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DEVELOPMENT AND EVALUATION OF HERBAL-ENRICHED NUTRACEUTICAL GUMMIES FOR GERIATRIC HEALTH

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Keywords:

Elettaria cardamomum (elaichi), fennel seeds(sauf), *Zingiber officinale* (ginger), Bagasse, Herbal Gummies

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ABSTRACT

The growing emphasis on holistic health and preventive nutrition has driven interest in innovative nutraceutical formulations suitable for younger populations. Herbal-enriched nutraceutical gummies have emerged as an effective, palatable, and user-friendly medium for delivering health-promoting bioactive compounds. This review explores the development and evaluation of herbal-based gummy supplements aimed at supporting "Geriatric" health—interpreted as a broad focus on child to adolescent well-being. Key medicinal herbs such as *Elettaria cardamomum* (Elaichi), Fennel Seeds (Sauf), and Gingiber officinale (Ginger), Bagasse are highlighted for their roles in enhancing immunity, supporting cognitive development, and improving metabolic balance.Strategies including the choice of gelling agents, natural sweeteners, and taste-masking techniques to ensure compliance and acceptability. Evaluation parameters such as ph, Swelling ratio, Disintegration, texture, shelf-life, and safety are critically assessed. The article also addresses regulatory perspectives and future directions in the functional food sector, positioning herbal gummies as a promising approach to promote health in the younger demographic through nutraceutical innovation.

INTRODUCTION

The body is protected from infection by the structures, biochemical processes, and mediators that make up the immune system. Pre-existing immune responses to infection that have developed to identify pathogens and safeguard children are referred to as innate immunity. On the other hand, acquired immunity is unique to each foreign agent and occurs later, following exposure. The main components of innate immunity are various plasma proteins, phagocytic cells, dendritic cells, Natural Killer (NK) cells, and epithelial barriers. Nutraceuticals, which are bioactive compounds derived from edible sources, possess therapeutic properties that can modulate the immune system. These nutraceuticals have shown immunity-boosting effects, including active modulation and antiviral, antibacterial, and antifungal properties. Additionally, nutraceuticals can support the mental and physical development and well-being of toddlers. The preparation of the gummy formulation involves using several key tools and equipment to ensure precision and quality. Essential instruments include spatulas, 100 mL and 50 mL beakers, and measuring cylinders, which are crucial for accurate measurement and handling of ingredients. A weighing balance is used to precisely weigh the raw materials, ensuring the correct proportions are used. A muffle-equipped dissolution apparatus is also employed to thoroughly dissolve and blend the ingredients, achieving a uniform mixture essential for the consistency and effectiveness of the final gummy product. These tools and equipment facilitate a controlled and efficient production process, ensuring the formulation meets the desired specifications and quality standards. This methodical approach underscores the importance of precision and accuracy in creating a consistent and high-quality gummy formulation.[1]

Elettaria cardamomum:

Elettaria cardamomum, both small and large varieties, boasts an array of therapeutic properties that have been recognized for centuries. Small cardamom is renowned for its efficacy in treating gum and throat infections, as well as reducing inflammation in the lungs, alleviating symptoms of pulmonary tuberculosis, and aiding in digestive disorders. Studies have demonstrated that ethanolic aqueous extracts of cardamom possess anti-inflammatory effects, particularly against conditions like paw edema induced by carrageenan in rats. Remarkably, research indicates that *Elettaria cardamomum* may serve as an antidote against venomous snake and scorpion bites, showcasing its potential in emergency medical scenarios. Furthermore, large cardamom is valued for its ability to address gastrointestinal issues due to its cooling properties. Methanolic extracts of cardamom seeds have exhibited analgesic effects, offering relief from pain. In addition to its analgesic properties, cardamom (*Elettaria cardamomum*) has been investigated for its potential as an antidepressant, with ongoing studies evaluating its efficacy in the marble burying test for rats, which assesses antidepressant activity. Moreover, cardamom oil is recognized for its digestive benefits and laxative properties, aiding in the relief of colic and soothing gastrointestinal discomfort. *Elettaria cardamomum* 's sweet flavour isn't just for culinary use-it also harbors carminative properties that support gastrointestinal health, helping to alleviate issues such as diarrhea induced by castor oil and magnesium sulphate. In hot water extracts, cardamom fruit demonstrates its effectiveness in addressing gastrointestinal problems, highlighting its versatile and holistic therapeutic potential.[2]

