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Utilization of Clitoria Ternatia Flower Petal's Extract for the Development and Formulation of Functional Confectionery Product (Candy)

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Abstract: ***The present paper focuses on the development and formulation of a functional confectionery product incorporating Clitoria ternatea flower. The study investigates the flower's rich phytochemical profile, particularly its anthocyanin content, which provides natural blue coloration and significant antioxidant, anti-inflammatory, and neuroprotective properties. The literature survey highlights the therapeutic uses, safety aspects, and acceptability of Clitoria ternatea as a food colorant across Asian regions, confirming its suitability for human consumption when processed appropriately. Trials involved optimized recipes, proportions, and process optimization to ensure desirable color retention, texture, and microbial stability. The candy was prepared by using clitoria ternatea flower, with rigorous steps to deliver a product. Physical characterization, including moisture, ash, fat, fiber, protein, carbohydrate content, and energy value, utilized standard AOAC methodologies. The optimized formulation achieved target values: Moisture (2.14%), Ash (0.32%), Crude Protein (0.85 g/100g), Total Fat (3.42 g/100g), Fiber (0.25 g/100g), Carbohydrate (93.02 g/100g), and Energy Value (388.6 kcal/100g). pH (3.35) and Total Soluble Solids (TSS) (97.29 Brix) confirmed product suitability within FSSAI guidelines for confectionery safety and shelf stability. Sensory analysis, conducted with a 9-point hedonic scale and a panel of seven judges across multiple formulation trials, consistently rated the final product as highly acceptable in appearance, color, taste, texture, aroma, and overall appeal. Microbial Analysis verified absence of pathogic bacteria (E. coli, Salmonella, Staphylococcus aureus), Total Plate and yeast/mold counts well below FSSAI limits, confirming high hygienic standards and safety.***

Keywords: Clitoria ternatea flower, Herbal Candy , Antioxidants, Confectionery products, Natural Food Colorant.

I. INTRODUCTION

Clitoria ternatea L. is a well-known herb that belongs to the family Fabaceae. The Blue Butterfly Pea is a legume plant with a thin, long, climbing herbaceous vine with five leaflets, white to purple flowers, deep roots, and growing wild and in gardens in tropical regions. Blue butterfly pea flower (BPF) has solitary flowers with vivid, deep-blue, and white colouration. The butterfly pea flower is full of health- promoting antioxidants, flavonoids, and peptides as a natural remedy for various health complaints and it has historically been used as a laxative, purgative, diuretic, inflammation, indigestion, constipation, headache, arthritis, eye ailments, sore throat, and anthelmintic, as well as to relieve gastrointestinal swelling, sore throat, and mucous dysfunction. The BFP is commercially valued for natural food colouring, pea tea, dried flowers used for beauty products. The use of food colourant in food products is important in increasing product appeal. Food colourants are broadly categorized into natural and artificial food colours. The synthetic food colourants showed an adverse effect on human health. Some alternative to synthetic dyes includes anthocyanins, lycopene, turmeric, and chlorophyll. One of the leading available natural blue sources is that the C. ternatea flower. The food industry traditionally used blue dye of butterfly pea as a confectionary colouring and natural colourant for drinks. This edible natural colourant can be used in any food compound, replacing synthetic colourants in colour, taste, and cost economy. There are many different products formulated from BPF in the market nowadays. The idea of developing Aparajita flower Candy originates from exploring natural, functional sources for confectionery coloring and flavoring. The flower's anthocyanins provide a natural blue hue and health benefits such as improved memory, stress relief, and anti-aging effects. The candy is made by using the flower with natural ingredients like sugar, honey, and spices, resulting in a visually appealing and health-enriched treat that supports sustainable food trends. The quality of candies depends on factors like temperature, pH, color, texture, moisture content, and flavor retention. Proper control of composition, processing, and cooling conditions—particularly temperature distribution in cooling tunnels—is essential to prevent stickiness and recrystallization. Optimization models using systems like gPROMS help regulate cooling processes and production planning to ensure consistent quality and cost efficiency.

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II. LITERATURE REVIEW

A. Clitoria Ternatea Flower

Clitoria ternatea commonly known as Butterfly pea belonging to the family Fabaceae and subfamily Papilionaceae is a perennial leguminous twiner. Clitoria Linn. comprises 60 species distributed mostly within the tropical belt with a few species found in temperate areas. The mostly frequently reported species is Clitoria ternatea. The plant is mainly used as a forage as it is highly palatable for live-stock and it is well adapted to various climates. Native to the island of Ternate in the Molluca archipelago, this species is now widely grown as ornamental, fodder or medicinal plant . The plant originated from tropical Asia and later was distributed widely in South and Central America, East and West Indies, China and India, where it has become naturalized . Clitoria ternatea is commonly also called Clitoria, blue-pea, kordofan pea (Sudan), cunha (Brazil or pokindong (Philippines). This plant is known as Aparajit (Hindi), Aparajita (Bengali), and Kokkattan (Tamil) in Indian traditional medicine. It has several synonyms in Ayurvedic scriptures like: Sanskrit names: Aparajita, Girikarnu, Asphota and Vishnukranta. English names: Butter-fly pea, Mazerion and Winged leaved Clitoria. Local names: Aparajita (Hin), Aparajita (Beng), Gorani (Guj), Gokarna (Mar) and Buzrula (Arabic). The juice of flowers is reported to be used in insect bites and skin diseases . The roots are useful in asthma, burning sensation, ascites, inflammation, leucoderma, leprosy, hemicrania, amentia, pulmonary tuberculosis, ophthalmology and reported as bitter, refrigerant, ophthalmic, laxative, diuretic, cathartic, aphrodisiac, tonic. Consequently they are used in the treatment of a number of ailments including body- aches, infections, urinogenital disorders and as antihelmintic and antidote to animal stings. Seeds are cathartic and useful in visceralgia. They are considered safe for colic, dropsy and enlargement of abdominal viscera. The root, stem and flower are recommended for the treatment of snakebite and scorpion sting in India. (Manju Lata Zingare, *et al.* , 2013).

