

**FORMULATION AND STANDARDIZATION OF GUMMIES: INCORPORATING
COCONUT INFLORESCENCE SAP AND SPIRULINA**

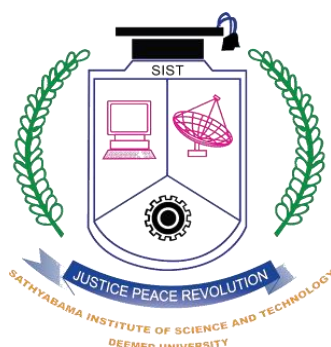
PROJECT REPORT

Submitted in partial fulfilment of the requirements for the award of
Bachelor of Science Degree in Clinical Nutrition and Dietetics

By

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DEPARTMENT OF CLINICAL NUTRITION AND DIETETICS

SCHOOL OF ALLIED HEALTH SCIENCES

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with Grade A++ NAAC

(Established under Section 3 of UGC Act,1956)

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BONAFIDECERTIFICATE

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We A.Girija (41736004) and B.Darshini (41736002) hereby declare that the Project Report entitled **"FORMULATION AND STANDARDIZATION OF GUMMIES: INCORPORATING COCONUT INFLORESCENCE SAP AND SPIRULINA"** done by us under the guidance of Ms. S. Priya (Internal) and Dr.L.Stanley Abraham (External) at the department of Allied Health and sciences and Ocean Research, Sathyabama Institute of Science and Technology, Chennai is submitted in partial fulfilment of the requirements for the award of Bachelor of Science and Degree in Clinical Nutrition and Dietetics.

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ABSTRACT

This study explores the formulation of gummies infused with coconut inflorescence sap and spirulina, presenting a novel approach to creating functional and nutritious confectionery products. coconut inflorescence sap, a traditional drink derived from the sap of coconut palms, is renowned for its unique flavor profile and nutritional richness, offering a natural source of sugars, vitamins, and minerals. Spirulina, a nutrient-dense blue-green microalgae, complements the coconut sap with its essential vitamins, and antioxidant properties. The gummies, formulated with these ingredients, serve as a convenient and enjoyable means to incorporate indispensable nutrients into the diet, especially to special population like sports fraternity . This innovative product combines the cultural significance of coconut sap with the nutritional powerhouse of spirulina, offering consumers a delicious and health-enhancing snack option. The formulation process ensures optimal taste, texture, and nutritional balance, providing a promising avenue for the development of functional food products with broad consumer appeal.

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CHAPTER 1

INTRODUCTION:

Coconut sap, also known as Neera, naturally ferments quickly at room temperature. This fresh sap is initially sweet and has a neutral pH, but within a few hours, it begins to change. The colour turns whitish, the pH becomes acidic, and a noticeable fermented odour develops. Traditional collection methods using mud pots at the top of the palm tree actually encourage this fermentation because the sap sits for extended periods (Hebbar, 2015).

To prevent fermentation and preserve the fresh qualities of the sap, two main approaches are used. Chilling the collection containers keeps the temperature low, slowing down the fermentation process. Alternatively, collecting the sap more frequently (every hour) and storing it in a cold environment maintains its freshness (Arivalagan, 2015).

Neera, known as coconut inflorescence sap is a see-through white sweet juice collected from the spadix of an unopened coconut tree. It has high nutritional value and is a good digestive enzyme. Nevertheless, Neera undergoes spontaneous fermentation, first alcoholic and then acidic because of the presence of natural yeast and bacteria. Nonetheless, Neera continues to be consumed in India, Sri Lanka, Africa, Malaysia, Indonesia, Thailand and Myanmar as a popular nutritious drink. (Femi, 2020)

The coconut sugar, a natural sweetener with low glycemic index compared to cane sugar, is becoming popular in developed countries. Based on (Trinidad 2010) studies, the GI of coconut sap sugar ranges from 35 ± 4 to 42 ± 4 . Additionally, (Solanki 2016) points out that there has been a high demand for palm sugars which include coconut sugar in European Union countries for five years now. This explains why this type of sugar is extracted from fresh saps of all types of palms including coconuts. Neera; which is fresh sap obtained from coconut trees has several benefits.

Neera can also help prevent jaundice, improve digestion promote clear urination and maintain cool body system. When they are already producing steadily which is usually at a young age, coconut trees can be tapped. Tapping takes place on the unopened inflorescence. Once swelling starts at the base as a result of development of female flowers in the spathe (a protective leaf-like structure, about 60 cm long) then tapping is done.



Fig.1.1-Representation of climbing tree

After stroking for 4–5 days, 7–10 cm of the tip of the inflorescence is sliced off. Sap begins oozing immediately after this cut has been made.



Fig .1.2- Representation of spadix

The process starts with preparing the part of the coconut tree called the spadix, just like mentioned before. Once the sap begins to ooze out, tappers apply clay, gummy material, or leaf extract to the cut surface. This isn't to stimulate sap production as believed, but rather to prevent the sap from seeping internally between the peduncles.

They also tie a coconut leaf lamina around the cut area to guide the sap downwards; otherwise, it might just flow along the surface, especially since the coconut spadix is usually upright or at an angle (20° – 30° to the main axis). The sap that trickles from the cut surface is collected in an open earthen pot or bamboo sac, placed at the top of the palm tree for about 8–12 hours. To stop the sap from fermenting, lime is coated on the inside of the collecting pot. This collected sap is oyster white with a strong smell and may contain insects, ants, pollen, and dust particles. The sap gathered without lime is specifically used for making toddy, which is an alcoholic drink.



Fig.1.3 -Representation of sap collection



Fig.1.4-representation of collection process



Fig.1.5-representation of filtration

Biochemical and mineral composition fresh sap is rich in sugars, minerals and proteins. It is also a rich source of phenolics and ascorbic acid and essential elements, viz. N, P, K, Mg and micronutrients Zn, Fe and Cu.

The Central Plantation Crops Research Institute has even developed a special "coco-sap chiller" that uses ice cubes to maintain a cool temperature around the collected sap. This innovative method ensures the sap remains sweet, unfermented, and free of contaminants like insects and dust (Manikantan, 2015). This fresh, high-quality sap is called Kalparasa and is considered a valuable health drink. It can be sold directly under refrigeration or processed into various natural products like sugar, jaggery, or syrup without needing any artificial additives (Mathew, 2015).