Fennel seed:

The pharmacological properties of greater Fennel Seeds included pulmonary antiseptic, neuromuscular antispasmodic, aphrodisiac, expectorant, anthelminthic, antibacterial (varying), cephalic, cardiotonic, diuretic, emmenagogue, sialagogue, and stomachic effects. The little cardamom pod is used to relieve gum and throat infections, as well as lung inflammation, pulmonary TB, and digestive disorders. Rats with paw edema caused by carrageenan showed an anti-inflammatory response to a cardamom extract in an ethanolic aqueous media. As an Antidote, certain studies have indicated that it is also efficacious against the venom of snakes and scorpions. anti-ulcerogenic Additionally, the huge cardamom is used to treat gastrointestinal disorders. The analgesic effect of cardamom seed methanolic extract is due to its cooling impact. For the gummy base, unflavored gelatin is commonly used, although vegan alternatives like agar-agar or pectin can be substituted. The fennel tea is gently heated with a sweetener such as honey or sugar and optionally enhanced with lemon juice or citric acid to balance flavor and aid in preservation. Bloomed gelatin is then added to the warm mixture and stirred until fully dissolved. Once combined, the liquid is poured into silicone molds and refrigerated until set, usually within a couple of hours. These gummies can be stored in the refrigerator in an airtight container and are best consumed within 7 to 10 days.Nutritionally, a small serving of fennel gummies (around three pieces) contains about 20 to 30 calories, primarily from the sweetener, and provides a modest amount of protein from the gelatin.[3]

***Zingiber officinale*:**

Zingiber officinale, a spice and medicinal herb that is widely used worldwide, is the root of the *Zingiber officinale* roscoe plant, which is a member of the Zingiberaceae family. Primary pharmacological properties of *Zingiber officinale* and the chemicals derived from it include anti- inflammatory, anti-tumorigenic, anti-apoptotic, anti-hyperglycaemic, anti-lipidemic, and anti- emetic properties. While *Zingiber officinale* lacks protein and other minerals, it is a great source of antioxidants. For this reason, studies have indicated that *Zingiber officinale* can lessen oxidative stress in a variety of ways. When the body produces an excessive amount of free radicals, oxidative stress results. Free radicals are harmful compounds that are created by several processes in metabolism. *Zingiber officinale* has been shown by researchers to be highly beneficial in preventing the formation of prostate cancer cells.[4]

***Beta vulgaris*:**

Beta vulgaris L., belonging to the Chenopodiaceae family, boasts a vibrant crimson hue. Also referred to as beet, chard, spinach beet, sea beet, garden beet, white beet, and Chukander (in Hindi), beetroot possesses potent therapeutic properties that positively impact human health. The integration of traditional remedies with conventional medicines has been cited in numerous medical treatises for treating various ailments, illnesses, and diseases. *Beta vulgaris* L., a well-known culinary plant, offers significant health benefits due to its rich natural components. It contains antioxidants, vitamins, and minerals that provide essential antidepressant, antibacterial, and anticarcinogenic properties. Furthermore, beetroot pigment is widely used as a culinary dye.[5]

***Apis mellifera*:**

Apis mellifera Linnaeus is a natural product renowned for its medicinal properties. It is reported to contain over 200 chemical

compounds. Primarily composed of fructose and glucose, honey also includes fructo-oligosaccharides, amino acids, nutrients, minerals, and enzymes. Honey exhibits biological activities, including antioxidant properties. Scientists recognize that free radicals can cause molecular changes and gene alterations in a variety of organisms. Oxidative stress is known to contribute to numerous diseases, leading researchers to seek natural sources with active components that can mitigate its effects on cells. Natural honey is rich in flavonoids (such as apigenin, pinocembrin, quercetin, galanin, chrysin, and hesperidin) and phenolic acids These bee-derived substances have been widely incorporated into nutraceutical formulations due to their diverse pharmacological properties. Honey, rich in flavonoids, phenolic acids, and enzymes, exhibits antioxidant, antimicrobial, and anti-inflammatory effects, which are particularly beneficial for the aging population in managing oxidative stress and chronic inflammation. Propolis, a resinous compound collected by bees from plant sources, possesses immunomodulatory and wound-healing properties, while royal jelly has been shown to support cognitive function, reduce fatigue, and improve skin health in elderly individuals.[6]