1) History

From ancient times “Shankhpushpi” is known as reputed drug of Ayurveda and reported as a brain tonic, nervine tonic and laxative. It is considered as a “Medhya- Rasayana” in Ayurvedic texts. It comprises of entire herb with following botanicals viz. Convolvulus pluricaulis (Convolvulaceae), Evolvulus alsinoides (Convolvulaceae), Clitoria ternatea (Papilionaceae) and Conscora decusata (Gentianaceae). It is an Ayurvedic drug used for its action on the CNS (Central Nervous System), especially for boosting memory and improving intellect .The flowers of the plant Clitoria ternatearesemble a conch shell; therefore it is commonly called “Shankpushpi” in the Sanskrit language where it is reported to be a good “Medhya” (brain tonic) drug and, therefore, used in the treatment of “Masasika Roga” (mental illness). Extracts of thisplant have been used as an ingredient in Medhya- Rasayana, are juvenating recipe used for treatment of neurological disorders. (Prasanna Lata Zingare *et al.* , 2013).

2) Plant Description

Clitoria ternatea has twining fine stems, 0.5-3 m long. The leaves are pinnate, with 5-7 elliptic to lanceolate leaflets, 3-5 cm long and shortly pubescent underneath . Flowers are solitary, deep blue to blue mauve; very short pedicellate and 4-5 cm long .Pods are flat, linear, beaked, 6-12 cm long, 0.7- 1.2 mm wide and slightly pubescent with upto 10 seeds. The seeds are olive, brown or black in colour,often mottled, 4.5-7 mm long and 3-4 mm wide. (Dubey *et al.* , 2013).

3) Phytochemical Composition

The benefits of *C. ternatea* have been recognized since ancient times, believed to be a natural curefor many diseases, and also used as a natural food additive. Besides the phytochemical compounds, the nutritional composition of *C. ternatea* flowers has been identified. The percentage of fat, carbohydrate, fiber, and protein are, respectively, 2.5, 2.2, 2.1, and 0.32%, while the moisture content is 92.4%. The flowers were also identified as being rich in calcium (3.09 mg/g), magnesium (2.23 mg/g), potassium (1.25 mg/g), zinc (0.59 mg/g), sodium (0.14 mg/g), and iron (0.14 mg/g) (Multisona *et al.*, 2021). The various parts of *Clitoria ternatea* contain diverse phytoconstituents with significant bioactive potential. Major compounds identified include pentacyclic triterpenoids such as taraxerol and taraxerone, while the roots contain ternatins, alkaloids, flavonoids, saponins, tannins, carbohydrates, proteins, resins, and starch. The presence of taraxerol can be determined through High-Performance Thin Layer Chromatography (HPTLC) using aluminium TLC plates. The leaves primarily contain flavonoid glycosides such as Kaempferol-3-glucoside, Kaempferol-3-rutinoside, and Kaempferol-3- neohesperidoside, which are identified through UV and NMR analysis. The seeds are rich in nucleoproteins with amino acid sequences similar to insulin, along with delphinidin-3,3,5-triglucoside, β-sitosterol, γ-sitosterol, hexacosanol, and anthocyanin glucosides. Recent studies have also revealed the presence of malonylated flavonol glycosides in petals, and multiple anthocyanins—such as ternatins (C1–C5, D3), preternatins (A3, C4), and newly identified compounds (A3, B2, B3, B4, D2)—in the flowers.

Additionally, C. ternatea contains a wide range of secondary metabolites including triterpenoids, flavonol glycosides, anthocyanins, and steroids. Other notable components include essential amino acids, mucilage, adenosine, phenolic glycosides, ethyl D-galactopyranoside, p- hydroxycinnamic acid, tannic acid, and a toxic alkaloid, contributing to their nutritional and therapeutic potential. (Pratik Eknath Surse et al. , 2024).

4) Medicinal Effects Of Clitoria Ternatea

Clitoria ternatea, commonly known as butterfly pea, is recognized for its wide range of medicinal and functional properties that extend beyond basic nutrition. Rich in bioactive compounds such as flavonoids, anthocyanins, terpenoids, and polyphenols, it exhibits antimicrobial, anti-inflammatory, analgesic, antipyretic, antidiabetic, hypolipidemic, and antioxidant activities. Studies have shown that its extracts can inhibit protein denaturation, reduce inflammation, and relieve arthritis symptoms due to the action of compounds like quercetin and kaempferol. Traditionally used to treat asthma and bronchitis, the plant's extracts also display antihistamine and bronchodilator effects. Furthermore, it demonstrates pain-relieving and fever-reducing properties comparable to standard drugs like paracetamol. The plant's antidiabetic effects are linked to improved glucose metabolism and insulin regulation, while its hypolipidemic potential aids in lowering cholesterol and triglyceride levels.

In addition, C. ternatea promotes wound healing, inhibits platelet aggregation, and exhibits cytotoxic activity against cancer cells, especially breast cancer lines, by inducing apoptosis. It also enhances memory and cognitive function by increasing brain acetylcholine levels, suggesting neuroprotective benefits. The strong antioxidant power of its petals, attributed to anthocyanins, helps prevent oxidative damage and cellular degradation. Moreover, the plant shows significant antibacterial and antifungal activity against various pathogens. Overall, Clitoria ternatea serves as a potent natural ingredient with diverse therapeutic and functional health benefits, making it valuable for developing health-promoting food and nutraceutical formulations. (Shirodka *et al.* , 2023).