Spirulina platensis is a powerful algae with a long history as a superfood. Packed with protein, vitamins, and minerals, it's even more nutritious than some common foods like soybeans (Jung 2019). This led the United Nations to recognize its potential. Beyond its impressive nutritional content, spirulina also boasts antiviral, antibacterial, and antioxidant properties. It's even been linked to benefits like diabetes control, cancer prevention, and reduced inflammation (Krüger 2019). This versatility has earned it the title of "superfood." *Spirulina* thrives in salty or alkaline water, using sunlight to convert carbon dioxide into food and releasing oxygen in the process. This means it can be grown in areas with limited freshwater resources, making it a sustainable and powerful source of nutrition (Waldeck,2019).

Compared to other algae like *Scenedesmus* and *Chlorella*, *Spirulina* is a bit of a diva. It needs a richer environment to thrive. This explains why it's naturally found only in salty lakes. Growing it elsewhere requires a special recipe (Ogawa, 2012). Scientists have tweaked an original formula to create mediums that meet *Spirulina*'s specific demands. These mediums are high in alkalinity and constantly replenish bicarbonate ions, which are essential nutrients for these picky algae (Cifferi,2012).

Spirulina isn't just a powerful food source, it's also a potential medicinal powerhouse. This algae is used in everything from agriculture to medicine because of its unique chemical makeup (Hoseini, 2013). Packed with protein, complex sugars, healthy fats, essential fatty acids, vitamins, and minerals, Spirulina offers a range of health benefits. Studies suggest it can fight viruses, bacteria, and even cancer (Darani, 2013). It may also help protect against heavy metal poisoning, boost the immune system, and combat inflammation due to its antioxidant properties. Researchers are still exploring the full extent of Spirulina's medicinal applications, but the potential is promising (Mozafari,2013).

Agar agar powder, a seaweed extract, is your secret weapon for delicious vegan and vegetarian dishes. This natural gelling agent forms strong gels at cool temperatures, thickening soups, sauces, and desserts without altering their flavour. Unlike gelatin, it's completely plant-based, making it a versatile and cruelty-free addition to your kitchen.

The magic of agar agar powder lies in its ability to transform liquids into gels when heated with water. This makes it a fantastic substitute for gelatin, especially for vegans and vegetarians. Unlike gelatin, which comes from animals, agar agar is plant-based and sets at cooler temperatures, around body temperature. This wider setting range opens it up for use in many more recipes, letting you create delicious dishes with all sorts of textures (Junianto, 2021).

CHAPTER 2

REVIEW OF LITERATURE:

2.1. COCONUT INFLORESCENCE SAP

The aptly named “tree of life,” the coconut palm offers a treasure trove of benefits. Neera, the sap collected from its unopened flowers, is a particularly valuable product. This healthy and therapeutic drink boasts a wealth of nutrients, surpassing even milk in terms of calories. Neera fights various ailments, from diabetes and cancer to electrolyte deficiencies and hair loss (Maria, 2022).

2.1.1 NUTRITIVE VALUE

Packed with minerals, vitamins, and the protein-building block glucamic acid, neera promotes healthy digestion. Its vitamins A and C act as antioxidants, protecting cells from damage (Malhija, 2022). Diabetics can also enjoy this beverage as its low glycemic index and load prevent blood sugar spikes. However, to fully understand its potential, further research is needed to explore the exact chemical makeup of neera, particularly the levels of total sugar, reducing sugar, ethanol, and specific vitamins (Sherin, 2022).

2.1.2 COLLECTION PROCESS

Coconut inflorescence sap is commonly collected using earthen pots hung on the unopened flower clusters of the coconut tree. Although this method is straightforward and popular, it has some drawbacks. The sap can quickly ferment at room temperature, leading to the creation of an alcoholic drink known as “toddy.” Additionally, the open containers allow the sap to come into contact with dust, insects, and other impurities, which can reduce the quality of the product. This exposure can also lower the sap’s Ph level due to fermentation, affecting its overall taste and usability (Hebbar, 2015). Researchers have developed improved methods for collecting coconut inflorescence sap that maintain its freshness. The coco-sap chiller uses a container with ice cubes to keep the temperature low, around 2-3°C, which slows down fermentation and allows for longer collection periods.

2.1.3 SELECTION OF INFLORESCENCE AND PREPARATION:

Tapping Coconut:

When they are already producing steadily which is usually at a young age, coconut trees can be tapped. Tapping takes place on the unopened inflorescence. Once swelling starts at the base as a result of development of female flowers in the spathe (a protective leaf-like structure, about 60 cm long) then tapping is done.

Tapping Stage:

After stroking for 4–5 days, 7–10 cm of the tip of the inflorescence is sliced off. Sap begins oozing immediately after this cut has been made.



Fig.2.1.3.1-Representation of spadix tapping

2.1.4 TRADITIONAL METHOD OF COLLECTING COCONUT SAP:

The process starts with preparing the part of the coconut tree called the spadix, just like mentioned before. Once the sap begins to ooze out, tappers apply clay, gummy material, or leaf extract to the cut surface. This isn't to stimulate sap production as believed, but rather to prevent the sap from seeping internally between the peduncles. They also tie a coconut leaf lamina around the cut area to guide the sap downwards; otherwise, it might just flow along the surface, especially since the coconut spadix is usually upright or at an angle (20°–30° to the main axis). The sap that trickles from the cut surface is collected in an open earthen pot or bamboo sac, placed at the top of the palm tree for about 8–12 hours. To stop the sap from fermenting, lime is coated on the inside of the collecting pot. This collected sap is oyster white with a strong smell and may contain insects, ants, pollen, and dust particles. The sap gathered without lime is specifically used for making toddy, which is an alcoholic drink.

Another method uses elongated cuboidal boxes that limit the sap's exposure to air, further preventing fermentation and preserving the sap's quality (Samsudeen et al, 2020).

2.1.5 POST HARVESTING CHANGES OF SAP

These factors were tested over time, with the sap being analyzed after 4 and 8 hours. Each factor had three different levels, offering a variety of conditions to compare. To keep the temperature of the sap below the surrounding environment, the researchers used ice or a mix of ice and water in coolers, depending on whether the temperature needed to be maintained at 10 °C or below, or between 11–20 °C (Jintana Wiboonsirikul, 2024).

2.1.6 POST FERMENTATION PROCESS

The movement of sap is sluggish and it is also highly susceptible to fermentation, which makes it very difficult for one to collect unfermented sap. Lime is often applied during tapping to prevent fermentation (M. Arivalagan, 2015). However, this sap still turns white and smells awful as if unhealthy when lime is added into it.

The fermented sap is known as toddy, which has an off smell making it inedible despite its nutritional value (K. B. Hebbar, 2015).