Bagasse:

Bagasse, the fibrous byproduct of sugarcane processing, has emerged as a valuable ingredient in the formulation of herbal nutraceutical gummies, particularly those targeted toward geriatric health. Rich in insoluble dietary fiber, bagasse supports digestive function by enhancing gut motility and preventing constipation—common issues in older adults. Its prebiotic properties also contribute to the growth of beneficial gut microbiota, thereby improving immunity and nutrient absorption. Furthermore, finely processed bagasse can act as a natural texture enhancer, improving the chewiness and consistency of gummies without the need for synthetic agents. As a functional filler, it can reduce the overall sugar content of the gummies, making them suitable for individuals with dietary restrictions such as diabetes. Bagasse may also serve as an effective carrier for herbal bioactives like turmeric, ashwagandha, or ginger, aiding in their controlled release and stability. In addition, the presence of residual polyphenols and flavonoids in bagasse adds antioxidant potential to the formulation, which can be beneficial in combating age-related oxidative stress. The utilization of bagasse in this context not only adds functional and therapeutic value but also aligns with sustainable and eco-friendly manufacturing practices by promoting the valorization of agricultural waste.[7]

Gelatin:

Gelatine type A, is a powder made from the acidic breakdown of collagen. It also contains a heterogeneous collection of water-soluble proteins with large average molecular weights, such as glycine, proline, and hydroxyproline.Gelatin has been employed in in vitro coated cell culture to increase cell line adhesion. This compound can be employed as a blocking reagent in numerous biological methods, including immunity chemistry, ELISA, and western blotting. Beyond its physical properties, gelatin also has potential health benefits. Being rich in amino acids, particularly glycine and proline, it may support joint health, skin elasticity, and gut function. Recent studies have explored its use in tissue engineering and regenerative medicine, where gelatin-based scaffolds are being investigated for their ability to support cell growth and tissue repair.[8]

MATERIALS AND METHODS

Materials:

The main material used in this study were *Elettaria cardamomum*, Amomum subulatum Roxb, *Zingiber officinale*, *Beta vulgaris* L., *Apis mellifera* Linnaeus, Bagasse), procured from local market Ingredients and passed through a 500-mesh screen after grinding. The other excipients used were pharmaceutical grade or food-grade, namely gelatin, propylene glycol sodium benzoate

Method of preparation of nutraceutical herbal gummies (9-10)

1) Preparation of Plant Extracts:

• *Elettaria cardamomum*: The powdered cardamom seeds were subjected to Soxhlet extraction with ethanol as the solvent. The extraction process was carried out for 6-8 hours, and the extract was then concentrated using a rotary evaporator under reduced pressure to remove the solvent. The concentrated extract was stored at room temperature until use.

• *Zingiber officinale*: The powdered ginger was also subjected to Soxhlet extraction using ethanol as the solvent. After 6-8 hours of extraction, the extract was concentrated using the rotary evaporator and stored in a sealed container.

• Bagasse: Maceration was performed on the powdered bagasse. The powdered material was soaked in distilled water for 24 hours at room temperature. The mixture was then filtered, and the filtrate was concentrated under reduced pressure to remove excess water.

• *Beta vulgaris* (Beetroot): Hot water extraction was employed for *Beta vulgaris*. The powdered beetroot was mixed with boiling distilled water and left to steep for 30 -45 minutes. After filtration, the water extract was concentrated using a rotary evaporator.

