps and hard core, uniform granular texture, mild cooked flavour, free of doughy feel, juiciness, and optimum sweetness are all desirable characteristics of *Gulabjamun*. *Gulabjamun* of the highest grade were made with an SMP-based mix including 43.5 percent SMP, 25.0 percent semolina, 15% butter fat, 1.5 percent baking powder, and 0.1 percent cardamom. The stickiness and doughiness were addressed by replacing part of the maida in the mix powder with semolina (**Kant et al., 2015**).

The granularity, sponginess, and softness of the sweet were improved by adding 15% semolina. The suppleness was further enhanced by the addition of 15% butter fat. *Gulabjamun's* texture was improved by the use of baking powder. Higher concentrations resulted in a soapy taste and more porosity in the balls, with large air cells. Excess baking powder caused cracking in the balls during the frying process. 9 To disguise the powdery flavour of the SMP balls, cardamom powder was added (**Kant et al., 2015**).

**Mourya et al. (2021)** have created *Gulabjamun* mix powder formulations using both roller and spray dried skim milk. These mixes can be used to make highly uniform and acceptable sweets by both housewives and confectioners. These blends have a 9-month shelf life in metalized lamination pouches at room temperature.

In comparison to the mix made from spray dried skim milk, it is clear that drum dried skim milk may be efficiently employed in the formulation of *Gulabjamun* mix by carefully blending it in appropriate proportions with other components including maida, suji, vanaspati, and baking powder. The *Gulabjamun* created from the *Gulabjamun* Mix sample in the treatment DT1 (50:20:10:18:2) was determined to be more acceptable in terms of colour and appearance, flavour and taste, body and texture, and overall acceptability, according to the data collected from organoleptic evaluation (**Chandra and Thakur, 2015**).

**Table 2.1** The chemical make-up of *Gulabjamun* mix powder.

Constituent	SMP based mix (%)	WMP based mix (%)	Dried mix (%)
Moisture	8.44	8.20	3.51
Fat	15.03	15.10	14.36
Total protein	19.45	19.07	21.89
Total ash	3.89	3.93	3.98
Carbohydrate	53.19	53.70	56.26

## 2.6 Basic ingredients used for *Gulabjamun* preparation

*Gulabjamun* is made by combining a variety of ingredients. *Gulabjamun* is made from Khoa, Maida, Suji (Semolina), Sodium bicarbonate, Rose water, Cardamom, Saffron, Water, and other ingredients.

### 2.6.1 Khoa

Khoa is a notable indigenous milk product that serves as the foundation for a variety of traditional milk-based sweet treats (**Badola et al., 2022**). Khoa is a popular

product in India, where it is known by several names such as khoya, mawa, kava, palghova, and others.

More milk is produced in India than in any other country . Milk cannot be preserved for an extended period of time since it is perishable. More than half of India's milk is processed into a variety of traditional value-added milk products to preserve it, which have historically played a key role in the Indian economy. Khoa is a heat-desiccated indigenous milk product with added value. Around six lakh tones of khoa are generated annually as a result of its widespread use, accounting for 7% of India's total milk production (**Kumar *et al.*, 2013**).

BIS (IS: 4883-1980) divides khoa into three distinct categories based on its texture and composition, which can be used to make a variety of desserts.

**Table 2.2 Average Chemical composition of three varieties of khoa (BIS Specification)**

Constituents	Types of khoa		
	Dhap	Pindi	Danedar
<b>Total solid (%)</b>	66	56	61.5
<b>Fat (%)</b>	22.5	19.4	20.9
<b>Protein (%)</b>	19.5	17.1	18.4
<b>Lactose (%)</b>	19.4	16.7	18.9
<b>Ash (%)</b>	3.5	2.9	3.4
<b>End uses</b>	<i>Gulabjamun</i>	<i>Burfi, Peda</i>	<i>Kalakand, milk cake</i>

**Gupta and Gupta (2013)**

### 2.6.2 Binding materials

#### **Maida**

Maida has a good water binding property due to its starchy composition, and its use in the Gulabjamun mix lends the product firmness.

**Veni et al. (2016)** used 10% Maida on a khoa foundation to make *Gulabjamun* from khoa powder. **Ranganadham et al. (2016)** suggested using 20% maida while making *Gulabjamun* from khoa. In an SMP-based *Gulabjamun* mix (GMP), Ghosh et al. (1986) utilised 25% Maida, while in a WMP-based mix, they used 35% Maida. Maida concentration in *Gulabjamun* ready mixes ranges from 25 to 35 percent.

### **Suji (Semolina)**

**Joshi et al. (2009)** tested three different suji and maida combinations as binding agents in proportions of 10:30, 15:25, and 20:20 percent dry suji and maida mix. The authors discovered that combining suji and maida in a 15:25 ratio yielded the best results, with *Gulabjamun* having a soft and uniform texture, whereas those made from dry mix containing suji and maida in a 10:30 ratio were slightly gummy and spongy, and those containing 20:20 suji and maida had a coarse and soggy body. Suji (dried) The inclusion of 10% dry suji in *Gulabjamun* preparation produced a superior look but lower texture, flavour, and overall acceptability when compared to *Gulabjamun* made without suji. **Kushwah et al. (2018)** used dry suji at a concentration of 10% in khoa made from concentrated milk to produce acceptable *Gulabjamun*.

Suji already saturated *Gulabjamun* made with pre-soaked suji containing 10% (w/w) milk solids exhibited higher softness, springiness, flavour, body, and texture ratings than those made with dry suji, owing to greater porosity and sugar absorption (**Joshi et al., 2009**).

**Londhe et al. (2000)** investigated the use of different binders in khoa during *Gulabjamun* manufacturing, including maida (wheat flour), shingada (water chestnut), and sago (cassava). Due of their fundamental colour variances, these binding materials were found to alter the colour and look of *Gulabjamun*. Sago flour was chalky white, maida was snow white, and shingada was reddish. As a result, the colour of the *Gulabjamun* with Maida was the best. *Gulabjamun* with sago had a lower acceptability of flavour than *Gulabjamun* with maida, but it was found to be superior than shingada combinations. The quality of the shingada protein was shown

to be more compatible with the quality of the khoa protein, resulting in more durable and desirable body traits. The texture of maida-containing *Gulabjamun* was generally superior to that of shingada flour.

### 2.6.3 Raising agents

#### Baking Powder

Baking powder helps to swell the *Gulabjamun* during frying and enables for volume expansion and sugar syrup absorption by providing porosity.

**Vasava et al. (2018)** investigated the influence of various baking powder rates (0.0, 0.02, 0.05, 0.08, and 0.11 percent of the mix) on the physico-chemical characteristics and quality of *Gulabjamun*. They found that increasing the amount of baking powder used increased fat, total solids, sugar absorption, volume, and overall acceptance of the *Gulabjamun*.

According to **Krupa et al. (2011)** adding 1.5 percent baking powder to the designed mix resulted in excellent *Gulabjamun* quality. *Gulabjamun* at 1.0 percent were sticky and had a dry inner core, however at 2.0 percent, the *Gulabjamun* were excessively porous with many air cells in the ball, yet had a soapy taste and were prone to cracking when frying.

### 2.6.4 Other ingredients

#### Whey Protein Concentrates

In their investigation, **(Dewani and Jayaprakasha, 2002)** discovered that using whey protein concentrates (WPC) at a concentration of 40% resulted in the *Gulabjamun* having superior sensory qualities to the control. In the case of *Gulabjamun*, over 40% WPC, the product granularity increased excessively, the softness increased unnecessarily, and beyond 50% WPC, the balls disintegrated while frying.

According to **Devraj et al. (2006)** *Gulabjamun* of satisfactory quality can be made with 10% WPC. The addition of 10% WPC can result in the highest sensory scores and overall acceptance compared to the control. However, as WPC levels grew, sugar syrup absorption dropped but oil intake increased.

### **Cardamom**

Cardamom powder was added to the dry mix at 0.05, 0.10, and 0.20 percent by **(Lad et al., 2017)**. The addition of 0.1 percent cardamom powder was sufficient to hide the powdery and doughy flavour of the *Gulabjamun*, whereas the flavour was slightly stronger at 0.20 percent.

### **2.7 Skim milk powder**

Both operations' scientific underpinnings are detailed in length in the literature. A roller or a spray drier are typically used to dry milk. Spray drying is the process of turning concentrated liquid milk into dried powder by spraying it into a regulated flow of hot air within a drying chamber. The high evaporation rate is aided by the enormous surface area of the spray droplets. Pre-concentrated milk is dried on the surface of a hot drum in the roller drying method. A scraper scrapes the thin, dried milk coating from the drum as the water evaporates **(Amaladhas et al., 2017)**.

**Ranganadham et al. (2016)** used roller dried skimmed milk (SMP), butterfat, maida, suji, and baking powder to make *Gulabjamun* mix powder (GMP) . This formula was commonly used in commercial *Gulabjamun* production. Only a few small dairies in India make roller SMP. SMP that has been spray-dried, on the other hand, is readily available. As a result, GMP was developed utilising spray-dried SMP and other materials **(Wang et al., 2018)**.

**Table 2.3** Compositional specifications for Skimmed milk powder as FSSAI (2019).

Characteristic	Percentage (Per 100g) (FSSAI:2011) Standard Grade
Moisture	5.0
Milk fat % by mass. Max	1.5
Protein	34.0
Ash	9.3
Titration acidity	18
Insolubility Index (ml)	2.0

## 2.8 Water chestnut flour

Water chestnut, also known as 'Singhara,' is a major annual aquatic warm season crop that belongs to the Trapaceae family. It grows naturally in Kashmir valley's water bodies, particularly Wular Lake. It is a vital source of revenue, sustenance, and seasonal work for the people who live along the river's edge. Other persons who are directly or indirectly involved in its trade will also benefit. It can be consumed raw or roasted. It is also dried and processed into flour, from which traditional items such as chapattis and rotis are made. In the case of celiac illness caused by gluten indigestion, water chestnut flour can be a viable substitute for wheat flour. It produces flour that is easily digested and low in fat, making it ideal for dieting (Gagandeep *et al.*, 2010).

### Water chestnut's nutritional value

Water nut (*Trapa natans*) is another name for water chestnut (*Trapa natans*). It is a rooted floating aquatic annual or perennial plant that is widely found floating on the water surface of lakes and pools in India and other countries. The colour and shape of the outer cover in which the kernel is wrapped are fascinating elements of water caltrop. The water chestnut meat (kernel) is protected by a thick jet-black

exterior pericarp that resembles a buffalo horn protruding from its head (**Chiang *et al.*, 2007**).

The root system of the water chestnut is attached to the muddy soils at the pond's bottom. It is attached to floating leaves in the water body by herbaceous stalks (**Singh *et al.*, 2010**).

Water chestnut is mostly grown in India for human use, either as a vegetable, flour, or a variety of sweet desserts, depending on personal preference. Its flour is thought to be superior to rice in terms of nutritional value. It is a good source of nutrients and compares well to other foods. In all areas where the plant is found, the fresh kernel of the fruit is eaten as a food item. It is high in starch and has a flavour similar to chestnut. Water Because of its distinct flavour, chestnut is a valuable item in the food sector (**Shafi *et al.*, 2016**).

Before boiling or preserving, the dark brown corns of water chestnut are peeled. The tasty kernel is high in carbohydrates, proteins, and important minerals. The edible zone is mostly made up of starch-rich, thin-walled storage parenchyma that looks like potato and is interlaced with vascular strands. The fruits can be eaten fresh or boiled and roasted. According to Noda *et al.* (1996) 10, the principal components of free sugars in Chinese water chestnut juice are sucrose (8.58%), glucose (1.64%), and fructose (1.58%), with maltose as a trace component. The primary mineral present, potassium, was found to have a concentration of 408.57 mg. The minor minerals present were 0.21 percent iron and 0.08 percent manganese, respectively. Many meals benefit from the textural features of water chestnut starch, such as thickening soups and sauces. Water chestnut is a potential source of commercial starch in Asian countries due to its ease of implementation and administration (**Tulyathan *et al.*, 2005**).

Starch qualities are influenced by physical and chemical variables such as cultivars, growth period, environmental factors, granule size, amylose/amylopectin ratio, and mineral content (**Singh *et al.*, 2003**).