5) Safety and Toxicity Issues

Besides the merits of the curative abilities of this plant, several safety and toxicity issues have been discussed. The Thai Food and Drug Administration (FDA) database reported that dried *C. ternatea* flowers are allowed to be used as food and beverage ingredients and possess a history of long- standing consumption as food in Thailand . *C. ternatea* flower powder is also accepted as a food additive in ordinary food in Japan . The Taipei City Government Department of Health advised the application of *C. ternatea* merely as a food colorant and advised not to introduce it directly in food or as a food ingredient. Likewise, it was advised by the Taipei City Government Department of Health that beverages containing it should not be consumed by pregnant women . (Marcellus Arnold et al. , 2023 **).**

Hence, the use of *C. ternatea* flower in Asian countries as a traditional food colorant was noted without apparent adverse effects. However, the EFSA raised concerns about the safety of dried *C. ternatea* being sold in the EU due to the unknown toxicological profile of the cyclotidespresent in the *C. ternatea* and the possibility of exposure to cyclotides resulting from its planned use in the preparation of herbal infusions. The EFSA believes that the *C. ternatea* may provide a safety risk to human health. Other than the flower part of C. ternatea, the dosing trial on mice showed an unexpected impact. For instance, an ethanolic extract of aerial parts and root of C. ternatea, when is given orally to mice at a dose of 1500 mg/kg and above, caused the mice to become lethargic.

However, acute toxicity testing with albino mice Wistar rats orally given an aqueous ethanol extract (2000 mg/kg bodyweight) of the flower showed no evidence of mortality or abnormalities, and hematological results were not altered significantly. The extract showed no signs of acute toxicity andwas safe to consume . *Clitoria ternatea* flowers have the potential to be used as a functional food thatmay be included into a variety of foods or as a pharmaceutical supplement/drug that can be mixed with commercial medications to improve patient treatment efficacy. (Gramza-Michalowska *et al.* , 2007).

B. Sucrose

Sucrose is a naturally occurring sugar found abundantly in many plants, particularly in sugarcane (Saccharum spp.) and sugar beet (Beta vulgaris), making it easily accessible and widely used. Its production and utilization date back thousands of years, and global production continues to exceed 160 million metric tons annually. Major sucrose-producing countries include India, Brazil, Thailand, China, the United States, Pakistan, and Russia. However, excessive consumption of sucrose is associated with several health problems, including obesity, dental caries, diabetes, cardiovascular diseases, and hyperlipidemia. Therefore, converting sucrose into higher-value products offers a sustainable and beneficial approach to its comprehensive utilization. (Dawei Ni *et al.* , 2022). Sucrose, commonly known as table sugar, is a naturally occurring carbohydrate found in many plants, but it is most abundantly extracted from sugarcane and sugar beet.

It is a disaccharide, composed of two simpler sugars: glucose and fructose. It is widely used in the food industry not only for its sweetness but also for its crucial functional properties, particularly in jelly, jam, and preserve production. In traditional jelly recipes, sucrose plays a centralrole not just in taste but also in texture, preservation, and gel formation.

1) Molecular Chemistry Of Sucrose

- Molecular formula: $C_{12}H_{22}O_{11.}$
- Molecular weight: 342.30 g/mol
- Structure: Sucrose is a non-reducing sugar made up of one glucose unit and one fructose unit linked via a glycosidic bond (α-1,2 linkage). This linkage prevents either of the anomeric carbons from participating in redoxreactions, which is why sucrose is non-reducing.

2) Properties Relevant To Candy Making

- Solubility: Highly soluble in water, which allows it to easily incorporate into jelly mixtures.
- Hydrophilic Nature: Binds to water molecules,reducing water activity.
- Caramelization Point: Begins to break down and caramelize at temperatures above 160°C, this is not typically relevant in Candy making whichoperates at lower temperatures.

3) Role And Effect Of Sucrose In Candy

Beyond taste, sucrose plays a vital functional role by interacting with glucose syrup during cooking — a key step that determines the candy's final texture and structure. This interaction helps control crystallization, ensuring the candy sets properly with a smooth, glossy finish and stable form. In candy making, sucrose plays a crucial role in developing texture, structure, and stability. It promotes the formation of a firm yet smooth consistency by controlling moisture and contributing to the glassy structure of hard candies. High concentrations of sucrose lower the water activity, which helps inhibit microbial growth and extend the product's shelf life. In visually appealing candies sucrose enhances clarity and gloss, giving the product a translucent, shiny appearance. Its high purity and solubility also prevent unwanted crystallization, ensuring a smooth texture and uniform quality in the final product.

4) Nutritional Content Of Sucrose

TABLE I :- NUTRITIONAL CONTENT of SUCROSE

Component	Per 100 g of Sucrose
Energy	~387 kcal
Carbohydrates	100 g (all sugars)
Fat	0 g
Protein	0 g
Fiber	0 g
Vitamins & Minerals	Negligible

C. Glucose Syrup

The rapid increase in population has led to a corresponding rise in food demand, with sugar being one of the most essential commodities. However, the growing demand for sugar has not been matched by sufficient domestic production, resulting in higher prices and the need for imports from other countries. To address this issue, glucose syrup has emerged as a valuable alternative to traditional granulated sugar. Glucose syrup, a liquid sweetener derived from starch, is widely used across various industries — particularly in confectionery, beverages, and jam production. Beyond the food sector, it also serves as a raw material in the pharmaceutical and chemical industries due to its versatility and ease of use. Unlike granulated sugar, glucose syrup is already in liquid form, eliminating the need for dissolution processes, thus making it more practical and cost-effective for industrial applications. Commercially, glucose syrup is primarily produced from cassava starch (tapioca). However, there is significant potential to expand its production using other starch-rich crops such as corn, sago, taro, jicama, and various fruits. These crops are abundant in carbohydrates and can serve as sustainable raw materials to diversify glucose syrup sources. The production process of glucose syrup typically involves the hydrolysis of starch, followed by neutralization, decolorization, and concentration to achieve the desired glucose content. There are two main methods for starch hydrolysis: enzymatic and non- enzymatic. Among these, enzymatic hydrolysis is preferred because it is safer, more controlled, and yields a higher-quality product.