2) Gelatin Preparation: A key ingredient in the jelly formulation was gelatin which was used to provide structure and texture to the final product. Gelatin was dissolved in warm distilled water at a concentration of 3% w/v. The solution was gently heated at around 60°C and stirred continuously to ensure complete dissolution of the gelatin granules. Once fully dissolved, the solution was allowed to cool to room temperature, forming a smooth, viscous gel base that would hold the active ingredients and other excipients. The use of gelatin in nutraceutical gummy formulation is crucial, as it not only imparts the desired chewable consistency but also plays a significant role in encapsulating and stabilizing bioactive compounds

3) Preparation of Fennel Seeds and Honey: Fennel seeds (*Foeniculum vulgare*) were powdered using a mortar and pestle. The powdered fennel seeds were then mixed with *Apis mellifera* Linnaeus (honey) in a 1:2 ratio to form a homogenous paste. This blend was added to the gelatin mixture.

4) Formulation of Jelly: The concentrated extracts of *Elettaria cardamomum*, *Zingiber officinale*, Bagasse, and *Beta vulgaris* were added to the prepared gelatin solution. The mixture was stirred thoroughly to ensure uniform dispersion of the herbal extracts. Sodium benzoate was added at a concentration of 0.1% w/v to act as a preservative, and propylene glycol) was incorporated at a concentration of 2% w/v as a humectant to preserve the texture. This combination of functional additives contributed not only to the stability and safety of the product but also to its texture, making the gummies more appealing and easier to chew, especially for younger consumers.

5) Molding and Setting: The herbal gelatin mixture was poured into pre-cleaned molds. The molds were then allowed to cool at room temperature for 1-2 hours. Afterward, the

jellies were refrigerated for 6-8 hours to allow them to set completely. The use of clean, food-grade silicone or plastic molds ensured uniformity in shape and size, which is critical not only for aesthetic appeal but also for dosage accuracy in each gummy unit. Proper sanitation of the molds prior to pouring minimized microbial contamination, preserving the safety and shelf-life of the final product. The gradual cooling process at room temperature helped prevent the formation of air bubbles or surface irregularities, contributing to the visual clarity and smooth texture of the gummies.

6) Packaging: Once set, the jellies were carefully removed from the molds, and stored in airtight containers under refrigerated conditions to maintain freshness and prevent dehydration.