**Singh et al. (2009)** extracted and examined Water chestnut starch's structure and characteristics. Starch granules were discovered to be spherical, elliptical, or potato-like in shape, with a length of 10-30 m. The majority of the granules had smooth surfaces, although some exhibited minor creases or scratches. Water chestnut starch (6 percent conc.) had a pasting temperature of 71 percent, which was greater than potato (61°C at 450) and lily (62°C at 5 percent) starches (Takeda and Preiss, 1993), equivalent to Kuzu (70° C at 65) starch, and lower than maize (77° C at 6 percent) . It had a low viscosity (maximum 310BU), which stayed constant throughout heating and slightly rose during cooling. The starch exhibited an X-ray diffraction pattern that was intermediate between corn and potato starches.

According to **Singh et al. (2010)** moisture content of fresh water chestnut kernel is 81.12 percent, total soluble solids is 7.2 percent, total acidity is 0.142 percent, crude lipids is 0.36 percent, ash is 1.33 percent, crude fibre is 0.72 percent, total protein is 1.87 percent, total sugar is 5.63 percent, reducing sugar is 1.27 percent, and non-reducing sugar is 4.36 percent.

**Table 2.4 Compositional specifications for Water chestnut flour.**

Parameter	Percentage (%)
Moisture	9.80
Carbohydrate	83.7
Protein	2.80
Fat	0.39
Crude fiber	3.11
Ash	2.22

**Functional properties of flour**

According to **Omuetti et al. (2009)** oil absorption capacity is crucial since it improves mouth feel and flavour retention. According to **Yadav et al. (2014)** high water absorption capacity is attributable to the nature of starch and its potential

contribution to water absorption. According to **Correia *et al.* (2012)** the swelling characteristic of flour is generally connected to its protein and starch concentration; increased protein content in flour can cause starch granules to be lodged inside a rigid protein matrix, limiting swelling power. According to **Yadav *et al.* (2014)** Water chestnut flour has water absorption capacity, oil absorption capacity, least gelation concentration, swelling power, and solubility of 131 gm, 108 gm, 20 gm, 8.5 gm, and 0.12 g per 100 gm.

### **Utilization of water chestnut in other food stuff**

According to **Ahmad *et al.* (2012)** water chestnut is the most important source of starch, containing around 72 percent starch. Water chestnut starch is extracted and utilised as a stabilising ingredient in yoghurt. The addition of *Trapa bispinosa* starch had no effect on the taste or acceptability of the product. Water chestnut starch at 1.25 percent produced outstanding results in terms of water holding capacity, synergy, and viscosity, whereas water chestnut starch at 0.75 percent produced outstanding results in terms of all sensory qualities. Yogurt's shelf life has been extended to 25 days.

The noodles prepared from blends of water chestnut flour had good acceptable texture, eating, and 15 cooking quality, according to **Yadav *et al.* (2014)**. This result could encourage the use of non-traditional flour for the development of a variety of value-added noodles with increased nutrient levels and lower gluten levels.

Sensory and instrumental approaches were used to determine the sensory properties of cookies with varying amounts of chestnut flour. The dough moisture was 22 percent, and the wheat flour was substituted with chestnut flour in three levels (20, 40, and 60 percent). The control sample consisted entirely of wheat flour. Six trained members of the descriptive panel used the quantity descriptive approach (QDA) to describe the sensory quality of the cookies. Sensory evaluation of cookies with wheat flour partially replaced with chestnut flour revealed that samples with 20% chestnut flour were highly sensory assessed. The cookies with 20% chestnut flour were classified as having very good quality in a quality descriptive study. For the

control sample, the same quality category was used. The samples containing 20% chestnut flour had the greatest overall sensory impression score, which was quite similar to the value for the control sample (**Dokic et al., 2014**).

Improved biscuit was made utilising chestnut flour (CNF) at three levels (10, 20 and 30%) to wheat flour (72%), according to **Hegazy et al. (2014)**. (WF). Rheological qualities of dough, baking quality, colour, sensory properties, and biscuit shelf-life were all tested to determine the improved biscuit's technological properties. Chemically, the improved biscuit was assessed by measuring gross chemical composition, antioxidant activity, and total phenolic content. The findings showed that raising the amount of CNF resulted in higher fat, fibre, ash, and mineral content. Biscuit height and volume were raised as a result of CNF addition, but diameter and spread ratio were somewhat lowered; and the increase in biscuit specific volume was more significant when CNF was added at levels of 10%, 20%, and 30%. Furthermore, sensory evaluation revealed that raising CNF levels in biscuits decreased sensory scores for 16 colour and texture while boosting taste and leaving odour, appearance, and overall acceptability unaffected.

According to **Anu et al. (2015)** gluten-free water chestnut flour was used to substitute wheat flour at varied levels in the preparation of cookies. Cookies made with water chestnut flour had a better sensory analysis and included less moisture, fat, and protein. They were also soft and appealing in colour. Cookies made with water chestnut flour showed a higher spread ratio than cookies made with wheat flour.

According to **Bhat et al. (2015)** bread is one of the most popular foods in the globe, and its popularity has increased dramatically in recent years. The bread was made with various wheat flour and water chestnut flour combinations (T1, T2 and T3). For three treatments, the flour composition ratios were 9.7:0.3, 9.4:0.6, and 9.1:0.9. The bread with a 3% water chestnut flour additive had higher acceptance levels than the other two treatments. In comparison to T2 and T3, T1 had lower hardness levels. Sensory study revealed that a 3% water chestnut flour supplementation was promising (Table 2), and the panellists accepted the bread with a 3% water chestnut flour substitute level.

Cookies were made with wheat flour: water chestnut flour blends in the ratios of 100:0, 90:10, 80:20, and 70:30 w/w, according to **Walde *et al.* (2015)**. Cookies were discovered to combine well with Cookies made with 20% water chestnut flour were shown to have a wide range of sensory qualities and were widely accepted. Its general acceptability is nearly identical to that of the control group.

## **2.9 Sweet potato flour**

Sweet potato is a low-cost, high-nutrient food crop that has long been popular in the Southeast. It's also gluten-free and high in beta-carotene (provitamin A), potassium, dietary fibre, and a variety of other beneficial nutrients (**Kindeya *et al.*, 2021**).

Sweet potatoes can be made into flour, flakes, purees, canned goods, beverages, and a variety of snacks. Sweet potato flour and flakes can be used to partially replace wheat and other cereal flours, as well as to boost the beta-carotene content of baked goods and pancakes (**Truong *et al.*, 2018**).

## **2.10 Kuttu flour**

Buckwheat flour is known as kuttu ka atta in most northern and western Indian states and is consumed on fasting days, especially during Navaratri (religious days according to Hindu religion). Buckwheat is a popular pseudocereal with a high lysine content, mineral content, vitamins, and the bioflavonoid rutin and quercetin (**Rana *et al.*, 2004**).

Flavones, flavonoids, phytosterols, D-chiro-inositol, and myo-inositol are the most appealing of these chemicals. Buckwheat seeds are inherently gluten free, making them a nutritious alternative to gluten-containing grains in a gluten-free diet (**Mann *et al.*, 2012; Huang *et al.*, 2014**).

Galactosides of D-in chiro-inositol, fagopyritols, are the primary constituents of growing buckwheat seeds and are employed in the treatment of blood sugar

management. Fagopyritols and its derivatives are used to treat polycystic ovarian syndrome and non-insulin dependent diabetes mellitus (**Obendorf *et al.*, 2012**).

The major active ingredient in buckwheat leaves is rutin, a flavonoid with anti-inflammatory and anti-microbial properties that has a wide range of applications in medicine. Rutin protects insulin signalling and modulates diseases of glucose and lipid metabolism. Surprisingly, studies have revealed the importance of flavonoids as UV-B absorbants, with rutin, quercetin, and quercitrin acting as UV-B absorbing chemicals that protect cells by blocking UV radiation from reaching and harming important molecules like nucleic acids, notably DNA (**Germ *et al.*, 2002**).



## **MATERIALS AND METHODS**

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The research work “**Technological optimization of Instant Phalahari *Gulabjamun***” was carried out in the lab of Department of Dairy Science and Food Technology ( Institute of Agriculture Science), Banaras Hindu University Varanasi.

This chapter describes the materials utilised in the experiment, the processes used in the preparation of Instant Phalahari *Gulabjamun*, and the tests and evaluations of the product involved. The following experimental procedures were used.

The following sections provide the details of the experimental methodologies used during the current investigation:

- 1. Material required for preparation of experimental Instant Phalahari *Gulabjamun* .**
- 2. Procurement and collection of ingredients.**
- 3. Detailed procedure for manufacturing experimental Instant Phalahari *Gulabjamun* .**
- 4. Sensory Evaluation**

The Instant Phalahari *Gulabjamun* samples were evaluated for , colour and appearance, Body and Texture, Flavour, Taste and overall acceptability on a 9-point Hedonic scale by a sensory panel consisting of 10 judges.

- 5. Texture profile analysis**

Hardness, Cohesiveness, Adhesiveness, Springiness, Gumminess, Chewiness.

- 6. Proximate analysis of Instant Phalahari *Gulabjamun***

- a) Total Saturated Fat

- b) Total Unsaturated Fat
- c) Total Protein
- d) Total Carbohydrate
- e) Moisture
- f) Ash (Dry)
- g) Crude Fibre

## **7. Shelf life study**

- 1. TBA
- 2. HMF
- 3. TPC
- 4. Coliform Count
- 5. Effect of storage on Textural behaviour of Gulabjamuns

## **8. Cost Analysis**

### **3.1 Materials required**

Roller dried skim milk powder

Water chestnut flour

Desi Ghee

Baking powder

Cardamom powder

Butter paper

Sugar

Packaging materials

**3.1.2 Equipments used for the preparation of Instant Phalahari dry Gulabjamun balls**

1. Stainless steel Bowl
2. Electronic weighing balance
3. Measuring cylinder
4. Muslin cloth
5. Aluminium Mold
6. Oven

**3.1.3 Equipments used for analysis of Instant Phalahari Gulabjamun**

1. Autoclave, Tomy SX500 Japan.
2. Digital PH Meter, Tharom Scientific, Singapore.
3. Electronic weighing balance, Meter Toledo.
4. Hot air oven, perfit, India.
5. Incubators, Remi, Electrokinetik, India.
6. Laminar Air Flow, Lab Tech, India.
7. Muffle furnace, Snol, Lithuania.
8. Water bath, Vision Scientific, Korea.
9. Texture analyzer, TA XT, Plus, UK.
10. Spectrophotometer.
11. Spotless beaker.

## **3.2 Procurement and collection of ingredients**

### **3.2.1 Roller dried skim milk powder**

High quality roller dried skim milk powder was purchased from Model Dairy Plant, NDRI (Karnal)

### **3.2.2 Waterchest nut flour**

Fresh waterchest nut were procured from local market of Varanasi.

### **3.2.3 Desi Ghee**

Amul Desi Ghee was purchased from Amul Parlour Lanka, Varanasi.

### **3.2.4 Baking powder**

Refined baking powder was procured from local market of Varanasi.

### **3.2.5 Cardamom powder**

Fresh cardamom powder were procured from local market of Varanasi.

### **3.2.6 Butter paper**

Butter paper was purchased from shopping center Bhu campus , Varanasi.