The enzymatic process consists of several stages, including liquefaction (breaking down starch into shorter chains), saccharification (converting starch into glucose), bleaching (to improve color and purity), filtration (to remove impurities), evaporation (to concentrate the syrup), and finally, storage. The objective of ongoing research in this field is to identify and utilize alternative starch sources beyond tapioca for glucose syrup production, thereby promoting resource diversification and enhancing the sustainability of sugar substitutes in the food industry. (Harni et al. , 2021). Glucose syrup—commonly referred to as corn syrup when produced from corn starch—is a concentrated aqueous solution of mixed saccharides derived through starch hydrolysis. It is traditionally utilized as a sweetener and texturizing agent and is extensively used in the confectionery industry due to its cost-effectiveness and desirable functional properties. In recent years, the demand for glucose syrup has grown significantly, driven by the need for alternative sweeteners and the unique product qualities it imparts to various food formulations. (Musdalifa et al. , 2024)..

1) Molecular Chemistry

The main chemical backbone of glucose syrup is made up of glucose units linked via glycosidic bonds. Starch (from sources such as corn, cassava, rice, or wheat) comprises amylose (linear, α-1,4 bonds) and amylopectin (branched, α-1,4 and α-1,6 bonds). Through acid or enzymatic hydrolysis (using α- amylase and glucoamylase), these polymers are broken down into a mixture of smaller saccharides: glucose (monosaccharide), maltose, maltotriose, and higher oligosaccharides. The ratio of these components is quantified using the Dextrose Equivalent (DE), which reflects the extent of hydrolysis. High DE indicates a higher content of simple sugars and sweeter syrup. (.Nwalo et al. , 2014).

2) Materials And Methods

The primary raw materials used for glucose syrup production included cassava starch, corn starch, sago starch, taro starch, and jicama starch. The enzymatic agents employed were α-amylase and α- glucosidase. Additional chemicals used for analytical procedures comprised Luff reagent, distilled water, boiling stones, 20% potassium iodide (KI), 4N sulfuric acid (H_2SO_4), 0.1N sodium thiosulfate, 1% starch indicator, 3% hydrochloric acid (HCl), 25% sodium hydroxide (NaOH), and filter paper.
The equipment utilized for starch processing included pans, graters, weighing scales, trays, heating apparatus for glucose syrup preparation, stirrers, and thermometers. (Harni *et al.* , 2021).

3) Properties Relevant To Candy Making

- Sweetening Control: Glucose syrup is less sweet than sucrose, allowing for balanced sweetness inconfections.
- Prevents Crystallization: A key role is preventing crystallization of sucrose, which helps products remain smooth and glossy, a necessity for hard candies, caramels, and jellies.
- Texture & Mouthfeel: It acts as a texture modifier, providing chewiness in gummies and elasticityand preventing products from becoming too brittle or drying out.
- Moisture Retention: Glucose syrup is highly hygroscopic. In candies, it preserves moisture, contributes to longer shelf-life, and maintains texture under variable storage conditions.

Other Functions point, aids in caramelization, enhances color/shine, improves spreadability in fillings: It lowers freezing , and provides body/bulk to sugar confections.

4) Nutrition Profile Of Glucose Syrup

Table II: Nutritional Content Of Glucose Syrup

Nutrition Facts	
Calories (kcal)	285.0
Carbohydrates (g)	70.5
Proteins (g)	0.2
Fats (g)	0.0

100 grams of glucose syrup contain 285.0 kcal (1192 kJ), 0.2 grams of proteins, 70.5 grams ofcarbohydrates, and 0.0 grams of fats.

5) Role and Effect Of Glucose Syrup In Candy

Glucose syrup is fundamental in candy-making because:

- It gives plasticity and smoothness to hard/soft candies.
- Prevents unwanted graininess by inhibiting large sucrose crystals.
- Enables controlled flavor and sweetness, promoting the release of other taste components.
- Contributes shine and clarity to finished products.
- In functional candies, it can mask off-flavors and help deliver supplementary compounds (e.g.,vitamins, proteins).

III. MATERIAL AND METHODOLOGY

A. Material And Methodology

This chapter contains all the materials and methodology followed to prepare and test the product. The test methods for testing products are also discussed. Research work was carried out at the Department of Food Technology, Ballarpur Institute of Technology, Ballarpur.

B. Material Required For Research Study

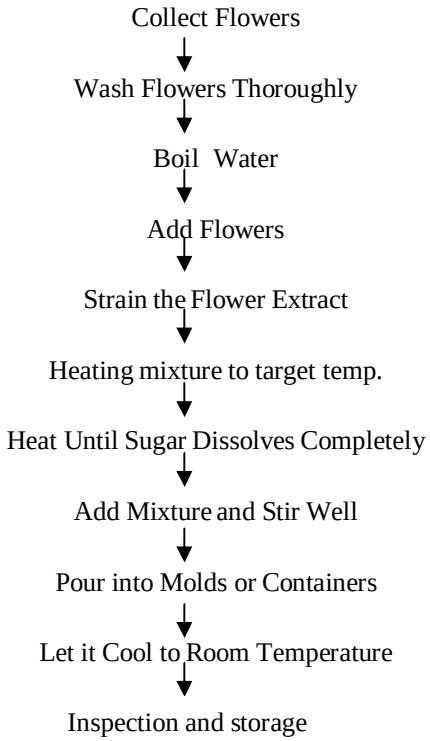
Ingredients :-

- C.ternatia Flower.
- Sugar.
- Glucose Syrup.
- Flavour.