Figures :-

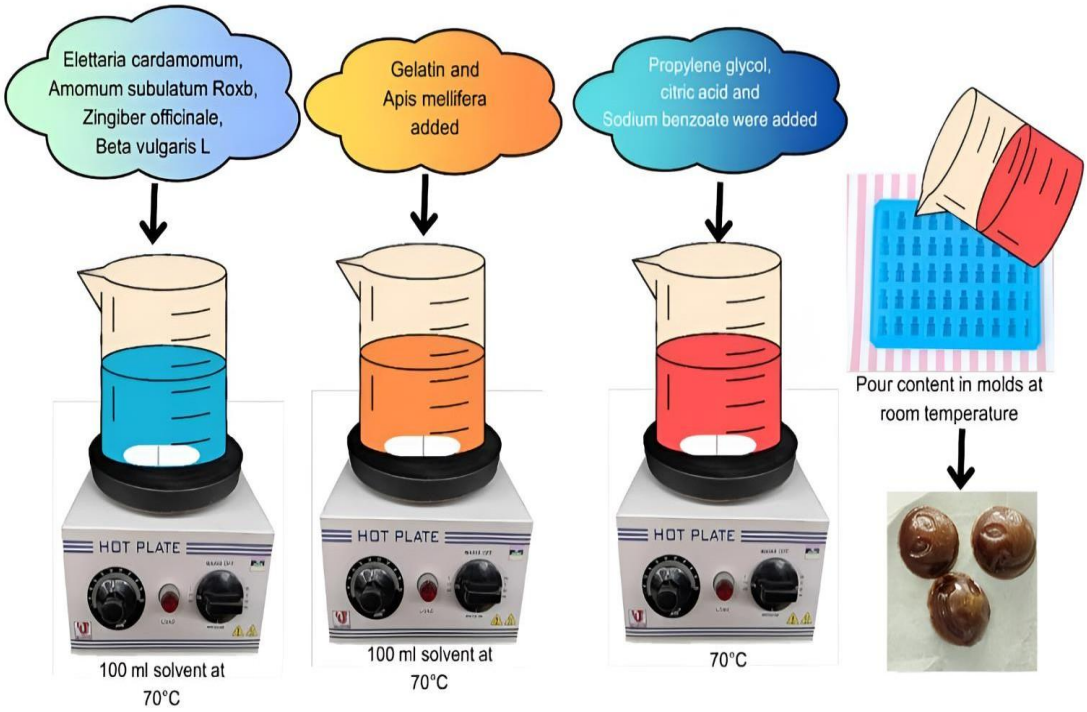

Fig no: 1 Steps to develop neutraceutical herbal gummies

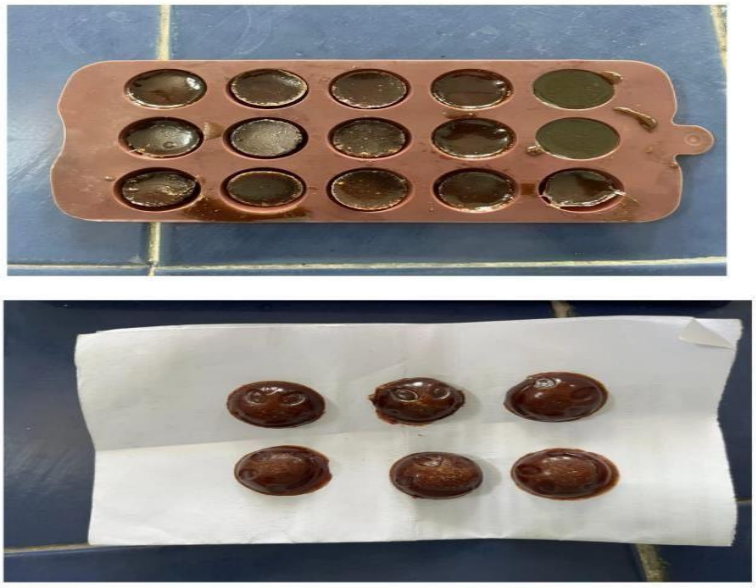

Fig no: 2 Herbal Neutraceuticals Gummies

Tables :-

Table no 1: Formulation design of herbal gummies:

Ingredients	Uses	F1	F2	F3	F4
Beta vulgaris L (g)	Antioxidant and anti-inflammatory activity	10	12	15	17
Zingiber officinale (g)	Antioxidant, anti-inflammatory activity and immunomodulatory activity	3	4.5	5	7
Ellettaria Cardamomum (g)	Antibacterial and anti-inflammatory activities.	1.70	2	2.5	3
Fennel Seed (g)	Antioxidant, cytotoxic activity.	2	3.5	4	5
Apis Millefera Linnaeus (g)	Immunostimulant	3	5	6	8
Bagasse (g)	Dietary Fibre,polyphenols,antioxidant	4	5	6	6
Gelatin (g)	Thixotropic agent	8	10	11	12
Propylene Glycol (%)	Plasticizer	2	3	4	5
Citric Acid (%)	Acidity modifier	1	1	1.5	1.5
Sodium Benzoate (%)	Preservative	0.5	0.5	1	1
Purified Water (ml)	—	100	100	100	100

Table No:2 Determination of herbal gummies

Batch	Parameter	Result
F1	Colour	Reddish Brown
F2	Odour	Crude
F3	Texture	Soft
F4	Consistency	Semisolid

Table no: 3 Solubility Test of herbal gummies

Batch	Solvent	Solubility Behaviour
F1	Water	Sparingly Soluble
F2	Ethanol	Soluble
F3	Ether	Slightly Soluble
F4	0.1N HCL	Easily Soluble

Table no: 4 Swelling ratio of herbal gummies

Batch	Time (hours)	Initial Weight (Wd)	Swollen Weight (Ws)	Swelling Ratio = (Ws-Wd)/Wd	Swelling %
F1	1	2.92	3.45	0.18	18.5%
F2	2	2.92	3.89	0.33	33.22%
F3	3	2.92	4.21	0.44	44.18%
F4	4	2.92	4.45	0.52	52.39%