### **3.2.7 Sugar**

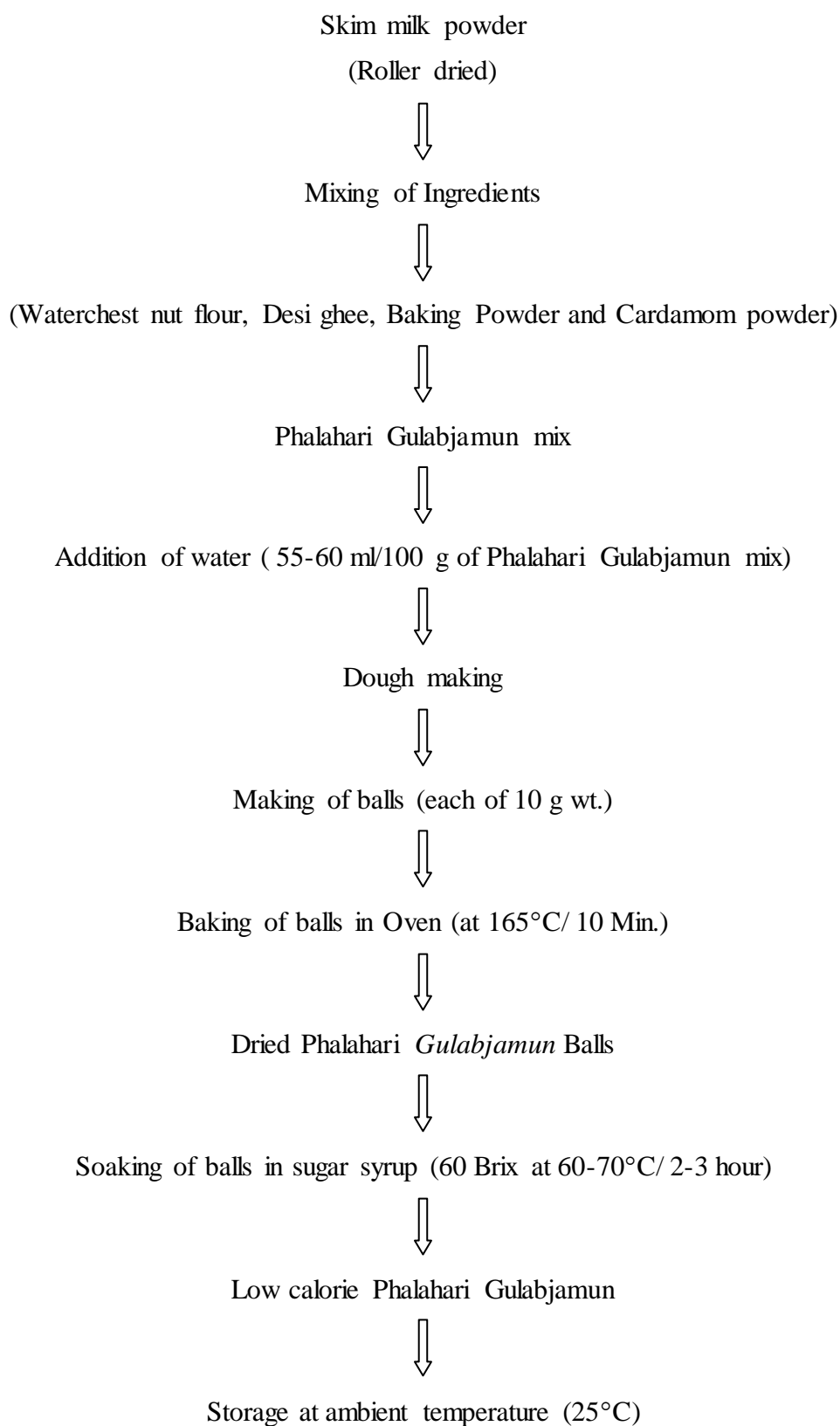
Sugar was purchased from local market of Lanka, Varanasi.

### **3.2.8 Packaging materials**

LDPE laminates were purchased from local market of Varanasi.

## **3.3 Manufacturing Method**

The Instant Phalahari *Gulabjamun* balls has been manufactured by using following flow chart as shown in fig.



**Fig 3.1 Process flow chart of Instant Phalahari *Gulabjamun*.**

Initially three types of flour (Water chestnut flour, Sweet potato flour and Kuttu flour), were used for the optimization of Instant Phalahari dry *Gulabjamun* balls.



**Fig. 3.2 Instant Phalahari Dry *Gulabjamun* balls**

### **3.4 Sensory Evaluation**

Semi-trained panel judges assessed the sensory qualities of Water chestnut flour (S1) based Instant Phalahari *Gulabjamun*, Sweet potato flour (S2) based Instant Phalahari *Gulabjamun*, and Kuttu flour (S3) based Instant Phalahari *Gulabjamun*. The sensory qualities of the finished product, such as colour and appearance, Body and Texture, flavour, Taste, and overall acceptability, were scored. The product was rated on a 9-point hedonic scale by a panel of ten judges (Kishor *et al.*, 2017)

The sensory score card is shown in Appendix I.

### 3.5 Texture Profile Analysis

The textural quality of instant phalahari gulabjamun balls were evaluated using the Instron Texture Analyzer of Stable Micro System equipped with 50 kg load cell. The analyzer is linked to a computer that recorded the data via a software programme.

Test mode : Compression

Pre-test Speed : 2.0 mm/sec

Test speed : 1.0 mm/sec

Post-test speed : 1.0 mm/sec

Trigger Load : 5 g

Target : 10.0 mm

Target mode : Strain

Distance : 10.0 mm

The textural properties of Instant Phalahari *Gulabjamun* were determined by using following textural parameters.

**3.5.1 Hardness:** It is defined as the value of the peak force of the first compression of the product.

Hardness, g (H) = maximum force of first compression

**3.5.2 Cohesiveness:** Extent to which a material can be deformed before it ruptures depending on the strength of internal bonds. (Ratio of the positive force areas under first and second compression)

$$\text{Cohesiveness (ch)} = \frac{\text{Area under the 2nd compression (A2)}}{\text{Area under the 1st compression (A1)}}$$

**3.5.3 Adhesiveness:** Force necessary to remove the material that adheres to the mouth when eating food.

Adhesiveness, g, mm (A3) = Negative area in the graph

**3.5.4 Springiness:** Height that the food recovers during die time that elapses between the end of the first bite and the start of the second bite.

Springiness = D1

**3.5.5 Gmminess:** Energy required to disintegrate a semi-solid food product to a state ready for swallowing.

Gumminess = Hardness  $\times$  Cohesiveness. (H X A2/A1)

**3.5.6 Chewiness:** Energy required for masticating a solid food product to make it ready for swallowing.

Chewiness, g (Cw) = Gumminess  $\times$  Springiness. (H X A2/A1) X D1



**Fig. 3.3 TPA of instant Phalahari *Gulabjamun***

### **3.6 Proximate analysis**

#### **a) Determination of Total Saturated Fat**

Determining of saturated fat in Instant Phalahari dry *Gulabjamun* balls by AOAC (2005) methods.

#### **b) Determination of Total Unsaturated fat**

Determining of Unsaturated fat in Instant Phalahari dry *Gulabjamun* balls by AOAC (2005) methods.

#### **c) Determination of Total Protein**

Protein content in Instant Phalahari dry *Gulabjamun* balls sample was determined as per the procedure given by IS : 7219.

Approximately 0.2 g of thoroughly mixed sample was transferred to a 300 ml Kjeldahl digestion flask, followed by 5 g digestion mixture as a boiling point elevator (K<sub>2</sub>SO<sub>4</sub>: CuSO<sub>4</sub>: in a 10:2 ratio) and 12.5 ml concentrated sulphuric acid to convert nitrogen to ammonium sulphate (Nelson, 1998). The flask's wall was cleaned with distilled water. The contents were then digested till they yielded a clear liquid. The contents of the Kjeldahl flask were transferred into a mini Kjeldahl distillation unit after cooling to room temperature.

To make the solution alkaline and liberate ammonia, 20-25 ml of 50% NaOH was added. The released ammonia was collected in 25 ml of 2% boric acid (H<sub>3</sub>BO<sub>3</sub>) with 2-3 drops of mixed indicator (10 ml of 0.1 percent bromocresol green + 2 ml of 0.1 percent methyl red indicator in 95 percent ethyl alcohol). Distillation was maintained until approximately 65 ml of distillate was obtained, and then it was titrated against N/10 H<sub>2</sub>SO<sub>4</sub> to a light violet colour end point. All of the reagents were used in the blank, except the sample, which was replaced with sucrose. The percentage of protein was determined as follows:

$$\% \text{ Nitrogen} = \frac{[14 \times (s-b) \times \text{normality of H}_2\text{SO}_4]}{[\text{Weight of sample (g)}]}$$

$$\% \text{ Protein} = 6.38 \times [\% \text{ Nitrogen}]$$

Where, S = Volume of H<sub>2</sub>SO<sub>4</sub> used for sample titration

b = Volume of H<sub>2</sub>SO<sub>4</sub> used for blank titration

**d) Moisture**

The moisture content was estimated using the AOAC technique (1995).

A 5g well-mixed sample was weighed correctly into a cooled and tared aluminium dish. The Instant Phalahari *Gulabjamun* balls were roasted for 4 hours in an oven set to 105°C. The meal was placed in desiccators and weighed after cooling. The moisture content was determined as follows:

$$\% \text{ Moisture} = \frac{W_2 - W_1 \times 100}{W_1 - W \times 100}$$

Where, W = Weight of empty dish (g)

W<sub>1</sub> = Weight of dish with the sample (g)

W<sub>2</sub> = Final weight of dish (g).

**e) Determination of Total Carbohydrate**

Total carbohydrate were determined by the difference method and calculated as follows.

$$\text{Total carbohydrate} = 100 - (\text{Total Protein} + \text{Fat} + \text{Ash} + \text{Moisture})$$

**f) Ash (Dry)**

The ash content was determined as per AOAC, (2005). About 3g of the sample was accurately weighed in the previously dried and weighed silica dish. The dish was heated in a muffle furnace at  $550\pm 10^0$  C for about 4-5 hours until light grey ash was obtained. The dish was cooled in a desiccator and weighed. The process of heating at  $550\pm 10^0$  C and subsequently cooling was repeated until weight variation was less than one milligram.

Total ash, percentage by weight was calculated:

$$\text{Ash \%} = \frac{(w_2 - w) \times 100}{(w_1 - w)}$$

Where,  $w_1$  = weight in g of the dish with the material taken for the test

$w_2$  = weight in g of the dish with the ash

$w$  = weight in g of the empty dish

**g) Crude Fibre (CF)**

The Crude content was determined as per AOAC, (2005). The moisture and free fat sample were sequentially refluxed with weak acid (1.25% NaOH), each followed by filtration using muslin cloth and repeated hot water washings. The remaining residue comprising of lingo-cellulose and cellulose was oven dried and ignited in a muffle furnace for ashing. The percent loss in weight of the original sample was expressed as crude fiber and expressed as percent on DM basis.

$$\begin{aligned} \text{Crude fibre (\%)} &= \frac{\text{Wt. of sample before ashing (g)} - \text{Wt. of sample after ashing (g)}}{\text{Weight of dry sample}} \\ &\times 100 \end{aligned}$$

### 3.7 Shelf life study of Instant Phalahari *Gulabjamun* balls

Instant Phalahari *Gulabjamun* was packed in LDPE laminated film. The storage-related alterations in the experimental samples were investigated. Fresh and stored samples of Instant Phalahari *Gulabjamun* were tested for TBA, HMF, sensory and microbiological qualities at 10°C and 25°C for 30 days with five days time intervals. On the basis of taste evaluation as well as obvious TPC (Total Plate Count) and CC (Coliform Count) growth on the surface, Instant Phalahari *Gulabjamun* was rejected.

#### 3.7.1 TBA ( Thiobarbituric Acid Value )

The extent of oxidation of fat in *Gulabjamun* was measured in terms of TBA value. The extraction method of **Strange *et al.* (1977)** was followed with slight modification.

A 0.2 gram sample of *Gulabjamun* was blended with 5 ml of 20% TCA (Tri-chloroacetic acid) and 5 ml of distilled water and kept undisturbed for 10 minutes to determine the TBA value. The contents were then filtered using Whatman No. 1 filter paper. The filtrate (5 ml) was pipetted into a test tube, and 5 ml of 0.01M 2-Thiobarbituric acid was added. The colour was generated by incubating the tubes for 30 minutes at 100°C in a boiling water bath. The contents were cooled to room temperature before measuring absorbance at 532 nm. In lieu of a sample, distilled water was used to make blank determinations. The absorbance at 532 nm was used to get the TBA value.

#### 3.7.2 HMF (Hydroxy Methyl Furfural)

Total HMF in *Gulabjamun* (fresh and stored) was determined by the method recommended by Keeney and Bassette (1959) with slight modification.