C. Preparation Of Candy

The standard recipe was taken from Doremus Mabel's Book of Candies…Old and New. After several trials and various observations, the number of raw materials mostly sugar and corn syrup were changed and new standards were prepared.

FLOWCHART OF PREPARATION OF CANDY :-



D. Procedure For Preparation Of Candy

1) Collection of Flowers: Fresh Aparajita (Butterfly Pea) flowers were collected from thegarden toensure quality and freshness.
2) Washing: The collected flowers were thoroughly washed with clean water to remove dirt, dust, orinsects.
3) Boiling of Water: A measured quantity of water was brought to a boil in a clean vessel.
4) Extraction of Flower Color and Flavor: The washed flowers were added to the boiling waterand allowed to simmer
5) Filtration: After sufficient extraction, the mixture was strained using a clean muslin cloth or sieve to obtain a clear blue-colored water.
6) Heating Mixture: Heat the mixture to a target temperature to reach the correct sugar concentration and consistency.
7) Heating to Dissolve Sugar: The mixture was gently heated while stirring until the sugar will completely dissolved. Care was taken not to boil the mixture vigorously.
8) Addition of Mixture and Stir well : Flower Extract was added directly to the hot mixture while stirring continuously to ensure complete dissolution.
9) Pouring into Molds: The hot Candy mixture was poured into clean molds or serving containers.
10) Cooling: The mixture was allowed to cool.
11) Unmolding and Serving: Once set, the Candy was gently removed from the molds and served.

E. Final Product

Fig 01 : Final Product.

F. Characterization / Analysis Of Candy

Proximate Analysis :-

1) ASH Content

5 g of Candy sample was taken in a previously dried silica crucible. After charring the crucible and was placed in a muffle furnace for ignition at 550 °C for 4 hours. The crucible was taken outside and cooled in a desiccator. The sample was ignited again after every half an hour until a constant weight was obtained accepted by the difference of 0.001. [AOAC 942.05].

$$\text{Ash \%} = [W_3 - W_1 / W_2 - W_1] \times 100$$

Where :- W1 : Weight of empty crucible (g)
W2 : Weight of crucible + raw sample (g)
W3 : Weight of crucible + ash (g)

2) Moisture Content

5 gm of the Candy sample was taken in a Petri-plate and the weight was measured, the Petri plates with samples are placed in a hot-air oven for drying with at temperature 105 °C, after 3 hours the sample was taken out and cooled in a desiccator, weight was taken and again placed in the hot-air oven to redry the sample and reweighed after half an hour until the constant weight was obtained for last three readings. [AOAC 2000]

$$\text{Moisture Content (\%)} = [W_1 - W_2 / W_1] \times 100$$

Where:- W1 = Weight (g) of the sample before drying .
W2 = Weigh (g) of the sample after drying.

3) Crude Fat Content

5 gm sample was weighed and packed in a thimble the prepared thimble was weighed to crosscheck the weight of the sample. The thimble was then enclosed in a big cellulose thimble and then it was placed in a Soxhlet extraction tube, 250 ml, of petroleum ether, was added to the Soxhlet extraction tube containing the sample. The heating mantle was turned on and the temperature was set at 60°C. Petroleum ether gets evaporated and condensed and falls over the sample drop by drop and the speed of dropping should be 150 drops per minute. When clear color petroleum ether was seen in Soxhlet after 12 hours, the assembly was turned off. The The ash of sample was taken boiled in a dil. HCL for 5 min Filter with ashless filter paper and wash with distil water After washing dry the crucible with ash in hot air oven for 3 hours at 105°C. Ignite in muffle furnace at 550°C for 1 hour and take the weight . 43 round bottom flask containing the solvent was separated from the assembly to recover the solvent. The solvent was recollected by using the downward distillation unit for the next use and the round bottom flask holding the extracted fat sample was dried in a hot air oven at 105 °C until all the solvent was removed after drying the RBF was cooled in a desiccator and the weight was taken until the last three successive reading shows the difference less than gm [AOAC(1995)].

$$\text{Crude Fat (\%)} = [W2 - W1 / W] \times 100$$

Where:
W1 = Weight of empty extraction flask (g)
W2 = Weight of flask after fat extraction (g)
W = Weight of the food sample (g)

4) Crude Fiber Content

The official process of AOAC (1990) was used to determine the crude fiber content of the test sample. The fat-free sample obtained from the fat extraction test was used to calculate crude fiber content. The sample was boiled in 200 ml of 1.25% H_2SO_4 for 30±1 minutes and filtered with Whatman filter paper and washed with hot distilled water 6-8 times to remove all the traces of the acid from the sample, sample was then recollected and boiled with 200 ml of 1.25% NaOH for 30±1 minutes, and after cooling it was filtered with Whatman filter paper and again washed with lukewarm distilled water to remove the NaOH present over the sample. After washing with distilled water, the sample was washed once with 10 % HCl followed by washing with absolute ethanol twice, after the residue was washed thrice with petroleum ether. After washing the remaining residue was collected in a previously weighed crucible and it was then dried in a pre-heated hot air oven at 105 °C for 3 hours. The crucible was cooled in a desiccator after cooling the weight was noted and then the crucible was placed in the pre-heated muffle furnace at 550°C until ash obtains, the crucible was cooled in a desiccator and the weight was measured and the fiber content was calculated by using the formula;

$$\text{Crude Fiber (\%)} = [W1 - W2 / W] \times 100$$

Where:
W1 = Weight of residue after digestion (before ashing) (g)
W2 = Weight of ash after incineration (g)
W = Weight of original sample (g)