Table no: 5 Determination of ph value of herbal gummies

Batch	Ph Value
F1	4.2
F2	4.1
F3	4.2
F4	4.3

Table no: 6 Spreadability of herbal gummies

Formulation	Initial area	Spreadability(cm^2)
F1	1.13 cm^2	9.61 cm^2
F2		6.60 cm^2
F3		3.46 cm^2
F4		2.54 cm^2

Table no: 7 Moisture content of herbal gummies

Time	F1	F2	F3	F4
0 min	1.9 gm	2.02gm	2.03gm	2.5gm
5 min	1.6 gm	2 gm	2.5gm	2.6gm
10 min	1.2 gm	1.9 gm	1.8gm	1.0hm
15 min	1.05gm	1.7 gm	2gm	1.9gm
20 min	1.02gm	1.5 gm	1.3gm	1.3gm
25 min	1 gm	1.4 gm	1.5gm	1.2gm
30 min	0.9 gm	1.3 gm	1.2gm	1gm
35 min	0.9 gm	1.3 gm	0.8gm	1gm

Table no: 8 Weight variation of herbal gummies

Formulation code	Average weight
F1	1.9
F2	2.02
F3	2.07
F4	2.1

Table no:9 Disintegration Time of Gummies in Purified Water

Batch	Gummy	Room Temperature (°C)	Disintegration Time (Minutes)	e Monitoring Method
F1	Gummy 1	37°C	10	Chronometer
F2	Gummy 2	37°C	12	Chronometer
F3	Gummy 3	37°C	11	Chronometer
F4	Gummy 4	37°C	15	Chronometer

RESULTS AND DISCUSSION

EVALUATION OF HERBAL GUMMIES

1) Determination of physical appearance: Inspection was conducted on all produced gummies to assess their appearance, including colour, transparency, homogeneity, and uniformity. By gently rubbing the prepared jelly between the thumb and index fingers, grittiness and stickiness were assessed.

2) Solubility Test: Solubility was obtained by adding the solute in a small amount to a fixed volume of solvents like water, ethanol, ether, and 0.1 N HCl during the pre-formulation solubility analysis.

3) Swelling ratio: By calculating gummy's starting weight, the development index was calculated. The amount of liquid in the gummy structure that can be absorbed is determined by the swelling index. Next, at a regulated room temperature of 25°C to 30°C, gummy mixture was immersed in 100 milliliters of filtered water for 10 sec. Following soaking, a chewable gummy is taken out and cleaned with filter paper to remove any remaining water that may have stuck to the gummy's surface Determination of ph value·

4) Determination of ph value: To evaluate the acidity or alkalinity of the jelly samples, a digital pH meter (Hanna Instrument) was employed. A total of four replicates were conducted to ensure

accuracy and reproducibility of the results. Prior to measurement, the pH meter was calibrated using standard buffer solutions (pH 4.0, 7.0, and 10.0) in accordance with the manufacturer's guidelines. The electrode was thoroughly rinsed with distilled water between measurements to avoid cross-contamination.

Ws=weight of chewable gummy after soaking. Wd=weight of chewable gummy before soaking

5) Spredability: The spreadability of jelly was tested by placing it between two slides with a 1000 g weight and pressing it for 5 minutes to a consistent The spreading area of the jelly was then estimated using the equation , which is represented as the area of a circle.in addition to measuring the spread area, various factors such as the viscosity, temperature, and composition of the jelly were considered, as they could all influence the spreadability. The jelly's ability to spread evenly was important in determining its quality for various uses, such as in food products where smooth application is necessary.

6) Moisture content: The moisture content was determined by drying finely grounded samples (10 g) in a hot air oven at 105 °C until a constant weight was achieved.

7) Weight variation: The jellies were removed from the moulds and weighed. The observed data was reported as mean standard deviation (SD), with the average weight of 10 jellies being used as the reference point.