Three gram of *Gulabjamun* were blended thoroughly with seven millilitres of distilled water. The tube was filled with 5 ml of 3 N oxalic acid and placed in a boiling water bath for 60 minutes. After cooling the contents of the tube, 5 ml of a 40

percent trichloroacetic acid solution was added. Whatman No. 42 filter paper was used to filter the precipitated mixture. 0.5 ml of the filtrate was pipetted into a 5 ml test tube and mixed thoroughly with 3.5 ml distilled water and 1 ml 0.05 M Thiobarbituric acid solution (aq.). For 50 minutes, the tubes were maintained in a water bath at 40°C. At 443 nm, absorbance was measured after cooling to ambient temperature. A blank test was performed in the same way as the above but with distilled water instead of *Gulabjamun*.

Using a standard stock solution (10 mol/ml) of HMF produced in distilled water, a standard curve of HMF concentration and optical density at 443 nm was created. Dilutions in the range of 1.0 to 10 mol/ml HMF concentration were prepared. For HMF determination, the dilutions were handled the same as the sample. The HMF content in the samples was calculated using the following regression equation based on the standard curve:

$$(\text{Absorbance} - 0.055) \times 87.5 \times 0.4 = \text{Total HMF (moles/100g)}$$

### **3.7.3 SPC (Standard Plate Count)**

The SPC was estimated on plate count agar (PCA) medium as per the procedure given in IS: 4079 (1967).

Total Plate Count Agar (Hi Media) was used to pour plate the suitably diluted *Gulabjamun* sample by serial dilution, which was then incubated at 37°C for 24 to 48 hours. The plates were removed from the incubator at the end of the incubation period, and colonies were enumerated and expressed as cfu/g of *Gulabjamun* samples. The plating was carried out twice.

### **3.7.4 CC (Coliform Count )**

Coliform count was carried out on dehydrated violet red bile agar (VRBA) medium (IS: 4079 - 1967).

Using Violet Red Bile Agar (Hi Media), the suitably diluted *Gulabjamun* sample was pour plated by serial dilution and incubated at 37°C for 24 hours. The plates were removed from the incubator at the conclusion of the incubation period, and colonies with dark red coloration were enumerated and expressed as cfu/g of *Gulabjamun* samples. The plating was carried out twice.

### **3.8 Cost analysis**

The cost of Instant Phalahari *Gulabjamun* was calculated on the basis of cost of raw materials, processing cost, machine cost, packaging and storage cost.



## RESULTS AND DISCUSSION

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Food is a basic necessity that must be met in order for everyone to survive. Previously, all food was produced by the people themselves in their own homes. However, in today's fast-paced world, time is valuable, thus many people have adjusted their eating habits and switched to a variety of different food, Products that are ready-to-eat. In today's world, instant food products are quite important. Both men and women are working in this situation. Since the demand for fast food has increased, products are becoming more popular and a growing number of firms have entered the sector of instant food. Items with a variety of brand names As a result, customers can select any brand of their choice. The purpose of this research is to optimized the Instant food products i.e Instant Phalahari dry *Gulabjamun* balls.

*Gulabjamun* is a Khoa-based sweet that is famous all throughout the country. *Gulabjamun* can be preserved for a week at ambient temperature and 20 - 22 days in the refrigerator after being fried in oil at 140°C and soaked in sugar syrup. Using new technology such as microwave processing, vacuum packing, and modified atmosphere packaging, the shelf life of *Gulabjamun* can be prolonged.

This study was carried out to standardise the process parameters for the production of enhanced Instant Phalahari dry *Gulabjamun* balls by using Roller dried SMP, Water chestnut flour, and oven processing for shelf life enhancement. The results of the optimization process, including Proximate analysis, Texture Profile Analysis, sensory and functional qualities, and storage stability of oven treated enriched Instant Phalahari dry *Gulabjamun* balls, are shown below with appropriate tables and figures.

### **Instant Phalahari *Gulabjamun* ingredient optimization balls**

The results of the optimization of ingredients used in the manufacture of Instant Phalahari *Gulabjamun*, such as Roller dried SMP, Water chestnut flour, Ghee, Baking soda, and Cardamom powder, are provided below.

#### **4.1 The impact of different kinds of flours on the sensory qualities of Instant Phalahari *Gulabjamun***

Different varieties of flours enriched Instant Phalahari *Gulabjamun* were provided to a panel of judges for judging the quality of the Instant Phalahari *Gulabjamun* in terms of colour and appearance, body and texture, flavour, juiciness, and overall acceptability. Table 4.1 shows the sensory scores obtained on a 9-point hedonic scale.

##### **4.1.1 Color and Appearance**

Different flours have a noticeable impact on the colour and look of Instant Phalahari *Gulabjamun*. Color and aesthetic sensory scores for control *Gulabjamun* were 8, 8.5, 7.5, and 7 for Instant Phalahari *Gulabjamun* enhanced with different flours, namely water chestnut flour (S1), sweet potato flour (S2), and kuttu flour (S3), respectively.

##### **4.1.2 Body and texture**

Body and texture sensory scores for the Control sample were 8.2 out of 9.0, compared to 8.1, 8.1, and 7.5 out of 9.0 for the Instant Phalahari *Gulabjamun* enhanced with water chestnut flour (S1), sweet potato flour (S2), and kuttu flour (S3), respectively. Table 4.1 shows that *Gulabjamun* made with water chestnut flour improves body and texture sensory scores.

##### **4.1.3 Flavour**

The flavour sensory score for control *Gulabjamun* was 8.1, compared to 8.5, 7.5, and 8 for Instant Phalahari *Gulabjamun* with waater chestnut flour (S1), sweet potato flour (S2), and kuttu flour (S3), respectively. Increase the flavour in water chestnut flour based *Gulabjamun*, as shown in Table 4.1.

#### 4.1.4 Taste

The taste score for control *Gulabjamun* was 8.1, compared to 8.5, 8 and 8.2 for Instant Phalahari *Gulabjamun* with water chestnut flour (S1) , sweet potato flour (S2) and kuttu flour (S3) respectively. Table 4.1 shows that *Gulabjamun* made with water chestnut flour improves the taste scores.

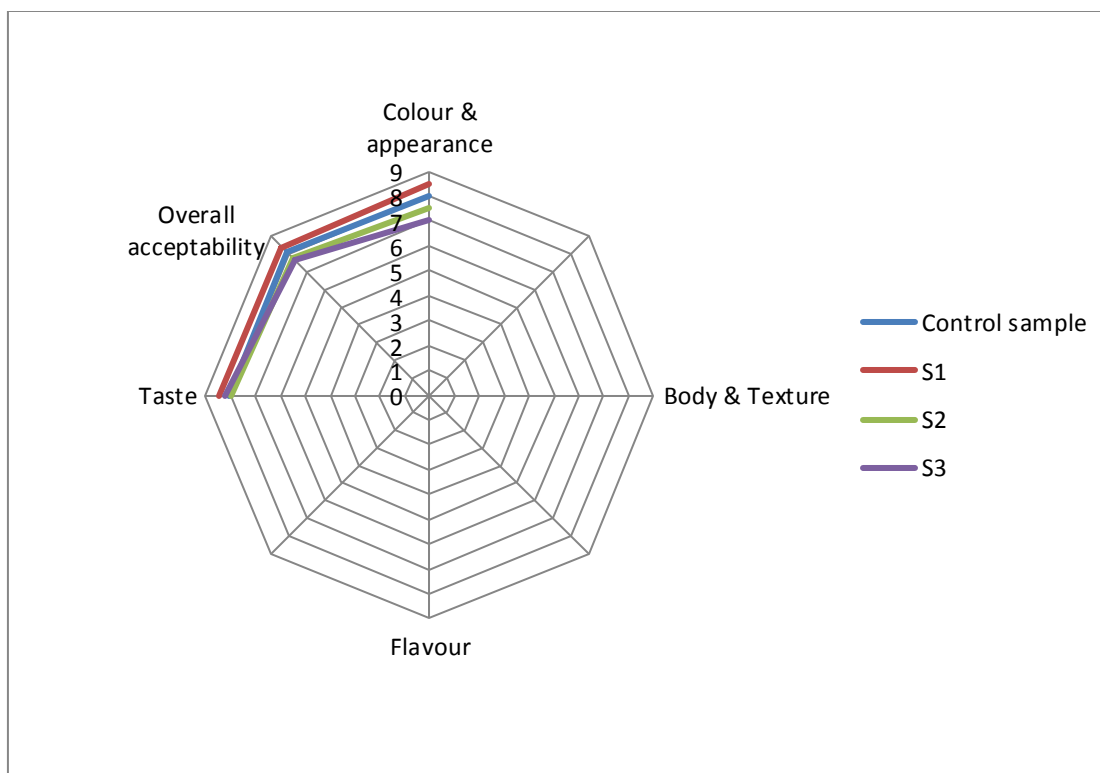
#### 4.1.5 Effect on overall acceptability

The overall acceptability scores awarded for control *Gulabjamun* was 8.1 as against 8.4, 7.775 and 7.675 for Instant Phalahari *Gulabjamun* with water chestnut flour (S1), sweet potato flour (S2) and kuttu flour (S3) respectively.

**Table 4.1 Effect of different types of flours on sensory attributes of Instant Phalahari *Gulabjamun***

Parameter	Control sample	S1	S2	S3
Colour and appearance	8.00±0.36a	8.50±0.34a	7.50±0.34b	7.00±0.36b
Body and Texture	8.20±0.14a	8.10±0.21a	8.10±20a	7.50±0.01b
Flavour	8.10±0.12a	8.50±0.18a	7.50±0.22b	8.00±0.21a
Taste	8.10±0.12a	8.50±0.11a	8.00±0.14a	8.20±0.15a
Overall acceptability	8.10±0.12a	8.40±0.16a	7.77±0.19b	7.67±0.25b

- The values shown are the Mean±SE of ten Panelist score card.
- Values with different superscripts in table are significantly different (p<0.05)



**Fig. 4.1** Average percentage of sensory evaluation in the sample of control and experimental sample of Instant Phalahari *Gulabjamun*

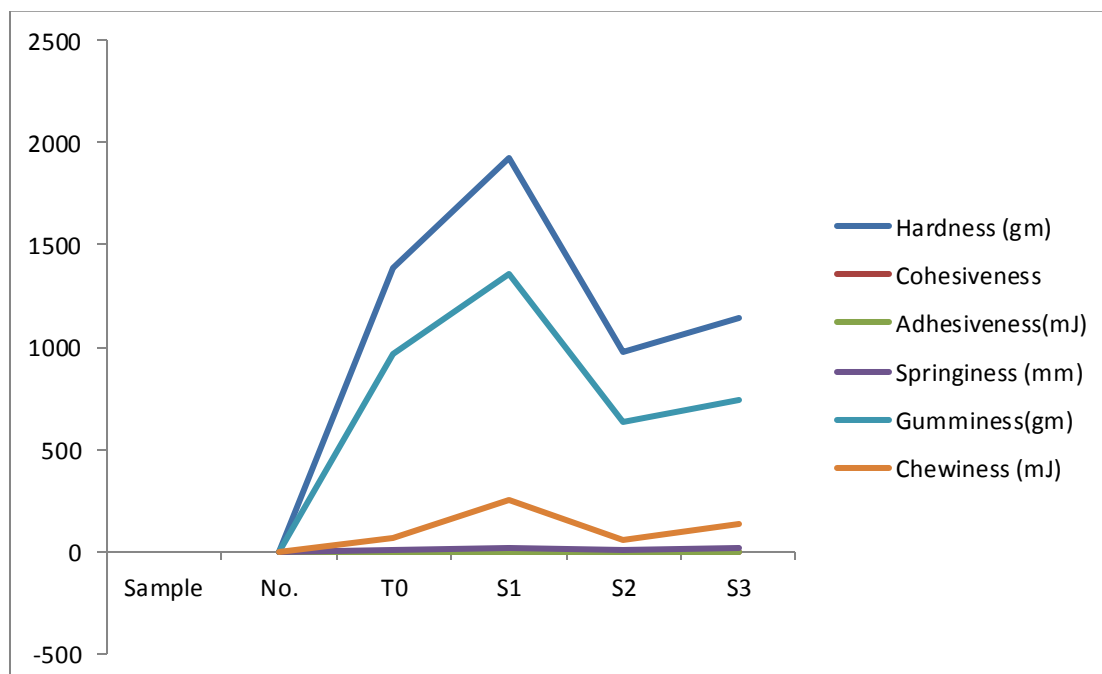
#### 4.2 Texture Profile Analysis (TPA)

*Gulabjamun's* texture is a significant feature that influences consumer acceptance. Control sample (T0) for dry and wet *Gulabjamun*, Water chestnut flour (S1) and (W1), Sweet potato flour (S2) (W2), and Kuttu flour were used to make TPA of the dry and wet Instant Phalahari *Gulabjamun* balls under standardised settings (S3) and (W3). TPA was measured using a TA35 cylindrical probe at 1 mm/s and 50% compression. Using the Texture Expert Exceed software (v 2.55) provided by the manufacturer along with the instrument, different textural qualities like as hardness, cohesiveness, adhesiveness, springiness, gumminess, and chewiness were estimated from the resulting force-time curves. Table 4.2 and 4.3 summarises the findings concerning the textural qualities of *Gulabjamun*.