2.1.7 FACTORS AFFECTING SAP YIELD

The sap yield varies with the species, seasons, spathes of the same tree, and time of tapping. In one spathe of an inflorescence, sap can be harvested for a month or even more than a month, and in the same period, the second spathe might also be ready for the tapping. The sap can be harvested for up to six months from three spathes exuding sap from the same tree simultaneously (Chayanika Sarma, 2022).

2.1.8 ANTIOXIDANTS IN COCONUT SAP

Coconut inflorescence sap or neera is a type of sweet liquid that comes from the non-opened flower clusters of coconut palms. With the coming of ages, it became famous for a healthy drink due to its abundance of bioactive ingredients usually associated with antioxidants (Hebbar, 2022).

Neera has been ascertained to contain a variety of types of phenolic compounds, which include phenolic acids and flavonoids. These types of antioxidants are known to exert strong antioxidant activity, and such antioxidants can effectively scavenge free radicals in the body and thus reduce oxidative stress and promote health (Sharafudeen, 2022).

The chemical composition of coconut inflorescence sap and ascertained that the sap had a great antioxidant activity. According to the study, the sap contains substances that help to donate hydrogen atoms to free radicals, thereby neutralizing them and reducing their evil effects (Hebbar, 2015).

The results are encouraging, but a lot of research needs to be done on the specific types and intensities of antioxidants in coconut inflorescence sap and its health benefits. It also becomes the need to investigate how different processing and storage methods can affect the antioxidant levels in the sap.

2.1.9 OTHER PRODUCTS FROM UNFERMENTED SAP

Coconut sugar has been widely used in the cuisine of Indonesian and many other Asian countries for centuries and is also very popular as a natural sweetener in Indonesia and now also gaining popularity as a sweetener in some developed countries (Somawiharja, 2018).

The sweet sap i.e **neera** from mature coconut trees has been enjoyed as a natural drink for many years, but selling it on a large scale has been challenging. This is because the sap can ferment quickly, turning it into an alcoholic beverage. This change in the drink's nature affects its marketability and stability, making it hard to offer it as a consistent, non-alcoholic product (Mohankumar, 2019).

Coconut sap honey is a delicious and unique product made from the sap of coconut trees. The sap used to make the honey has a Ph level between 6.0 and 6.5, ensuring a perfect balance of acidity and sweetness.

Making this honey is similar to producing jaggery, but it's important not to heat the sap for too long. Overheating can cause the sap to burn and change color, affecting the flavor and quality of the honey. This delicate process results in a rich, flavorful coconut honey that's perfect for adding a touch of sweetness to your meals (Balasubramanian, 2023).

2.2.SPIRULINA

The transformative impact of Spirulina farms as environmentally sustainable green food machines. Thriving in shallow ponds, this versatile algae exhibits rapid growth, doubling its biomass every 2 to 5 days. This remarkable productivity breakthrough yields an abundance of protein, surpassing traditional agricultural crops by significant margins - over 20 times more than soybeans, 40 times more than corn, and a staggering 400 times more than beef, all within the same land area (Robert, 2009).

2.2.1 NUTRITIVE VALUE

The investigators determined the nutritional value of processed *Spirulina maxima* in vitro in rat skeletal muscle. Dietary-fed rats were provided with six successive days of a diet containing 20% protein levels (Saranraj, 2012). *Spirulina platensis* had a nutritional value that fit somewhere between those of wheat gluten and casein supplemented with methionine.

Casein, along with supplementation from methionine, prepared from *Spirulina platensis* had been considered fairly similar in quality to casein sample with methionine (Usharani, 2012).

2.2.2 CULTIVATION

Spirulina, a commercial organism within the family *Spirodaceae*, is seen as a filamentous type of cyanobacterium. It is among the world's largest microalgal cultivation industries that are focused on growing it and currently generate 10,000 tons in annual production of the algae. Because it is enriched in proteins, phycocyanin, essential amino acids, polysaccharides, carotenoids, minerals, vitamins, and essential fatty acids, spirulina has lately been regarded as an ideal bio-resource and has attained increasing interest in recent years (Kanchana, 2012). Cultivation is generally considered an option for its extraction due to the abundant amounts of this pigment, and easy cultivation. The Cyanobacteria *Spirulina platensis* has a high tolerance towards alkaline Ph, for ease of cultivation; a large size for its cell aggregates for easy harvest; and an easily digested cell wall (Usharani, 2012).

2.2.3 Market prospects

The fluctuating price and the high labor costs made life hard for Indian coconut farmers. Somewhere, along the line, the fresh coconut sap, the Kalparasa, has provided the opportunity for Indian coconut farmers who have a load of price fluctuations and many labor costs (Hebbar, 2015).

Kerala-based company Palakkad Coconut Producers Company Ltd (PCPCL) leads the way in implementing the CPCRI method for sap collection as it becomes the first-to-market entity in the sale of fresh, unfermented coconut sap. The farmers harvest fresh sap, which is then taken to the storage center and then to several kiosks. Here, the fresh sap is sold to the consumers through juice dispensers. Market trends indicate that the Kalparasa is much in demand as a refreshing and an instant, natural drink for thirst quenching (Manikantan, 2015).

With the Kalparasa tapping, not only did the farmers increase their income, but a lot of employment opportunities also found for the youth and the tappers. The change has brought many economic benefits to the local economy and the consumers, who would definitely pave the way to a bright future for the industry (George, 2015).

2.2.4 HEALTH BENEFITS OF SPIRULINA

Research on Spirulina has revealed a wide array of potential health benefits beyond its antioxidant and anti-inflammatory effects. Some of these include: Spirulina, a type of blue-green algae, offers a wide range of potential health benefits. It has been shown to protect the liver and kidneys from damage, improve blood quality, and prevent anaemia. Some studies suggest that Spirulina may also have benefits for diabetes by helping to regulate blood sugar levels (Capelli, 2019). Additionally, Spirulina has been found to lower blood pressure, remove heavy metals from the body, and provide radioprotection against radiation-induced harm. It also shows promise in preventing liver and renal toxicity, boosting the immune system, and relieving allergic reactions. With its strong antioxidant properties, Spirulina is a valuable addition to a healthy lifestyle (Cysewski, 2019).

2.2.5 SPECIES

Various spirulina species are *Spirulina maxima*; *Spirulina platensis*, *Spirulina pacifica* (also known as *Arthrospira platensis*, *Arthrospira maxima*). *Arthrospira platensis* is the predominant species and commercially cultivated worldwide though *Arthrospira maxima* is produced in the South and Central American regions (Thomas, 2010).