8) Stability study: The gummy preparation was found to be stable throughout the 4-week study at room temperature and at 4°C. No significant changes in texture, color, or consistency were observed during this period, indicating that the formulation was resilient under the tested storage conditions. This stability suggests that the gummy product has good potential for maintaining its quality over extended periods, which is crucial for consumer satisfaction and product shelf life to further assess the stability, additional tests could be conducted to evaluate the effects of various environmental factors such as humidity and light exposure. Monitoring microbial growth and changes in pH over time would also be beneficial to ensure the product remains safe and effective. These factors would provide a more comprehensive understanding of the gummy's long-term stability and its ability to maintain its intended properties under different conditions.

9) Disintegration Time: Evaluation of disintegration time was used to predict the speed of disintegration of gummies in aqueous media while ensuring the release of the active ingredients from the gel matrix. The disintegration test was performed using a magnetic stirrer in a flask with 50 mL of purified water at 37°C. The chronometer was used to monitor the dissolving process and determine the dissolution time. The experiment was carried out with gummy bears that had been maintained at room temperature.

Result

As seen in Figure 2, manufactured gummies were 2 cm long, reddish brown in colour, and scented well The sensory assessment of the gummy formulations indicated that F1 exhibited an optimal texture, characterized by a smooth, non-sticky feel, making it suitable for further evaluation and testing. In contrast, F2,F3,F4 displayed unwanted clumping, which negatively impacted the uniformity and usability of the product. This issue may have arisen from an imbalance in the ingredient composition or inadequate incorporation of the plasticizer.[24-25] As a result, formulation F2,F2,F3,F3was excluded from further testing to prevent any adverse effects on the overall product quality. The viscosity and flow

characteristics of the gummy mixture were also taken into account during the development phase. By adjusting the proportions of gelatin, gelling agents, and plasticizers, the final product achieved the desired combination of elasticity and chewiness The incorporation of plasticizers such as glycerol and sorbitol reduced the gummies' hardness, while simultaneously enhancing their chewability and texture.

Discussion

The additives which has been used during experiment were essential for improving the overall sensory experience of the gummies, making them more enjoyable for consumers. Because citric acid was used as a pH modifier to improve the gelling power of the gelatin, this is regarded as somewhat acidic. The capacity of the nutraceutical gummy to expand in water was assessed using the swelling index. Gummy disintegration time and syneresis parameter are linked to the swelling index. By forming a barrier to prevent water loss from the chewable gummy structure, the plasticizer can affect the bonding microstructure of the gelling agent. By doing this, the texture of the chewable gummy remains unchanged from when it was initially kept. Because sucrose at the prepared pH immobilizes free water, an increase in propylene glycol reduces the syneresis potency. However, formula (F2),(F3),(F4) demonstrated syneresis; hence, it was not included in the analysis. In about 7 to 8 min, gummies broke down in cleaned water. The more rapidly the gummy dissolves in the medium, the faster the medication releases. Numerous factors, including as content, size, and ambient temperature, can affect how quickly gummies dissolve. Generally gummies disintegrate relatively slowly compared to other types of candies due to their gel- like consistency In a typical scenario where a gummy is placed in the mouth, it starts to dissolve as saliva breaks down the gelatin and other ingredients. The rate of dissolution can be influenced by factors such as temperature, pH of saliva, and the presence of enzymes in saliva that can break down the gummy material Humans require a variety of elements and minerals, many of which are derived from plant sources. For this reason, it is essential to determine whether kinds of plant materials meant for human consumption contain adulterants, residuals, and crude materials. The human body needs both organic and inorganic materials to function properly. Our diet primarily consists of proteins, carbohydrates, and fats, along with essential vitamins and minerals The quality of our food depends on the types and amounts of organic and inorganic substances and minerals it contains. These nutrients are vital for preventing diseases, coping with environmental pollutants, and enhancing our ability to work, contributing to a healthy diet (e.g., phosphorus, calcium, sodium, potassium). However, some elements can be toxic or harmful (e.g., mercury, lead, aluminum, cadmium). Minerals are widely used to address various health problems. Depending on the age and treatment of the plant, there may be differences in the kind and amount of ash that remains after plant extracts are burned The inorganic part of the plant is represented by its ash content, which varies over time and among different plant organs. Calculating the ash value for inorganic solutes is important for materials used in medical applications. Plant ash is used in several herbal remedies because inorganic salts, unlike organic plant components, are often essential in medicine. Results indicates that adulteration of raw ingredients by substances. An interesting characteristic of ash is its varying solubility in different solvents. Therefore, this study evaluated the solubility of ash in both water and hydrochloric acid.