**Table 4.2** Textural properties of Control Gulabjamun ( Sugar syrup soaked) and Instant Phalahari dry *Gulabjamun* balls blended with different types flours

Sample No.	Hardness (g)	Cohesiveness	Adhesiveness (mJ)	Springiness (mm)	Gumminess (g)	Chewiness (mJ)
	H	A2/A1	A3	D1	H×A2/A1	(H×A2/A1)×D1
<b>T0</b>	1389	0.69	0.04	6.44	970	62.46
<b>S1</b>	1930	0.66	-0.10	19.94	1353	254
<b>S2</b>	975	0.61	0.10	9.23	630	57
<b>S3</b>	1140	0.61	0.00	18.73	743	136.50

- Values are mean of triplicate samples.
- The TPA graph of Instant Phalahari dry *Gulabjamun* balls is shown in Appendix II.

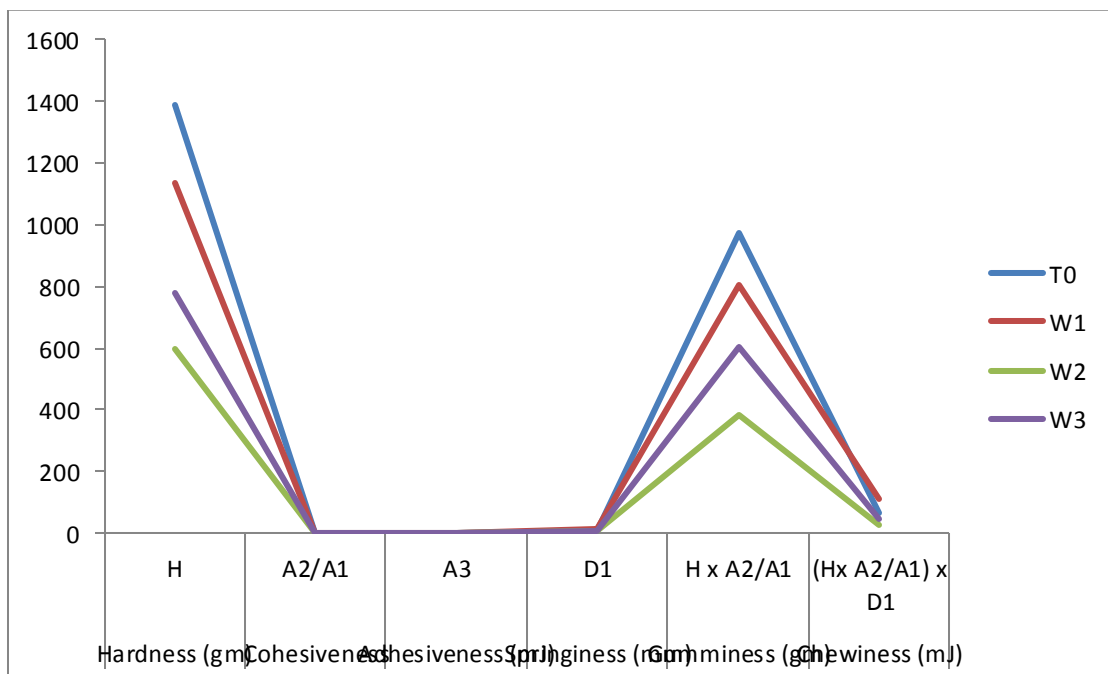


**Fig. 4.2** TPA curve of control and experimental Instant Phalahari dry *Gulabjamun* balls.

**Table 4.3** Textural properties of Control (Sugar syrup soaked) *Gulabjamun* and Instant Phalahari wet *Gulabjamun* balls (Sugar sryup soaked) blended with different types flours

Sample No.	Hardness (g)	Cohesiveness	Adhesiveness (mJ)	Springiness (mm)	Gumminess (g)	Chewiness (mJ)
	H	A2/A1	A3	D1	H x A2/A1	(Hx A2/A1) x D1
<b>T0</b>	1389	0.69	0.04	6.44	970	62.46
<b>W1</b>	1135	0.67	0.00	13.78	806	108.90
<b>W2</b>	595	0.73	0.20	7.25	385	27.40
<b>W3</b>	780	0.83	0.20	8.08	602	47.70

- Values are mean of triplicate samples
- The TPA graph of Instant Phalahari wet *Gulabjamun* is shown in Appendix III.



**Fig. 4.3** TPA curve of control and experimental Instant Phalahari wet *Gulabjamun* .

#### **4.2.1 Hardness**

The most often used criterion for determining the texture of *Gulabjamun* is its hardness. In the treatment of Instant Phalahari dry *Gulabjamun* balls blended with different types of flour comparison to control sample ( S1, S2 , S3 and T0) , Instant Phalahari dry *Gulabjamun* balls had maximum hardness of all treatment and Instant Phalahari wet *Gulabjamun* balls blended with different types of flour comparison to control sample of *Gulabjamun* such as water chestnut flour , sweet potato flour, kuttu flour (W1, W2, W3 and T0) a wide range of hardness values was observed, as indicated in table 4.2.1 and 4.2.2. Control sample had the maximum hardness of all the treatments, while treatment S2 and W2 had the lowest. This indicates that adding sweet potato flour to the *Gulanbjamu* softens it. *Gulabjamun* hardness is determined by a number of elements, including moisture content and mineral content.

**Yawale et al. (2012)** investigated the effect of maida and baking powder levels on khoa powder *Gulabjamun* mix textural profile analysis and found that hardness varied from 2.65 to 4.90 N and 2.75 to 4.81 N, respectively. Textural profile investigation of the effect of wheat bran level in peda and *Gulabjamun* by Lingayat and Nalawade (2014) revealed that hardness ranged from 40.959 to 20.674 and 2.157 to 1.843, respectively.

#### **4.2.2 Cohesiveness**

The ratio of the area under the second bite curve before reversal compression to the area under the first bite curve is known as cohesiveness. In terms of cohesiveness, the T0 treatment of dry *Gulabjamun* balls yielded the maximum cohesiveness, whereas the W3 treatment of wet *Gulabjamun* balls yielded the highest cohesiveness.

**Adhikari et al. (1993)** investigated the textural features of khoa and *Gulabjamun* prepared from cow's milk and found that laboratory and market *Gulabjamun* had cohesiveness of 0.35 and 0.39, respectively. **Yawale et al. (2012)** investigated the effect of maida level in khoa powder *Gulabjamun* mix textural profile and found that cohesiveness ranged from 0.25 to 0.30. **Lingayat et al. (2014)** investigated the influence of wheat bran level on cohesiveness in peda and

*Gulabjamun* and found that cohesiveness ranged from 0.161 to 0.125 and 0.2673 to 0.2553, respectively.

#### **4.2.3 Adhesiveness**

Adhesiveness is measured as a negative peak following the first peak and is connected to sensory stickiness. Treatment S2 and W2, W3 of dry and wet Instant Phalahari *Gulabjamun* balls has the maximum adhesiveness, while treatment S1 and W1 of dry and wet *Gulabjamun* balls has the lowest.

**Adhikari et al. (1993)** investigated the textural features of khoa and *Gulabjamun* prepared from cow's milk and found that laboratory and market *Gulabjamun* had similar adhesiveness. According to **Rasane et al. (2012)** variations in the adhesiveness of market samples of burfl could be related to differences in sugar concentration. **Lingayat and Naiawade (2014)** investigated the influence of wheat bran level on adhesiveness in peda and *Gulabjamun*, finding that adhesiveness ranged from 0.166 to 0.179 and 0.061 to 0.016, respectively.

#### **4.2.4 Springiness**

The degree of springiness is determined by elements such as heat treatment and hardness. The treated samples S1, S3, of Instant Phalahari dry *Gualbjamun* balls and W2, W3, T0 of Instant Phalahari wet *Gulabjamun* balls showed a substantial change. However, when compared to treatments S2, S3, and W2 and W3, therapy S1 and W1 had the greatest score.

**Yawale and Rao (2012)** investigated the textural profile of the effect of maida and baking powder levels in khoa powder *Gulabjamun* mix and found that lowering maida levels decreased *Gulabjamun* springiness. The textural profile investigation of the effect of wheat bran level in peda and *Gulabjamun* by **Lingayat et al. (2014)** found that springiness varied from 7.920 to 7.920 and 18.391 to 16.546, respectively.

#### **4.2.5 Gumminess**

Gumminess is related to the basic criteria of hardness and cohesiveness, and is calculated by multiplying the two. The highest gumminess was found in S1 of Instant

Phalahari dry *Gulabjamun* balls T0 of Instant Phalahari wet *Gulabjamun*, whereas the lowest values were found in S2, S3 and W2, W3.

**Patel et al. (2006)** found a high level of gumminess in plain peda made the traditional way. **Lingayat et al. (2014)** investigated the influence of wheat bran level on gumminess in peda and *Gulabjamun*, finding that gumminess ranged from 6.618 to 2.170 and 0.5765 to 0.4705, respectively.

#### 4.2.6 Chewiness

Chewiness is a result of gumminess and springiness and relates to the energy required to masticate food into a state that is ready for swallowing. *Gulabjamun's* chewiness is one of its most notable textural characteristics. *Gulabjamun's* chewiness was modified by the use of water chestnut flour. S2 and W2 had the least chewiness of all the treatments, while S1 and W1 had the most chewiness of the Instant Phalahari dry and wet *Gulabjamun* balls.

**Adhikari et al. (1993)** investigated the chewiness of khoa and *Gulabjamun* prepared from cow's milk and found that laboratory and market *Gulabjamun* had 12.35 and 17.53 mN mm, respectively. Chewiness ranged from 52.422 to 20.674 and 10.602 to 7.784 according to **Lingayat et al. (2014)** textural profile investigation of the effect of wheat bran level in peda and *Gulabjamun*.

**Table 4.4 Proximate analysis of Instant Phalahari *Gulabjamun* dry balls**

S.No.	Parameter	Per 100g
1	Total Saturated fat	7.29g
2	Total Unsaturated fat	3.25g
3	Total Protein	13.69g
4	Total Carbohydrate	33.28g
5	Moisture	24.90g
6	Total Ash (Dry)	3.27g
7	Crude Fiber	3.45g

- Results of Proximate analysis of Instant Phalahari *Gulabjamun* is shown in Appendix IV.

The proximate analysis of Instant Phalahari dry *Gulabjamun* balls was determined by different procedure. Total saturated fat value was found 7.29 g by AOAC (2005) methods. Total Unsaturated fat value was found 3.25 g by AOAC (2005) methods. Total Protein value was found 13.69 g by IS:7219 methods. Total Carbohydrate value was found 33.28 g by Calculation methods. Moisture content was found 24.90% by Lab methods. Total (Dry) Ash content was found 3.27% by Lab methods. Crude Fiber value was found 3.45g by AOAC (2005) methods.

#### **4.4 Shelf life study of Instant Phalahari *Gulabjamun* dry balls**

The storage behavior of Instant Phalahari *Gulabjamun*, like that of any other dairy or food product, is critical to economic success. The shelf life of any dairy or food product is critical from both a manufacturing and a consumer standpoint. The proliferation of microorganisms causes a variety of changes in the product, as well as a loss of flavor during storage.