2.2.6 INDUSTRIAL CULTIVATION

Microalgae can hardly be harvested from the environment and thus has to be produced in small-scale industrial facilities, or better, large-scale industrial production facilities—recently, offshore production of microalgae has been studied.

Spirulina is not an eukaryotic microalga but a prokaryotic cyanobacteria (Bacteria, Cyanobacteria, Cyanophyceae, Oscillatoriales, Microcoleaceae, *Arthrospira*) (Zurano, 2021). Nevertheless, it has been in a common trend among both the reviewers and other scientists in addressing the extraction of *Spirulina* proteins.

Though *Spirulina* contains high protein content, when used in the production of hydrolysates and bioactive peptides, the extraction of *Spirulina* proteins should first be accomplished to speed up proteolysis and increase the degree of purification of the products (Silvia, 2021).

The need for the disruption step of cell walls is in general mandatory because most microalgal strains contain strong cell walls. Not only with regard to microalgal products in general, but when it comes to food applications, this step will also improve its extractability (Ainoa, 2021).

2.2.7 FUNCTIONAL FOOD

Functional foods are a rather new food category, which promises health benefits after consuming the product that go beyond basic nutrition. The idea for functional foods started in Japan back in 1984 with government-funded research projects that were called “Systematic analyses and development of functional foods.” Since that time, the functional foods market has been growing continuously, and it seems likely that it will continue to grow in the future (Tomas, 2020).

2.2.8 POWDER FORM PIGMENTATION

Arthrospira (*Spirulina*) *platensis* or *A. maxima* most-commonly comprise commercial spirulina powder. Those species, otherwise known as spirulina, are Gram-negative, nontoxic species of cyanobacteria that are, in its broadest sense, utilized either as a dietary supplement or as natural additives. In this aspect, spirulina is just one of the best food and quality drug resource due to its high content of protein, lipids, vitamins, minerals, chlorophyll, β -carotene, and polysaccharides (Park, 2018).

Two distinct natural colors exist, namely carotenoids and C-phycocyanin, which have enabled spirulina use to be in line with consumer awareness regarding the importance of natural color agents for their nutritional, pharmacological, and health-related benefits.

By this measure, the number of applications of natural pigments, especially spirulina as a source of these pigments, is on the increase, especially in the food and cosmetic industries (Kim, 2018).

2.3. AGAR AGAR POWDER

Agar agar powder, a seaweed extract, is your secret weapon for delicious vegan and vegetarian dishes. This natural gelling agent forms strong gels at cool temperatures, thickening soups, sauces, and desserts without altering their flavour. Unlike gelatin, it's completely plant-based, making it a versatile and cruelty-free addition to your kitchen (Najia, 2016).

2.3.1 FOOD GRADE

Agar agar powder is a key ingredient loved for its special way of setting foods. It turns into a gel at about 35°C (95°F) and melts when hotter. This feature is perfect for making jelly, pudding, sweets, and vegan options like fake cheese.

Agar's skill in forming a clear, firm gel is great for making food look good and feel different. Plus, agar is a no-cal choice, doesn't have fat, and fits a vegan diet, making it a hit for those who watch what they eat (Najia, 2016).

2.3.2 INDUSTRIAL USES

In the world beyond cooking, agar agar powder is used in many work areas. In biotech, agar is key in growing tiny life forms and samples because it jells, making a firm space for cells to grow and get checked. Also, agar can soak up water and stay the same for a long time, which helps in making drugs, clothes, and even in teeth care (Rao, 2016).

2.4. FOOD GRADE PRESERVATIVES

2.4.1 CITRIC ACID

Citric acid reigns supreme as the go-to acid in the food world. This molecule, with its three acidic groups, it dissolves easily in water. It's what gives citrus fruits their zing, and food manufacturers love it for that reason. But citric acid is a multi-talented player (Hattori, 2011). Its acidity helps fight off microbes, keeping foods like tomato juice and jams fresher for longer.

It also acts as a behind-the-scenes antioxidant by grabbing metal ions that would otherwise spoil food. So next time you enjoy a refreshing salad dressing or a scoop of sherbet, remember, citric acid might be playing a part in keeping it delicious. (Kirimura, 2011).

2.4.2 POTASSIUM SORBATE

Potassium sorbate, a form of sorbic acid, is a common preservative found in many store-bought foods. Scientists have developed various methods to test for potassium sorbate and other preservatives to ensure food safety and compliance with regulations (Sushanth, 2022). To make food last longer and prevent spoilage from mould, fungus, and other microbes, food manufacturers often add preservatives.

2.4.3 PROPYLENE GLYCOL

Propylene glycol is a synthetic food additive belonging to the same chemical group as alcohol and is a colorless, odorless syrupy liquid that is denser than water and leaves almost no taste in it (Wei, 2018). It is considered to have greater solubility in most substances than water and is moisturizing, hence it is a good food additive. PG is widely used in all kinds of processed foods and beverages for its functionalities (Zhang, 2018).

While having similar melting points, PG and EG are not interchangeable. Whereas EG is toxic to humans and hence considered unfit for use as a food additive, PG is regarded as safe for consumption. The most common uses of PG, with respect to food products, are related to texture modification, flavour, appearance, and extension of shelf life (Wu, 2018).

These additives are carefully regulated, especially in the European Union. Rules specify which foods they can be used in, how much can be added, and their exact chemical makeup (Salwan, 2022).

CHAPTER 3

AIM AND OBJECTIVE

3.1. AIM

The aim of this thesis is to develop and optimize a unique gummy product that combines novel and traditional foods, specifically spirulina and coconut inflorescence sap. This includes the formulation and standardization of the gummies, sensory evaluation to assess consumer appeal, analysis of their nutritive value, and the implementation of innovative packaging and marketing strategies to enhance product quality and marketability.

3.2.OBJECTIVE

1. New and Old Foods (Spirulina and Coconut Inflorescence Sap):

- This objective seeks to study new and old foods like spirulina and coconut inflorescence sap used in the preparation of gummies. Spirulina, for its rich nutrient content, and coconut inflorescence sap, a natural sweetener, could be combined to make a unique product very rich in health but also pleasing to the taste buds.

2. Standardization of Gummies Incorporating Coconut Sap and Spirulina:

- This objective focuses on the standardization of the formulation of gummies incorporating coconut sap and spirulina, including the best ingredient ratio and the appropriate processing method that would result in the desired texture, taste, and nutritional value, but with the same consistency across different batches.

3. Sensory Evaluation :

- Objective 3 focuses on determining the acceptability and liking of the gummies, through the conduct of sensory evaluation among a sample of 100 people. They were asked to rate the taste, texture, and overall liking and hence the product received the desired feedback for further improvement.