5) Crude Protein

Content The crude protein content in the sample was calculated by the Kjeldahl method described in AOAC 2001.11. The Kjeldahl method takes place in three major steps - Digestion - Distillation - Titration

Digestion- 1 gm sample was weighed and transferred to a digestion flask carefully so that the sample will not stick to the walls of the flask, 2 gm catalysts (A mixture of 7 g Potassium sulfate and 0.8 g Copper sulfate) were added to the flask. 20 ml Sulphuric acid ($H2SO4$), was pipette out carefully and transferred slowly into the digestion flask as it is the strong acid it breaks down and digests the sample completely. The digestion flask was kept over the heating mantle at 100 °C for 2-3 hours (modified) until the light green color was obtained. Let the digestion flask cool down to room temperature.

Distillation- Set up the assembly for distillation, one end was holding the digestion flask and another end was attached to the condenser with the help of digesting bulb, and the tip of the condenser was dipped into the conical flask containing 30 ml of 4% boric acid. Ensure that the tip of the condenser was completely dipped so that no ammonia (NH_3) can escape. Add 60 ml of distilled water to the digested food sample through the downward funnel. Now pour 50 ml of 40 % NaOH appearance of dark brown or black

color shows the complete neutralization of the H2SO4, distillation unit was run for 2-3 hours at 100°C (modified) until ammonia (NH3) gets collected in the boric acid sample and its volume reached to 100 ml or more.
Titration- The collected ammonia in boric acid was prepared for titration. 7 drops of methyl red and 10 drops of bromocresol green were added and the titration was done with 0.1 N HCL until the solution turned from blue to red/pink. The burette reading was taken and the protein nitrogen was calculated by using the given formula;

$$\text{Crude Protein (\%)} = (A-B)\times N\times 14.01\times 10\times 6.25 \,/\, W\times 1000$$

Where,
A- Burette reading of sample .
B- Burette reading of blank .
N- Normality of HCL used for titration.14.01- Atomic wt. of Nitrogen.
W- Weight of the sample .
10- Factor to convert mg/g to percent.
6.25- nitrogen to the protein conversion factor.

6) Carbohydrate Content

The total carbohydrate content was calculated by the difference method. All the calculated proximate values were subtracted from 100; the resulting value is the carbohydrate content of the given test sample.

Total Carbohydrate = 100 – [Moisture content + Total Ash + Crude Fat + Crude Fiber + Crude Protein]

7) pH Analysis

The pH of the Candy was measured using a **Digital pH Meter** . A representative Candy sample of 01 gm was mixed with 10 ml of distilled water and blended to obtain a uniform suspension . The electrode of the caliberated pH meter was immersed in the mixture and the reading was recorded once it stabilized.

8) Total Soluble Solid (TSS) Analysis

TSS was measured by using a Hand Refractometer . A few drops of the Candy solution (Prepared by mixing 01 of Candy with 10 ml of distilled water) were placed on the prism of the refractometer, and thereading was noted in °Brix .

9) Physiological Analysis

The physiological examination of jelly on their physical characteristics, such as their thickness, length, average weight, and shape, all of which support their uniformity, appeal, and portion management. For the convenience of handling and eating, jelly are usually made into little coffee beans shapes . To guarantee uniform portion sizes,the average weight of each piece is frequently standardized, falling between 1-2 grams. Depending on the design, their lengthand thickness typically change, resulting in a small and practical size. In addition to improving the appearance, consistency in these physical characteristics guarantees that each jelly has the same amount of nutrition, cooking, and texture.

- Physical measurements:- In this test, various physical parameters like weight, length, and thecandies thickness were calculated.
- Shape: The shape of the candy was identified by a sensory test by the visual method. Various shapes can be made by using molds or cutters.
- Average Weight: 05 Candies were selected randomly from the prepared batch and their weight was measured. The average weight was calculated by using the formula.
- Length : 01 Candies were selected randomly and the horizontal length of candy from the top was calculated by usinga Digital Vernier Caliper Scale.
- Thickness : By using a Digital Vernier Caliber Scale, the average thickness (vertical height) of selected 01 Candy was calculated.
- Width :- By using a Digital Vernier Caliber Scale, the average Width of selected 01 Candy wascalculated.

10) Microbial Analysis

Microbial analysis is an essential aspect of food quality and safety evaluation, carried out to determine the hygienic condition and microbial stability of a product. It helps to ensure that the developed product is free from harmful microorganisms and safe for human consumption. In the present study, microbial analysis of the formulated Aparajita (Clitoria ternatea) flower candy was performed to assess its microbiological quality and shelf-life stability.

The analysis included the determination of Total Plate Count (TPC), Yeast and Mold Count, Coliform Count, and the detection of pathogenic microorganisms such as Salmonella and Staphylococcus aureus. These parameters are important indicators of contamination during processing, handling, and storage.

By comparing the obtained results with the permissible limits prescribed by FSSAI (Food Safety and Standards Authority of India), the safety and microbiological acceptability of the developed candy were evaluated. The results of the microbial analysis provide critical insights into the hygienic practices followed during production and the overall microbiological stability of the functional confectionery product.

IV. RESULT AND DICUSSION

A. Sensory Analysis

A 9 Pointer hedonic scale was used to do sensory analysis. 5 different samples of different proportions were prepared. 7 panelists gave their different judgments over the parameters. Parameter for sensory analysis – Taste, Appearance, Aroma, Mouth feel, Color and Overall acceptance. The Candy received positive feedback from the evaluators across all sensory parameters. Most panelists rated the candy between 8 (Like) and 9 (Like Very Much), indicating a high level of acceptability and consumer appeal.