Fresh and stored samples of Instant Phalahari dry *Gulabjamun* balls were evaluated for TBA and HMF. In microbiological properties (Total plate count and coliform count) at preset time intervals (after every 5th day at 10<sup>0</sup> C and at 25<sup>0</sup> C) for 30 days.

##### **4.4.1 TBA**

TBA value was significantly increased in storage time. Higher value was found in 30 days and lowest value was found in 0 days at both temperatures (Table 4.5).

**Table 4.5** Effect of storage condition on TBA (absorbance at 532nm) of Instant Phalahari dry *Gulabjamun* balls at different temperature

Temperature	TBA Value (OD at 532 nm)						
	(DAYS)						
	0	5	10	15	20	25	30
10° C	0.035	0.038	0.045	0.051	0.061	0.067	0.071
25° C	0.035	0.042	0.053	0.063	0.069	0.089	0.111

- Values are mean of triplicate samples.

#### 4.4.2 HMF

The effect of storage condition on HMF content of Instant Phalahari dry *Gulabjamun* balls is given in Table 4.6.

Table 4.6 showed that there was a gradual increase in HMF content of Instant Phalahari dry *Gulabjamun* balls upon storage condition.

**Table 4.6** HMF content of Instant Phalahari dry *Gulabjamun* balls upon storage condition

Temperature	HMF Value (OD at 443 nm)						
	(DAYS)						
	0	5	10	15	20	25	30
10° C	8.98	9.32	10.14	11.6	13.56	14.66	16.56
25° C	8.98	11.04	14.02	17.03	18.56	21.98	24.04

- Values are mean of triplicate samples.

The formation of the hydroxyl methyl furfural (HMF) molecule is directly linked to the amount of heat applied during food preparation and is used as a browning indicator in dairy products. HMF is one of the chemicals that rises during storage after being exposed to high temperatures during the manufacture of Instant

Phalahari dry *Gulabjamun* balls. Instant Phalahari dry *Gulabjamun* balls held at both temperatures had a significantly significant ( $p < 0.01$ ) rise in HMF content. During storage, however, the values increased rapidly at ambient temperature ( $25^{\circ}\text{C}$ ) and significantly at  $10^{\circ}\text{C}$ .

#### 4.4.3 Effect of storage on Microbial Quality of Instant Phalahari dry *Gulabjamun* balls

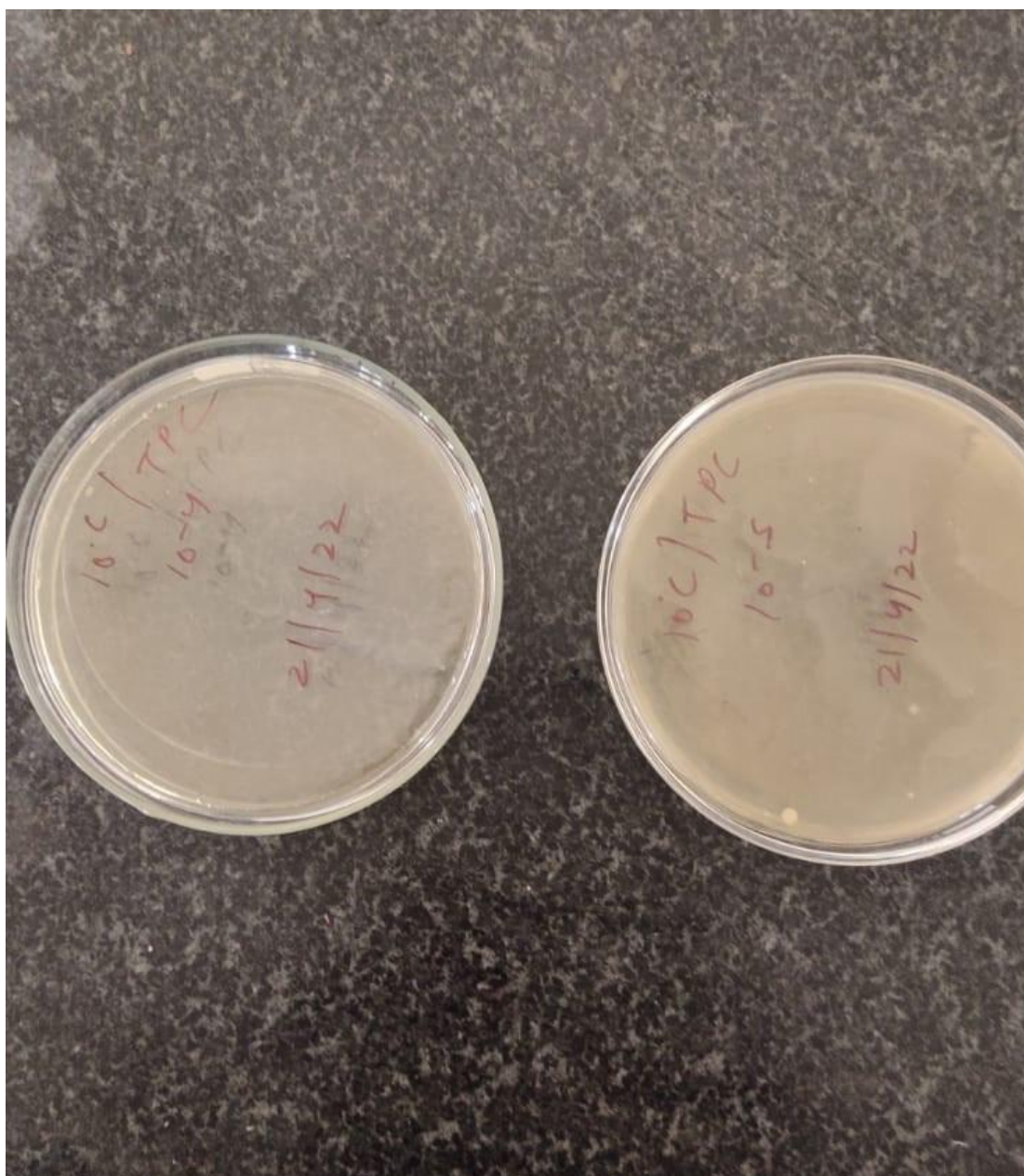
Table 4.7 shows the effect of storage time at refrigeration temperature ( $10^{\circ}\text{C}$ ) and Table 4.8 show the effect of storage at ambient temperature ( $25^{\circ}\text{C}$ ) on SPC and Coliform count of Instant Phalahari dry *Gulabjamun* balls.

**Table 4.7 shows the effect of storage time of Instant Phalahari dry *Gulabjamun* balls at refrigeration temperature ( $10^{\circ}\text{C}$ ) on SPC (Standard Plate Count) and CC (Coliform Count)**

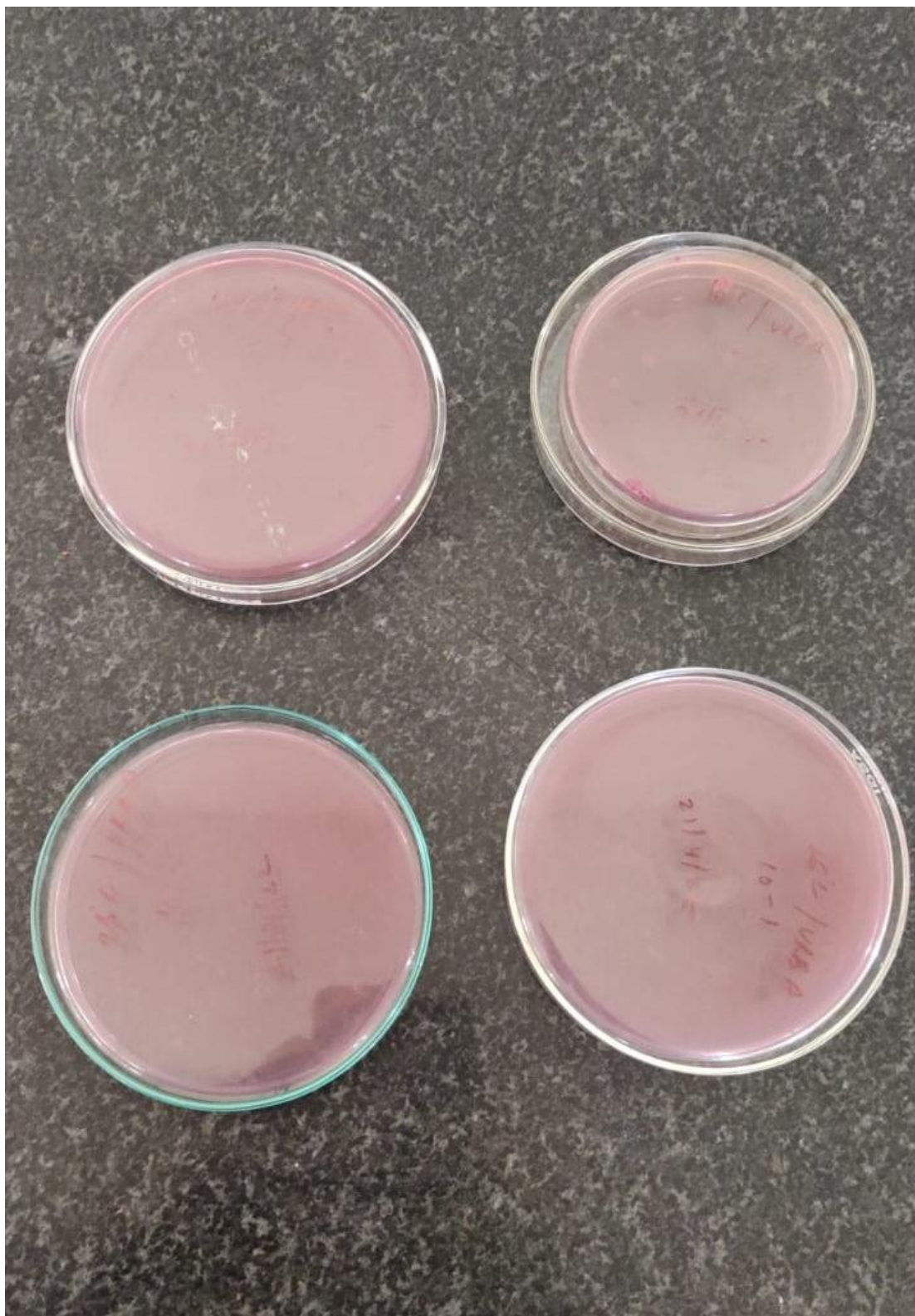
Attributes	Storage period ( $10^{\circ}\text{C}$ ) (Days)						
	0	5	10	15	20	25	30
SPC (cfu/g)	NIL	NIL	NIL	4	10	12	16
CC (cfu/g)	NIL	NIL	NIL	NIL	NIL	NIL	NIL

**Table 4.8 shows the effect of storage time of Instant Phalahari dry *Gulabjamun* balls at refrigeration temperature ( $25^{\circ}\text{C}$ ) on SPC (Standard Plate Count) and CC (Coliform Count)**

Attributes	Storage period ( $25^{\circ}\text{C}$ ) (Days)						
	0	5	10	15	20	25	30
SPC (cfu/g)	NIL	NIL	6	10	18	28	32
CC (cfu/g)	NIL	NIL	NIL	NIL	NIL	NIL	NIL



**Fig. 4.4** SPC (Standard Plate Count) of Instant Phalahari *Gulabjamun* during shelf life study



**Fig. 4.5** CC (Coliform Count) of Instant Phalahari *Gulabjamun* during shelf life study

At 10°C, the standard plate count increases dramatically, and at 25°C, it increases rapidly. And we found that the coliform count was negative at 10°C for the first 30 days of storage, and that the coliform count was also negative at 25°C.

#### 4.5 Cost Analysis

The cost of Instant Phalahari dry *Gulabjamun* balls was calculated on the basis of cost of raw materials, processing cost, machine cost, packaging and storage cost was calculated using market values for the years 2021-2022.