4. Nutritional Value Analysis of Gummies and Coconut Inflorescence Sap:

- This objective focuses on the analysis of the nutritional value of the prepared gummies and the coconut inflorescence sap to determine the presence and levels of essential nutrients such as vitamins, minerals, proteins, and sugars. It provides insights into the health benefits of the product and gives support to the nutritional labelling and marketing claims.

5. Innovative Packaging and Marketing of the Gummies:

Objective This level aims at developing effective packaging and marketing strategies for the gummies. Such measures may bring into play innovative packaging to enhance the shelf life and appeal of the product; marketing strategies can be focused on the health benefits and unique ingredients to attract consumers interested in natural and nutritious snacks.

CHAPTER 4

MATERIALS AND METHODS

4.1 MATERIALS

The methodology section introduces the formulation and standardization procedures employed for the production of the gummies.

4.1.1 MATERIALS USED:

Agar Agar, Xanthum Gum, Water, Sugar, Propylene glycol, Coconut inflorescence sap, Spirulina, Lemon juice, Sorbitol, Citric acid and Potassium sorbate.

4.2 METHODOLOGY

4.2.1 PRE-PREPARATION:

Three solutions were prepared:

Solution 1, containing Agar Agar, xanthan gum, and Lemon juice

Solution 2, composed of water, sugar, and propylene glycol and

Solution 3, a mixture of coconut inflorescence sap, spirulina, sorbitol, citric acid, and potassium sorbate.

4.2.2. PREPARATION:

First, Solution 1 is prepared by combining agar agar powder, grams of sugar, and lemon juice that has been diluted. Additionally, propylene glycol is mixed into Solution 1.

Meanwhile, Solution 2 is created with a mixture of coconut inflorescence sap, spirulina, citric acid, and potassium sorbate.

To prepare the gummies, Solution 1 is heated for 3 minutes. Just before turning off the heat, Solution 2 is introduced and thoroughly mixed into Solution 1. This ensures that all ingredients are evenly distributed throughout the mixture.

Once the solutions are combined, the resulting mixture is poured into gummy molds and left to set for approximately 1 hour at room temperature. After this initial setting period, the molds are transferred to a refrigerator and left to chill for 24 hours.

Following the refrigeration process, the gummies are fully prepared and ready to be enjoyed. This method ensures that the gummies have the proper consistency and flavor, making them a delicious and satisfying treat.

The addition of Lemon flavor further enhances the taste profile, providing a refreshing and citrusy element to the coconut inflorescence sap and spirulina-infused health gummies. This combination not only offers potential health benefits but also a delightful sensory experience for consumers.

4.3 FORMULATION

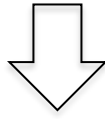
Materials used	Formulation 1	Formulation 2	Formulation 3	Formulation 4
Coconut Inflorescence sap	30 ml	30 ml	30 ml	30 ml
Spirulina	1.5g	1g	0.75g	0.5 g
Lemon Juice	20ml	20ml	20ml	20ml
Sorbitol	10ml	10ml	10ml	10ml
Agar Agar	3g	3g	3g	3g
Sugar	180g	150g	120g	90g

Table 4.3.1-Representation of formulations

Propylene glycol is added as binder and citric acid, potassium sorbate, are added as preservatives. The fourth formulation, which utilizes 30ml of Coconut nectar, 0.5g of Spirulina, 0.5g of Citric Acid, 0.5ml of Propylene Glycol, 20ml of lemon juice, 0.5g potassium sorbate, 10ml of sorbitol, 3g of 3g of Agar Agar, and 90g of Sugar, was selected for preparation due to the optimal consistency of the resulting gummies.

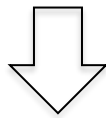
FLOW CHART OF GUMMIES PREPARATION

Solution 1 is heated

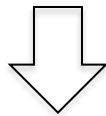


Prepare Solution 2

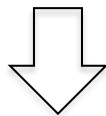
- Mix coconut nectar, spirulina, citric acid, and potassium sorbate



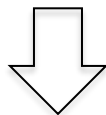
Combine Solution 1,2 and mix thoroughly



Pour the mixed solution into Molds



Allow the mixture to set for 1 hour at room temperature



Refrigerate the filled Molds for 24 hours

Table 4.3.2-Representation of gummies preparation

4.4 QUALITY ANALYSIS:

This study delves into consumer perception of gummy candies through sensory evaluation with a diverse group of 100 participants. By analysing their feedback on factors like appearance, texture flavour, aroma and mouthfeel, this research aims to identify the ideal gummy characteristics across different age demographics.

CATEGORIES	MEAN $\pm$ STANDARD DEVIATION
APPERANCE	7.68 $\pm$ 1.32
TEXTURE	7.41 $\pm$ 1.55
FLAVOUR	7.42 $\pm$ 1.51
AROMA	6.86 $\pm$ 1.67
MOUTHFEEL	7.28 $\pm$ 1.60