B. Sensory Evaluation

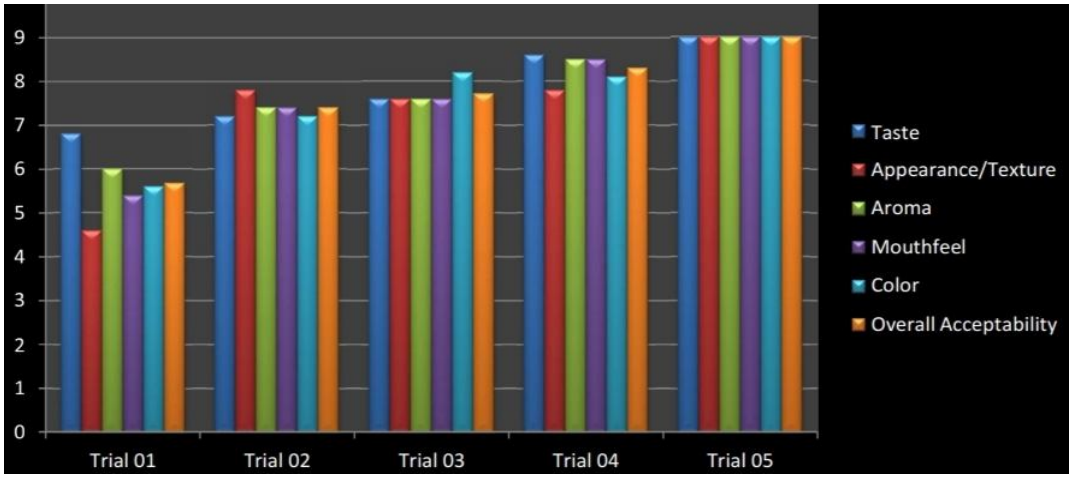


Fig 02 :- Graphical Representation of Sensory Evaluation

C. Sensory Analysis (Acceptability of Product)

We prepared different samples of our product in different proportions, and one of them was selected. Out of those prepared samples.

Fig 03 :- Acceptable Sample

D. Proximate Analysis

In the proximate analysis moisture content, total ash content, acid-insoluble ash, crude fat, crude fiber, and crude protein were determined. The results of the proximate analysis are provided in the following table .

TABLE III :- PROXIMATE ANALYSIS RESULTS.

Sr. No.	Test Parameter	Results	Unit of Measurement
1	Moisture	2.14	%
2	Total Ash	0.32	%
3	Crude Protein	0.85	g/100g
4	Total Fat	3.42	g/100g
5	Crude Fiber	0.25	g/100g
6	Carbohydrate (by diff.)	93.02	g/100g
7	Energy Value	388.6	Kcal/100g

1) *ASH CONTENT :* The total ash content of the Candy gives the idea of the mineral matter present in any sample. The higher the ashcontent higher is the number of minerals present in a sample. The ash value calculated in the sample is 0.32 %.
2) *MOISTURE CONTENT :* The moisture content plays an important role in determining the shelf-life of the product. The moisture content in the candy is 2.14 %.
3) *CRUDE FAT (G/100G) :* It gives an idea about the lipid content of the product. Determination of crude fat is depended upon the extraction condition and the solvent used. It is observed that the crude fat content of prepared candy is low i.e., 3.42 gm.
4) CRUDE FIBER (G/100GM) : Crude fiber content gives the idea of indigestible cellulose material present in a food sample. The crude fiber content of the candy was found to be low as the aqueous extract was used to prepare the candy. The crude fiber content of the candy was found to be 0.25 gm.
5) *CRUDE PROTEIN (G/100GM) :* In this analysis, we first calculate the nitrogen content of the food material and then calculate the protein content by multiplying the obtained nitrogen value with the protein factor (6.25). The crude protein content of the prepared candy is 0.85gm.
6) *CARBOHYDRATE (BY DIFF.) :* Total carbohydrate boosts us up with calories which is essential to do daily work. The carbohydratecontent of the prepared candy is 93.02 gm.
7) *ENERGY VALUE (KCAL/100G) :* The Energy Value of prepared Candy is found to be 388.6 kcal/100gm).
8) *pH Analysis :* The pH of the candy was determined to evaluate its acidity, which plays a vital role in flavor, shelf life, and microbial stability. The pH value of the C. ternatia flower candy was found to be (3.35) , indicating a slightly acidic nature due to the presence of natural plant extracts. A lower pH helps in enhancing the microbial safety of the product by inhibiting the growth of spoilage organisms. The obtained pH was within the acceptable range for confectionery products, ensuring both good taste balance and storage stability.
9) *TOTAL SOLUBLE SOLIDS (TSS) :* The Total Soluble Solids (TSS) content of the candy was measured using a refractometer and expressed in °Brix. The TSS value was found to be 97.29°Brix , which reflects the concentration of sugars and soluble solids in the product. Higher TSS contributes to sweetness, texture, and preservation of the candy. The observed TSS value was in accordance with typical sugar-based confectionery products, indicating proper formulation and boiling temperature during preparation. This optimum TSS level enhances both flavor and product firmness, maintaining consumer appeal.
10) *PHYSICAL ANALYSIS :* The physical parameters of the developed C. ternatia flower candy were analyzed to assess its external characteristics, texture, and overall product uniformity. The candy exhibited an attractive appearance with a glossy surface and uniform shape, indicating proper heating and molding during preparation. The average weight of the candy was found to be within acceptable limits (Length :- 14.66 mm , Thickness :- 12.00 mm , Width :- 9.98 mm) , showing consistency among all samples. The texture was firm yet easily chewable, suggesting balanced sugar concentration and adequate solidification. These physical attributes contribute significantly to consumer acceptability and product stability during storage.