**Table 4.9 Cost study of oven-dried Instant Phalahari dry *Gulabjamun* balls.**

Heads	Skim milk powder (roller dried) -500 g		
	Rs/kg	Qty used for Instant Phalahari dry <i>Gulabjamun</i> balls (kg)	Amount in (Rs) (Instant Phalahari dry <i>Gulabjamun</i> balls)
<b>A) Manufacturing Cost</b>			
<b>a) Raw Material cost</b>			
Skim milk powder	500	0.5	250
Water chestnut flour	200	0.25	50
Desi ghee	800	0.23	184
Baking soda	32	0.15	5
Cardamom powder	5000	0.01	50
c) Printed card box @ 8/ per film		10 Packages	80
d) Power and utilities Power @ Rs.27/3kwh (i.e. Power of Oven 3kwh)		5	45
e) Operating labour cost @550/day		60 minute	69
<b>Sub Total</b>			733
B) Maintenance and repair cost @ 5% of Sub-total			30
C) Processing including Profit margin@20% of Sub-total			120
<b>Total Product Cost</b>			883
<b>Net Product</b>			1 kg Instant <i>Gulabjamun</i> mix
<b>Total Balls</b>			100 balls
<b>Cost of each balls</b>			Rs 8.83/ball



## SUMMARY AND CONCLUSION

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*Gulabjamun* is an important indigenous dairy product that is widely consumed across the country. Small-scale dealers still control the technique for this traditional indigenous dairy product. *Gulabjamun* contains a high water activity, which causes quick deterioration at room temperature due to unsanitary manufacturing techniques. As a result, modern processing techniques could be used to extend the shelf life of this product.

With these facts in mind, this study was conducted to improve the nutritional status of *Gulabjamun* by incorporating SMP and Water chestnut flour into the *Gulabjamun* mix, as well as to extend its shelf life by using a modern processing technique, such as oven processing to produce Instant Phalahari *Gulabjamun* dry balls. The findings of this research are presented below.

1. The ingredients such as Roller dried SMP, Water chestnut flour, desi ghee, baking soda and cardamom powder used for Instant Phalahari *Gulabjamun* preparation were of good quality as they are confirmed with legal standards. In drying method, the proportions of SMP, Water chestnut flour, desi ghee baking soda and cardamom powder was 50:25:23:1.5:0.1. The Instant Phalahari *Gulabjamun* balls were baked at 160-180°C for 15-20 minutes in oven.
2. Out of the three flour varieties used in Instant Phalahari *Gulabjamun*, Water chestnut flour, Sweet potato flour, and Kuttu flour, the Instant Phalahari *Gulabjamun* with Water chestnut flour had the best sensory quality in terms of colour and appearance, body and texture, flavour, and overall acceptability. It had the highest overall acceptance rating of 8.4 out of 9.0, compared to 8.1 for control.
3. Instant Phalahari dry *Gulabjamun* balls : Texture Profile Analysis (TPA) found that the hardness of Sweet potato flour (S2) based Instant Phalahari dry

*Gulabjamun* balls (975 g) was lower than all other samples, however the hardness of Kuttu Flour (S3) based Instant Phalahari *Gulabjamun* balls (1140 g), Control sample had (1389 g) and Water chestnut flour based Instant Phalahari dry *Gulabjamun* balls (1930 g) was higher. Whereas S2 and S3 samples have similar cohesiveness (0.61), whereas T0 sample had (0.69) has greater cohesion and S1 sample had cohesion (0.66). Adhesiveness was highest in S2 (0.10 mJ) sample as compared to T0 (0.04 mJ), S1 (-0.10 mJ) and S3 (0.00 mJ). Springiness of T0 sample (6.44 mm) was less than other sample i.e. S2 sample (9.23 mm), S1 sample (19.94 mm) and S3 sample (18.73 mm). Gumminess (630 g) of S2 sample was minimum where as these parameters were maximum in S1 sample (1353 g), T0 sample (970 g), and S3 sample (743 g). And Chewiness in S2 sample (57 mJ) was less than other sample i.e. T0 sample had (62.46), S1 sample had (254 mJ) and S3 sample had (136.50mJ).

4. Instant Phalahari wet ( Sugar syrup soaked) *Gulabjamun* balls : Texture Profile Analysis (TPA) found that the hardness of Sweet potato flour (W2) based Instant Phalahari *Gulabjamun* (595 g) was lower than all other samples, however the hardness of Kuttu Flour (W3) based Instant Phalahari *Gulabjamun* (780 g), Water chestnut flour based Instant Phalahari *Gulabjamun* (1135 g) and Control sample T0 (1389 g) was higher. Whereas Cohesiveness of W1 sample had (0.67) was lower than all samples, however the cohesiveness of T0 sample had (0.69), W2 sample had (0.73), and W3 sample had (0.83). Adhesiveness was similar in W2 and W3 (0.20 mJ) sample as compared to W1 (0.00mJ) and T0 (0.04) . Springiness of T0 sample (6.44 mm) was less than all other sample i.e W2 sample (7.25 mm) W1 sample (13.78 mm) and W3 sample (8.08 mm). Gumminess (385 g) of W2 sample was minimum where as these parameters were maximum in T0 sample (970 g), W1 sample had (806 g) and W3 sample had (602 g), and Chewiness in W2 sample (27.40 mJ) was less than other sample i.e. T0 sample (62.46mJ), W1 sample (108.90 mJ) and W3 sample had (47.70mJ).

5. In the approximate analysis : As per a 100 g sample of Instant Phalahari dry *Gulabjamun* balls, we found 7.29 g Total Saturated Fat, 3.25 g Total Unsaturated Fat, 13.69 g Total Protein, 33.28 g Total Carbohydrate, 24.90 percent Moisture, 3.27 percent Total Ash (Dry), and 3.45 g Crude Fiber.
6. Oven baked treatment increased the shelf life of Instant Phalahari dry *Gulabjamun* balls . The shelf life of enhanced Instant Phalahari *Gulabjamun* stored at ambient (25<sup>0</sup> C) and refrigerated temperature (10<sup>0</sup> C) was dramatically increased after baking. The standard LDPE packaging might be successfully stored for up to 30 days. Enriched *Gulabjamun* (without oven baking) packed in LDPE lasted up to 6 and 8 days at room temperature. The oven baked samples were successfully preserved in LDPE pouches for up to 30 days.
7. To determine the shelf life of Instant Phalahari dry *Gulabjamun* balls, we conducted physico-chemical and microbiological tests at regular intervals for 30 days (every 5 days). We used TBA and HMF values in the Physico-chemical test. We used TPC (Total Plate Count) and CC in our microbiological investigation (Coliform Count).
8. In terms of physico-chemical parameters, such as TBA and HMF value, storage time at both temperatures increased significantly. TBA 30 days yielded the highest value (0.71) at 10<sup>0</sup> C and (0.111) at 25<sup>0</sup> C, while 0 days yielded the lowest value (0.35) at both temperatures. In 30 days, the highest HMF value (16.56) at 10<sup>0</sup> C and (24.04) at 25<sup>0</sup> C was discovered, while the lowest value (8.98) was discovered in 0 days at both temperatures.
9. In terms of microbiological parameters, at 10°C, the total plate count increases dramatically, and at 25°C, it increases rapidly. And we found that the coliform count was negative at 10°C for the first 30 days of storage, and that the coliform count was also negative at 25°C .
10. The Cost of production of Instant Phalahari dry *Gulabjamun* balls was calculated., the production cost of Instant Phalahari dry *Gulabjamun* balls was (Rs. 8.83/piece). It has got more shelf stability of 30 day against 6 days of

control *Gulabjamun* at refrigeration temperature and ambient temperature respectively.

## **CONCLUSION**

*Gulabjamun* is a Khoa based sweet, popular throughout the country. Because of unhygienic technique of production and poor packaging method, the shelf life of *Gulabjamun* is low (3 days at room temperature). The nutritional and functional characteristics for Phalahar vrat, (who practice this do not consume cereal grains) could be enhanced by incorporating the roller dried SMP, water chestnut flour, and desi ghee to develop value added Phalahari dairy products. On the basis of the study, it is concluded that Instant Phalahari dry *Gulabjamun* balls with SMP and Water chestnut flour at the rate of 50 % and 25% of the *Gulabjamun* mix and baked to Oven processing for 15-20 min extends the shelf life of the product for 30 days at ambient temperature. Instant Phalahari *Gulabjamun* caters the fastest serving of delicious dairy sweets along with extended shelf life.



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# APPENDICES

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## Appendix I

### SENSORY EVALUATION OF INSTANT PHALAHARI GULABJAMUN

#### SCORE CARD

DATE: .....

TIME: .....

NAME OF THE PANELIST : .....

**Instruction:** Given below are the samples of Instant Phalahari gulabjamun . you are requested to judge the sample on the 9 point hedonic scale for the parameters listed below :

Sample	Colour and Appearance	Body and Texture	Flavour	Taste	Overall acceptance

#### Key

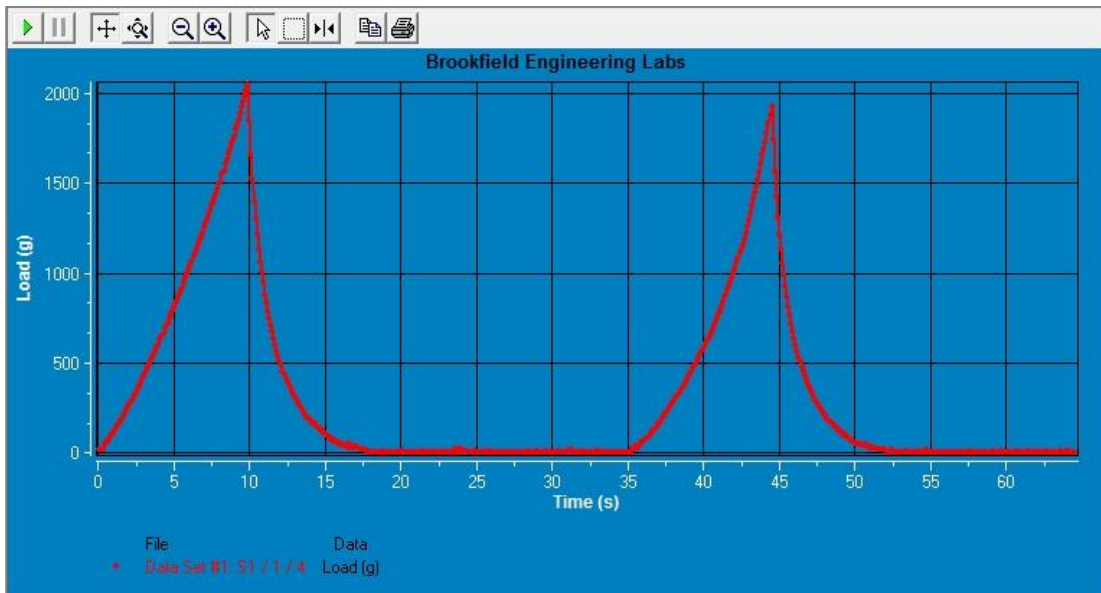
1. Dislike extremely
2. Dislike very much
3. Dislike moderately
4. Dislike slightly
5. Neither like nor dislike
6. Like slightly
7. Like moderately
8. Like very much
9. Like extremely

Signature: .....