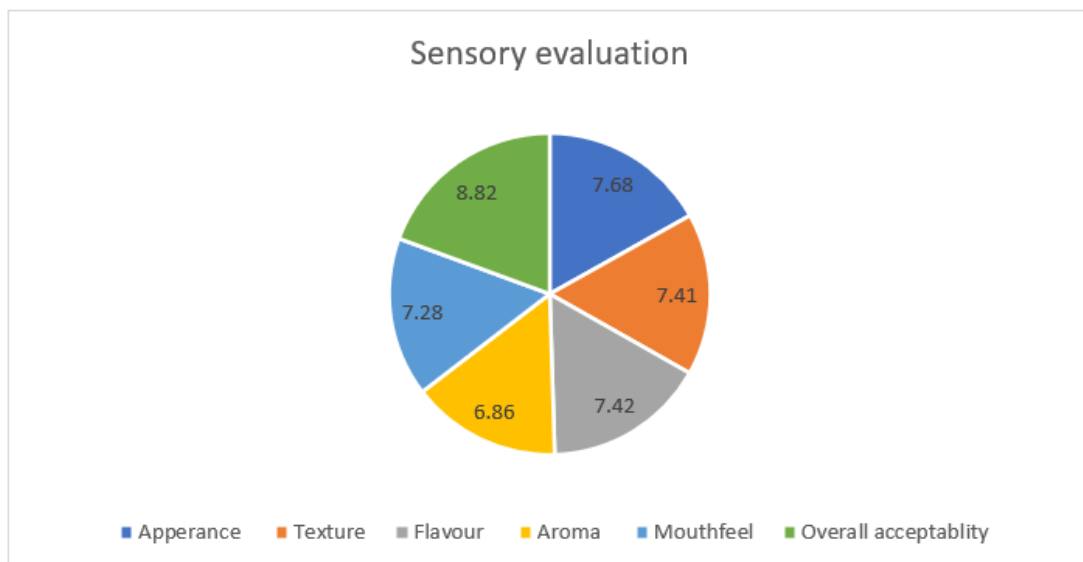


Fig.4.4.1 - representation of sensory evaluation

4.5 QUESTIONNAIRE

1. Appearance

RATING RANGE (1-10)	NO. OF RESPONSES
1-5	2
6-10	98

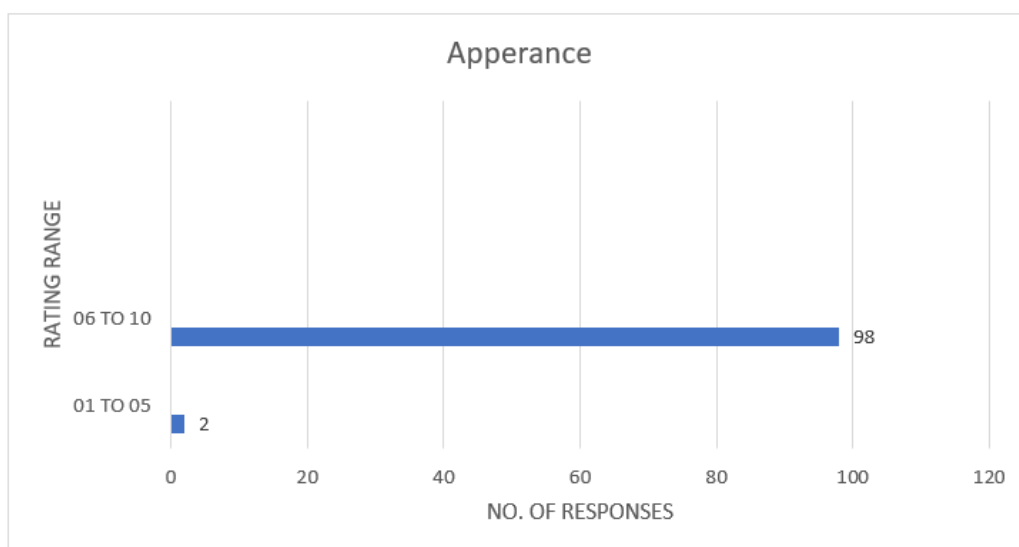


Fig. 4.4.2- representation of appearance

2.Texture

RANGE OF RATING (1-10)	NO. OF RESPONSES
1-5	0
6-10	100

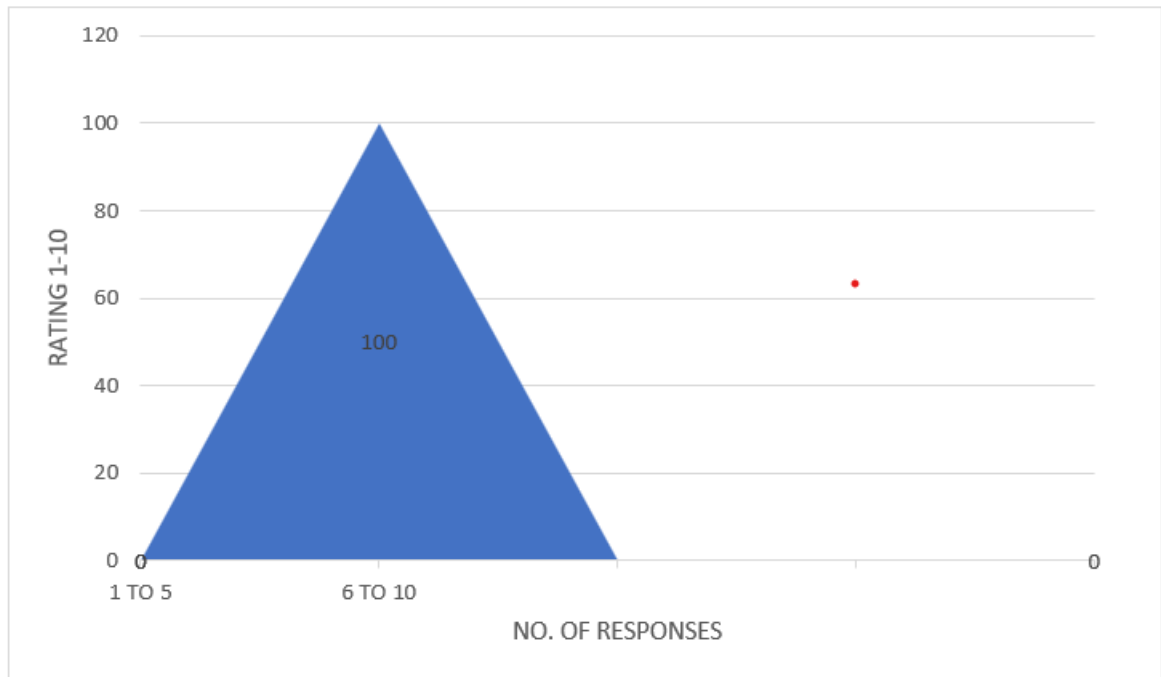


Fig. 4.4.3 - representation of texture

3. Flavour

RANGE OF RATING (1-10)	NO. OF RESPONSES
1-5	5
6-10	95

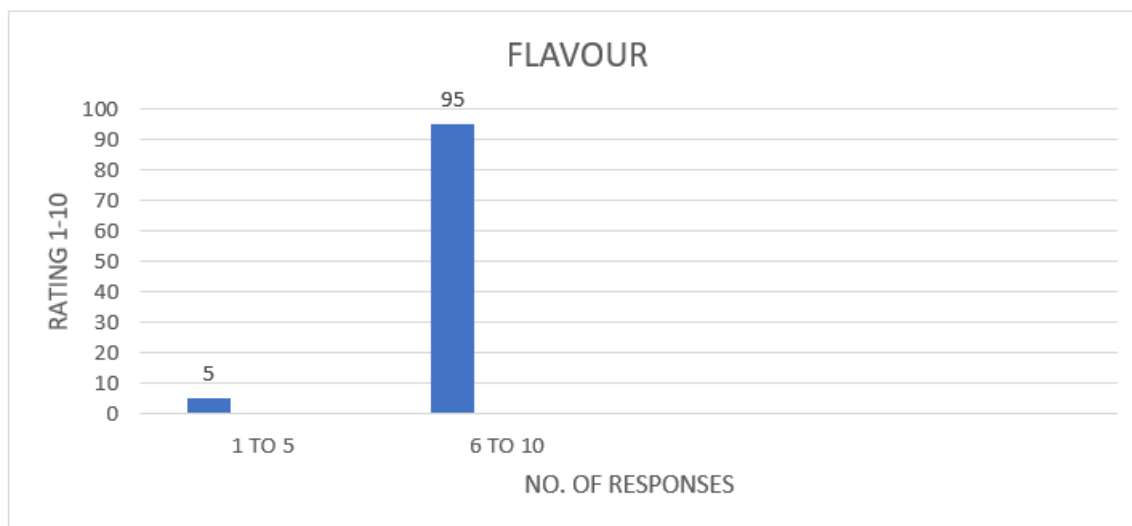


Fig.4.4.4- representation of flavour

4. Aroma

RANGE OF RATING (1-10)	NO. OF RESPONSES
1-5	15
6-10	85

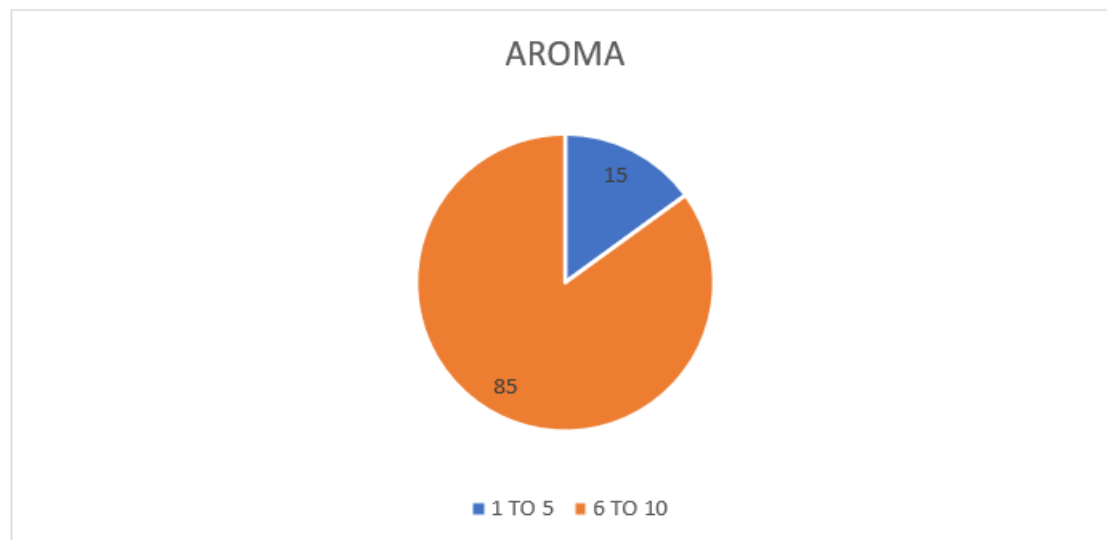


Fig. 4.4.5- representation of aroma

5. Mouthfeel

RANGE OF RATING (1-10)	NO. OF RESPONSES
1-5	2
6-10	98

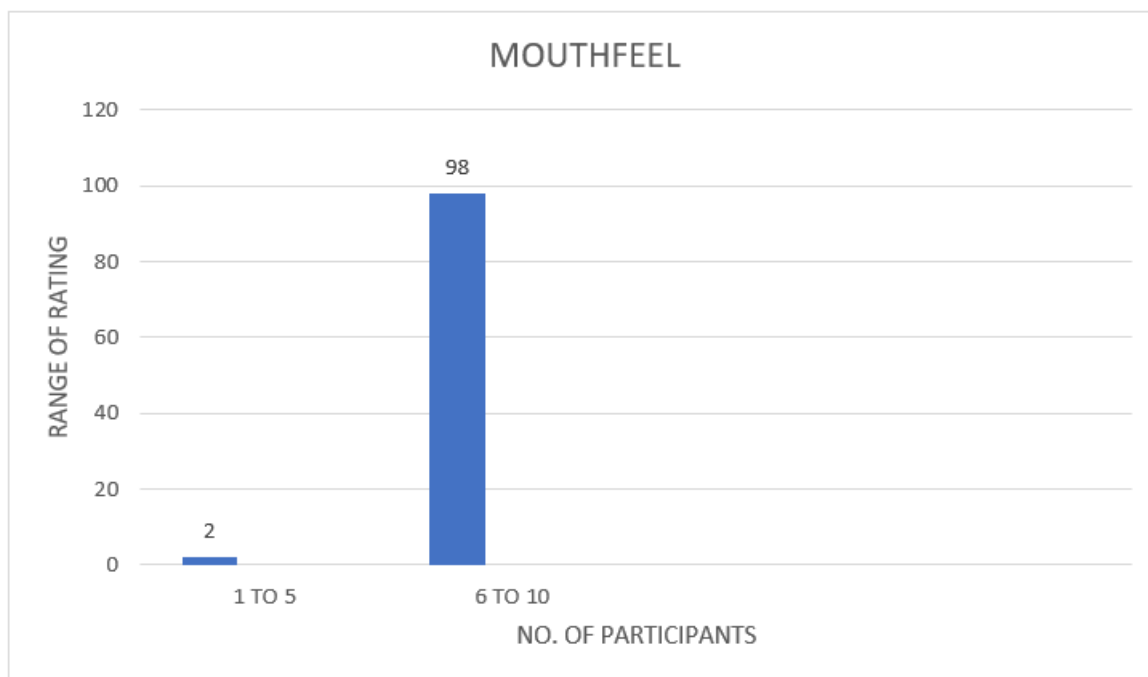


Fig . 4.4.6 - representation of mouthfeel

6. Overall acceptability

RANGE OF RATING (1-10)	NO. OF RESPONSES
1-5	0
6-10	100

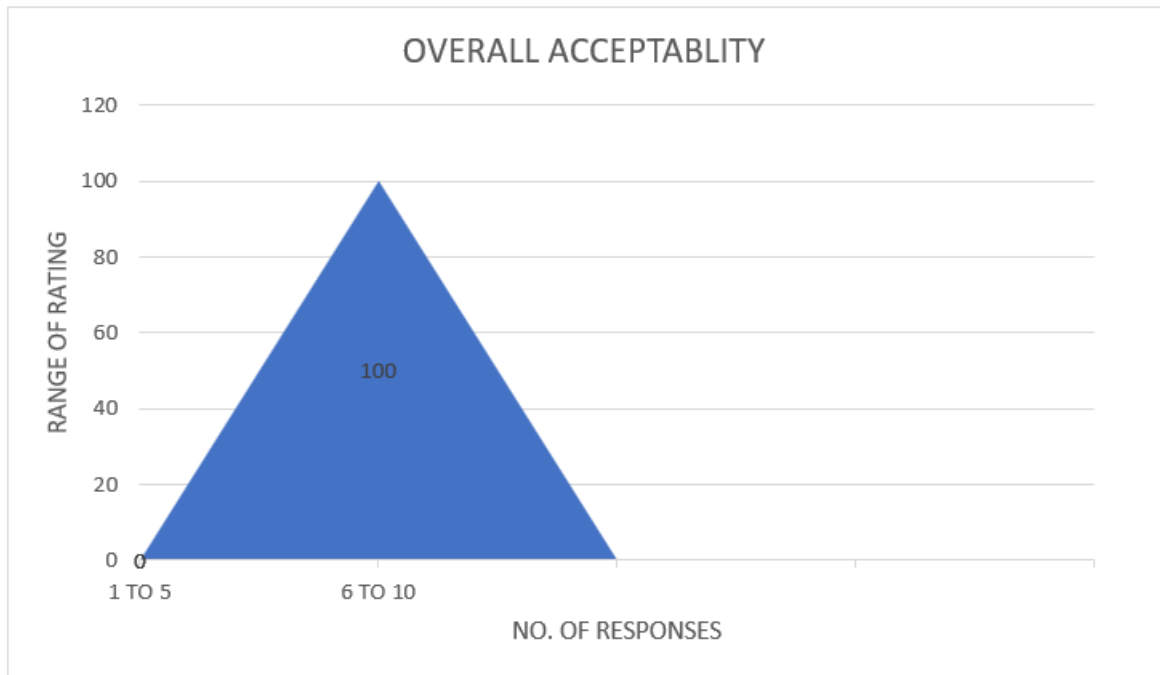


Fig. 4.4.7- representation of overall acceptability

CHAPTER 5

RESULTS AND DISCUSSION

5.1 FORMULATION

The formulated spirulina and coconut-infused gummies have been successfully prepared using the described methodology and ingredients.

5.2 Taste and Texture

The gummies exhibit a delightful combination of flavours, with the refreshing citrusy note from the lemon juice complementing the sweetness of the coconut inflorescence sap. The agar agar contribute to the gummies' firm yet chewy texture, providing a satisfying mouthfeel.

5.3 Nutritional Benefits

These gummies are not just tasty treats; they are also packed with nutritional benefits. The coconut inflorescence sap provides essential minerals, vitamins, and glucamic acid, which promote healthy digestion. Spirulina, known for its superfood status, offers a wealth of nutrients, including protein, vitamins, essential fatty acids, and antioxidants. This combination makes the gummies a nutritious snack option.

5.4 Preservation

The addition of citric acid and potassium sorbate serves dual purposes. Citric acid not only enhances the flavour profile but also acts as an antioxidant, helping to preserve the gummies by preventing oxidation. Potassium sorbate is a common food preservative that inhibits the growth of molds and yeast, extending the shelf life of the gummies.