E. Microbial Analysis

We have performed a microbial analysis of our product. Clitoria Ternatia flower Candy have undergone thorough microbial testing, and the results are negative for harmful microorganisms. This confirms that our product is safe for consumption, adhering to stringent and safety standards. Consumers quality can enjoy our Clitoria Ternatia flower Candy with confidence, knowing it is free from microbial contamination and crafted with the highest levels of hygiene and care .

Table IV :- Microbial Analysis Results.

Sr. No.	Test Parameter	Unit of Measure--ment	Results	Requirementas per FSSAI - 2011	Test Method
1	Total Plate Count	cfu/g	120	NMT 40000	IS 5402 - 2012
2	Yeast & Mold Count	cfu/g	<10	NMT 100	IS 5403 - 2012
3	Coliform Count	cfu/g	<10	NMT 100	IS 5401(Part 1) - 2012
4	E.coli	cfu/g	Absent	Absent	IS 5887(Part 1) - 1976
5	Salmonella	per 25g	Absent	Absent	IS 5887(Part 3) - 1999
6	Staphylococ cus aureus	cfu/g	Absent	Absent	IS 5887 (Part 2) - 1976

V. CONCLUSION

The paper conclusively demonstrates that Clitoria ternatea flower is an effective natural candidate for the formulation of functional candy, offering distinct advantages in natural coloring, antioxidative capacity, and health-promoting bioactivity. Scientific evaluation of proximate composition, physicochemical, and microbial characteristics validates the product's safety and quality within regulatory standards. Sensory trials recorded high consumer acceptability. This research pioneers the integration of traditional medicinal plants into contemporary food technology, presenting a sustainable alternative to synthetic colorants and highlighting functional food innovation. Clitoria ternatea flower candy is positioned as a promising entrant in the functional confectionery , contributing positively to consumer health trends, market diversity, and sustainable food practices.

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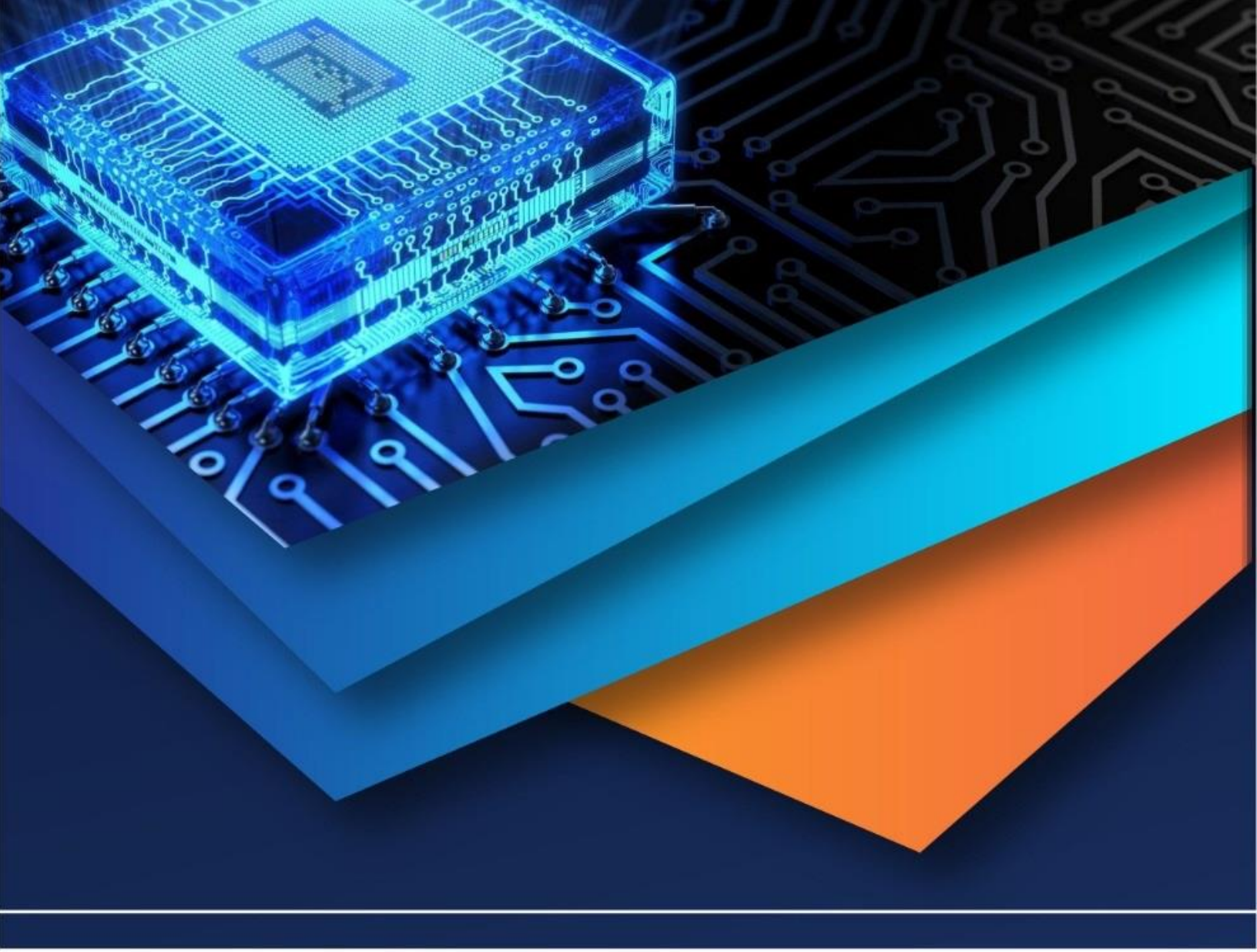

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