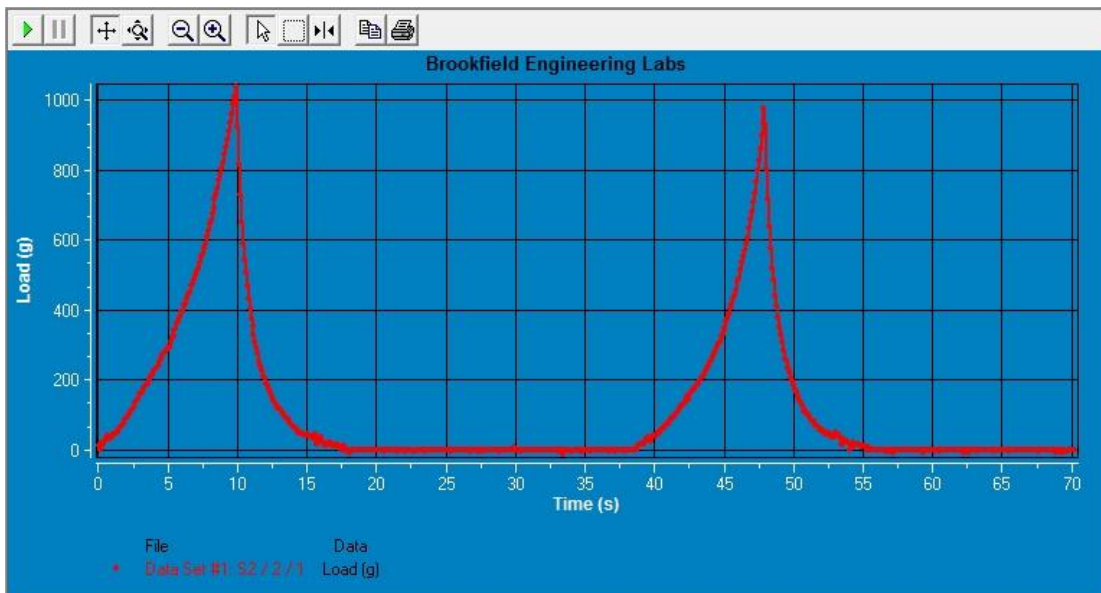
Remark: .....

Appendix II

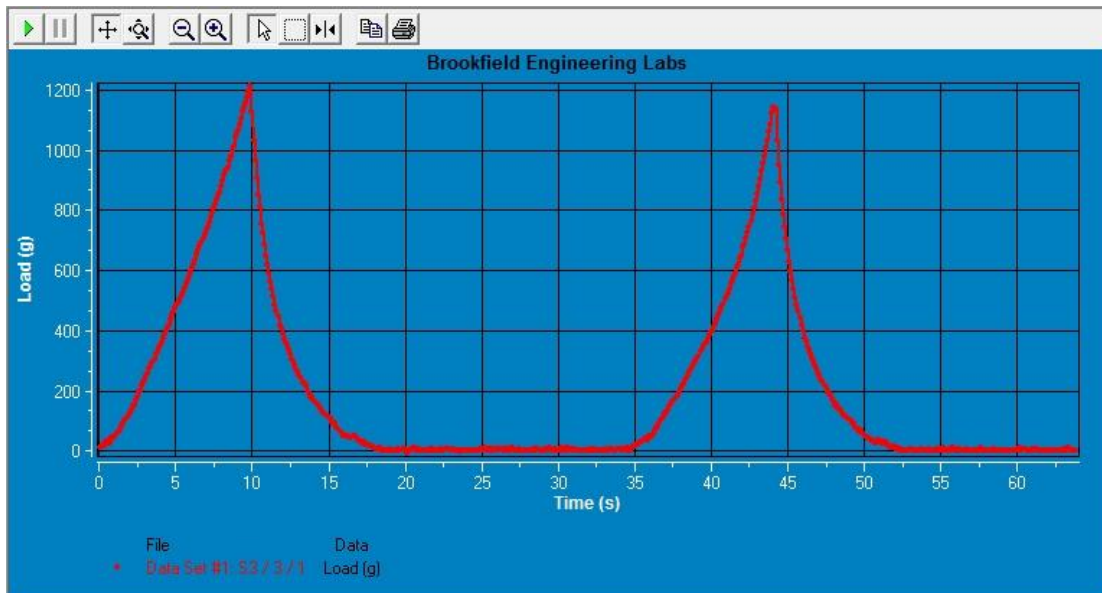
TPA Graph of Instant Phalahari dry Gulabjamun balls (S1 Sample)



TPA Graph of Instant Phalahari dry Gulabjamun balls (S2 Sample)

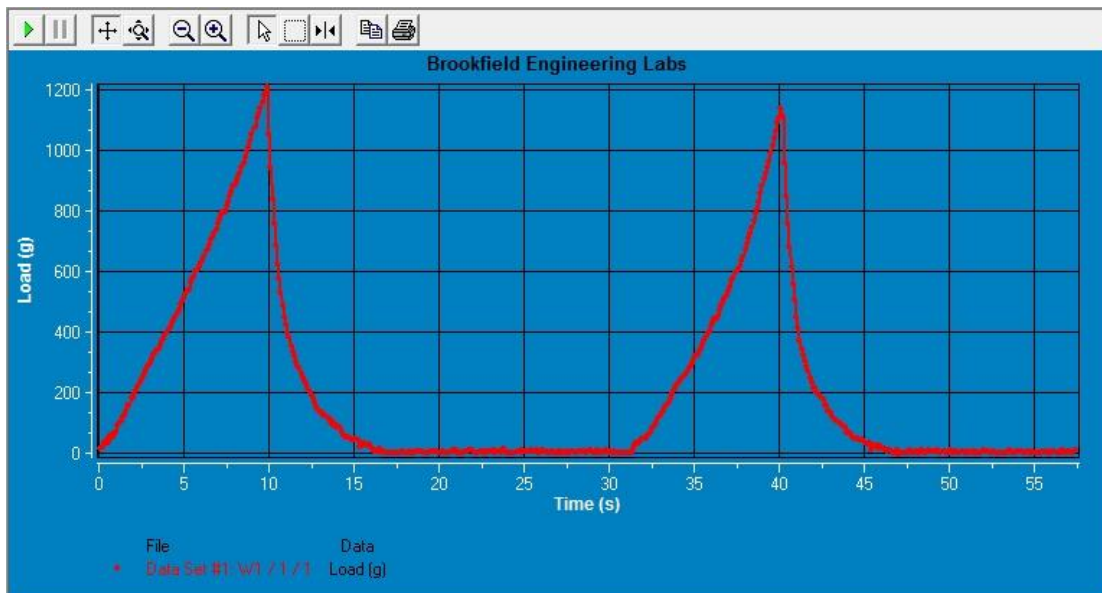


**TPA Graph of Instant Phalahari dry Gulabjamun balls (S3 Sample)**

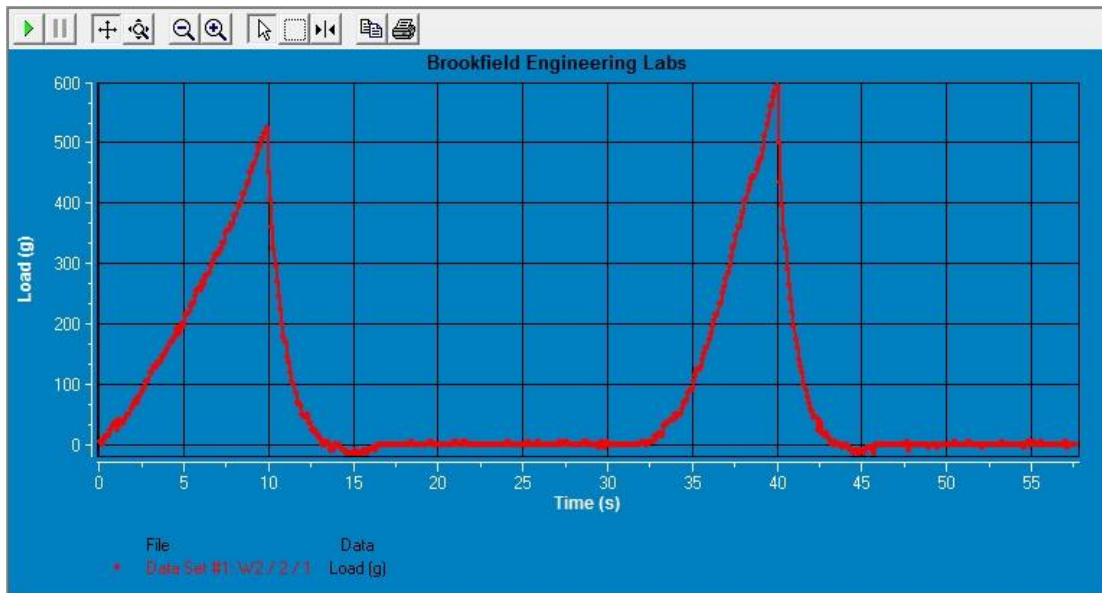


**Appendix III**

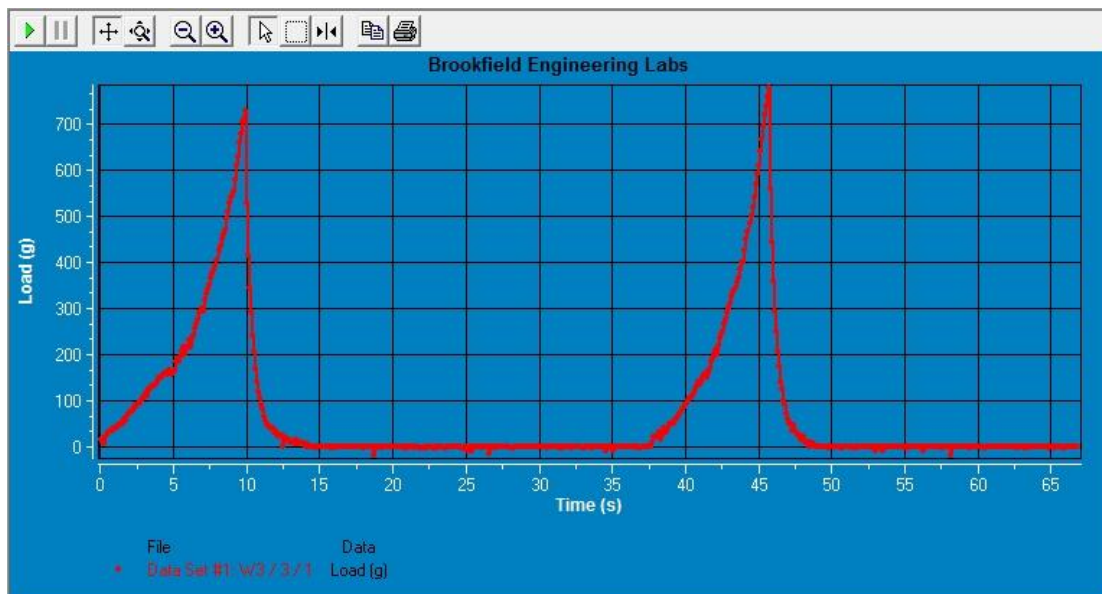
**TPA Graph of Instant Phalahari wet Gulabjamun (W1 Sample)**



TPA Graph of Instant Phalahari wet Gulabjamun (W2 Sample)




TPA Graph of Instant Phalahari wet Gulabjamun (W3 Sample)





Appendix IV

Result of Approximate analysis of Instant Phalahari Gulabjamun



ISO 9001 : 2015

## Opal Research & Analytical Services<sup>TM</sup>

STQC Directorate Certificate No. CETE/N/4321/2018, Govt. Of India

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Mob.: 9369069069  
9717557863  
9053355335

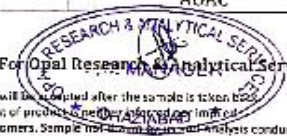
### Test Report

Report No:- ORAS/CT/0002022040571	Date : 28/05/2022
Issued to:- Srubhatta Jaysurya DSFT, BHU, Varanasi-221005, U.P.	Your Reference : Email
	Date of Receipt : 24/05/2022
	Our Reference : Email
	Test Started on : 24/05/2022
	Test Completed on : 28/05/2022

Sample Description : One sample received as Gulab Jamun Dry Balls

#### "Proximate Analysis of Gulab Jamun Dry Balls"

S. No.	Parameter	Test Result as per 100gm	Protocol
1	Saturated Fat	7.29gm	AOAC
2	Unsaturated Fat	3.25gm	AOAC
3	Protein	13.69gm	IS:7219
4	Carbohydrate	33.28gm	By Calculation
5	Moisture	24.90%	Lab Method
6	Total Ash (Dry)	3.27%	Lab Method
7	Crude Fiber	3.45gm	AOAC



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- The total liability of our Laboratory is limited to the invoiced amount. No liability will be accepted after the sample is taken back.
- The result stated refers only to the samples and applicable parameters under terms of product and/or standard as limited.
- The sample description is not verified in all cases and is given as described by customers. Sample not for consumption. Analysis conducted on "As received basis" unless specified otherwise.
- Routine Samples are disposed after suitable Retaining period, while sample of perishable goods are disposed immediately after reporting of sample.
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