5.5 Consistency and Flavour

The selected formulation, includes Coconut Inflorescence sap, Spirulina, Citric Acid, Propylene Glycol, lemon juice, potassium sorbate, sorbitol, Agar Agar, and Sugar, has resulted in gummies with optimal consistency and flavor. This formulation strikes a balance between the sweetness of the sugar, the tanginess of the lemon juice, and the earthy notes of spirulina.

5.6 Consumer Appeal

With the rising demand for functional foods and plant-based snacks, these spirulina and coconut-infused gummies cater to health-conscious consumers. The natural ingredients, vegan-friendly formulation, and potential health benefits make them an attractive option for those seeking nutritious and delicious snacks.

Sensory Experience

Beyond the nutritional aspects, these gummies offer a delightful sensory experience. The combination of flavours and textures, from the chewiness of the gummies to the burst of lemony freshness, provides a satisfying treat for consumers of all ages.



Fig.5.1.1-Representation of final gummy product

Summary and Conclusion

The formulated spirulina and coconut-infused gummies represent an innovative and healthy snack option that merges old and new foods, such as spirulina and coconut inflorescence sap. This unique combination of flavors and textures appeals to health-conscious consumers, offering a vegan-friendly and plant-based formulation that includes natural ingredients like coconut inflorescence sap, spirulina, lemon juice, and agar agar. These ingredients provide essential nutrients and health benefits, making the gummies a nutritious and appealing snack. The preparation methodology results in gummies with a refreshing citrus flavor from lemon juice, sweetness from coconut inflorescence sap, and an earthy undertone from spirulina. The use of agar agar ensures the gummies have a firm yet chewy texture, enhancing the overall sensory experience for consumers.