Conclusion

The development of gummies represents a significant advancement in the nutraceutical and pharmaceutical industries. Their increasing popularity demonstrates their appeal and effectiveness as a delivery vehicle for vitamins, minerals, and other supplements. Gummies are a pleasurable and handy alternative to traditional supplement forms such as tablets and capsules, which some people find difficult to swallow. Creating high-quality gummy formulations is a rigorous procedure that requires carefully acquiring fresh ingredients from reputable local markets. Precise measurement and thorough blending are required, with specialist equipment such as dissolving machines and pH meters. These tools ensure that the combination is homogenous and the pH levels are minimax suitable, which improves the overall quality and stability of gummies. Quality control procedures must be strictly enforced throughout the manufacturing process. Monitoring the physical qualities, such as hardness, gumminess, and chewiness, maintains consistency between batches. Furthermore, preventing syneresis during storage is critical for preserving product quality over time.Ultimately, a high-quality product that meets consumer expectations is produced through the laborious process of creating gummy formulations, which includes precise measurement, ingredient procurement, and quality control. Gummies boost their standing in the supplement industry by offering a convenient and tasty way to ingest nutrients and supplements, in addition to being an efficient means of delivering these products to consumers. Recent innovations have further expanded the functional capabilities of gummies, including the incorporation of novel bioactive compounds like adaptogens, probiotics, and cannabinoids. With consumer preferences shifting toward plant-based, allergen-free, and low-sugar options, manufacturers are increasingly exploring alternative gelling agents such as agar-agar and pectin, and sugar substitutes like stevia and erythritol. Such developments align with current trends in personalized nutrition and clean- label products, enhancing the appeal of gummies in both developed and emerging markets. From a regulatory perspective, gummy supplements must adhere to stringent quality standards to ensure dosage accuracy, stability, and safety. Standardized testing protocols, proper labeling, and adherence to Good Manufacturing Practices (GMP) are essential to gain consumer trust and market authorization. Additionally, as the global nutraceutical market continues to grow, cross-border regulations and harmonization of standards will play a crucial role in supporting the international distribution and commercialization of gummy-based supplements.

Future Scope

The development of herbal enriched nutraceutical gummies for Geriatric health represents a significant advancement in the field of functional foods and preventive healthcare. With the aging global population, there is a rising need for easily consumable supplements that address common health issues in the elderly such as digestive discomfort, reduced immunity, inflammation, and fatigue. The inclusion of traditional herbs like cardamom, ginger, fennel seeds, and beetroot not only enhances the nutritional profile of the gummies but also introduces phytochemical constituents that offer therapeutic benefits. These botanicals are known to aid in gastrointestinal health, regulate blood pressure, improve circulation, and reduce oxidative stress—making them

particularly beneficial for elderly individuals who often struggle with polypharmacy and poor nutrient absorption. Moreover, the formulation's use of natural sweeteners like honey and functional biopolymers such as gelatin provides a platform for the creation of texture-optimized, easily chewable products suitable for those with dental or swallowing difficulties. The addition of bagasse, a byproduct of sugarcane, presents a novel opportunity for utilizing agricultural waste in value-added food products. Future studies may explore its fiber content, prebiotic potential, and role in enhancing satiety or digestive efficiency in older adults. There is also potential for the gummies to serve as carriers for probiotics, vitamins, or even adaptogens, creating multifunctional delivery systems tailored to the complex nutritional demands of aging individuals. Further innovation may include personalization through nutrient profiling and AI- driven health analytics, allowing for targeted nutraceutical solutions based on individual health markers. Additionally, as the demand for natural and sustainable health products continues to rise, these herbal gummies could capture a strong position in both domestic and international wellness markets. Regulatory approvals, clinical trials, and consumer sensory evaluations will further validate the health claims and market potential of such formulations. With ongoing advancements in food technology and plant-based nutraceuticals, this line of products holds great promise for transforming the landscape of Geriatric nutrition.

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