The addition of citric acid and potassium sorbate acts as a preservative, extending the shelf life of the gummies and preventing oxidation. The gummies strike a balance between taste and nutrition, offering essential minerals, vitamins, and glucamic acid from coconut inflorescence sap, as well as protein, vitamins, essential fatty acids, and antioxidants from spirulina. This combination makes the gummies a nutritious snack option and a convenient way to incorporate superfoods like spirulina into one's diet. Sensory evaluation among 100 participants rated the gummies positively for taste, texture, and overall satisfaction, providing valuable feedback for further product improvements. These gummies cater to the growing demand for functional foods and plant-based snacks, making them a valuable addition to the functional foods market. Nutritional value analysis of the gummies and coconut inflorescence sap revealed essential nutrients such as vitamins, minerals, and sugars, supporting the nutritional labeling and marketing claims.

Effective packaging and marketing strategies, focused on the health benefits and unique ingredients, are essential to enhance the shelf life and appeal of the product. This approach can attract consumers interested in natural and nutritious snacks. In conclusion, the spirulina and coconut-infused gummies successfully fuse health and taste, offering an enjoyable sensory experience with their chewy texture and delightful flavor profile. They provide essential nutrients and antioxidants, making them a nutritious and convenient snack option for health-conscious consumers. The standardization of the formulation ensures consistent quality across different batches, and the inclusion of natural preservatives helps maintain product freshness and safety.

Sensory evaluation indicates that the gummies are well-received by consumers, offering valuable insights for further enhancements. Overall, the spirulina and coconut-infused gummies offer a win-win solution for consumers seeking a guilt-free indulgence that contributes to overall well-being. The combination of innovative formulation, standardization, and consumer appeal positions these gummies as a valuable addition to the functional foods market. With the right packaging and marketing strategies, the product has the potential to achieve significant success and widespread adoption.

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