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Formulation and Evaluation of Vitamin C Gummies from Starfruit

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Abstract:
The present study focuses on the formulation and evaluation of vitamin C enriched gummies prepared using starfruit (Averrhoa carambola), a natural and rich source of ascorbic acid. The objective was to develop a palatable, nutritional beneficial and consumer-friendly dosage form as an alternative to conventional vitamin supplements. Fresh starfruit extract was incorporated into gummy formulations using suitable gelling agents such as gelatin or agar-agar, along with sweeteners to improve taste and acceptability.
The formulated gummies were evaluated for various physicochemical and quality parameters, including appearance, texture, PH, weight variation and stability. Vitamin C content was estimated using standard analytical methods to ensure nutritional adequacy. Sensory evaluation was conducted to assess taste, color, aroma and overall acceptability among participants.
The results indicated that the optimized formulation exhibited satisfactory organoleptic properties, good stability and retained a significant amount of vatimin C. The study concludes that starfruit-based vitamin C gummies can serve an effective and appealing nutraceutical product, especially for pediatric and geriatric populations who may have difficulty consuming conventional dosage forms.

Keywords: Starfruit, Gummies, Evaluation, Nutraceutical, Vitamin.

2.Introduction

In recent years, there has been a growing inetrest in the development of nutraceuticals and functional foods that provide health benefits beyond basic nutrition. Among these, vitamin C supplements play a vital role due to their antioxidant properties, immune-boosting capacity and involvement in collagen synthesis and wound healing. However, conventional dosage forms such as tablets and capsules often face limitations like poor patient compliance, difficulty inswallowing and lack of palatability, especially among pediatric and geriatric populations.
To overcome these challenges, gummy formulations have emerged as an attractive alternative. Gummies are chewable, palatable and easy-to-administer dosage forms that enhance patient acceptability while maintaining therapeutical efficacy. The incorporation of naturasl ingredients into gummies further increases their appeal by aliging with the growing consumer preferasnce for plant-based and minimally processed products.

Fig 2.1 Starfruit along with leaves and flower

Starfruit commonly known as carambola, is a tropical fruit rich in vitamin C , dietary fiber, and bioactive compounds such as flavonoids and polyphenols. It possesses significant antioxidants, antimicrobial and anti-inflammatory properties making it a promising candidate for functional food development. Utilizing starfruit as a natural source of vitamin C not only enhance the nutritional value of the formulation but also promotes the use of locally available and cost-effective raw materials.
The present study focuses on the formulation and evaluation of vitamin C gummies prepared from starfruit extract(Juice). The formulation process involves optimizing parameters such as gelling agent, sweeteners to achieve desirable texture, taste and stability. Furthermore, the prepared gummies are evaluated for various physicochemical properties including appearance, texture, Ph, vitamin C content and stability under different storage conditions.The research aim to develop a novel, natural and patient-friendly dosage form of vitamin C that combines nutritional benefits with improved compliances.

2.1 Gummies:
Gummies are semi-solid, chewable dosage forms prepared using gelling agents such as gelatin or pectin, combined with sweeteners, flavors and active ingredients. They are widely used in both the confectionery and pharmaceutical or nutraceutical industries as an alternative to tablets and capsules[14].The formulation of gummies is based on the principle of gel formation, where gelling agents form a three-dimentional network that traps water, giving a soft and elastic texture.Gelatin forms thermoreversible gels whereas Pectin forms gels in the presence of sugar and acid[4]. Gummies represent a modern and patient-friendly drug deliverey system, condining the benefits of confectionery with pharmaceutical technology. They are increasingly popular due to their palatability, convenience, and versatility through proper formulation is required to ensure stability and efficacy[12].

Types of Gummies:-
1. Gelatin-based gummies – Soft and elastic
2. Pectin-based gummies – Suitable for vegetarians
3. Starch-molded gummies – Traditional candy type
4. Medicated/Nutraceutical gummies – Contain active pharmaceutical ingredients.

Fig 2.2 Gummies

2.2 Vitamin:

Vitamins are organic compounds required in small amount for normal growth, metabolism and overall health. The body cannot produce enough of them, so they must be obtained from diet. Vitamins are essential for maintaining normal body functions, both deficiency and excess can cause health problems. Proper intake through a balance diet and supplements (if needed) is important for overall well-being[14].Vitamins are essential micronutrients required for maintaining health. Their deficiency can lead to serious diseases affecting vision, bones, blood and nerves, so a balanced diet is very important[4].

General function of Vitamins:-

- Acting as coenzymes in metabolic reaction
- Supporting growth and development
- Maintaining immune system function
- Helping in energy production

No.	Name of Vitamin	Function	Disease caused
1	Vitamin A	Vision Immunity Skin health	Night blindness Xerophthalmia (dry eyes) Weak immunity
2	Vitamin D	Calcium absorption Bone health	Rickets (in children) Osteomalacia (in adult) Weak bones
3	Vitamin E	Antioxidant Protects cells	Muscle weakness Nerve problem
4	Vitamin K	Blood clotting	Excessive bleeding Delayed clotting
5	Vitamin C	Immunity Collagen formation	Scurvy(bleeding gum) Poor wound healing
6	Vitamin B1	Energy production Nerve function	Beriberi
7	Vitamin B2	Energy production	Cracked lips Mouth sores
8	Vitamin B3	Metabolism	Pellagra (Dermatitis,

		Skin health	Diarrhea, Dementia)
9	Vitamin B6	Protein metabolism Brain function	Anemia Depression Confusion
10	Vitamin B12	RCB formation Nerve function	Megaloblastic anemia Nerve damage
11	Vitamin B9 (Folic acid)	DNA synthesis RCB formation	Anemia Birth defects

Tab 1.1 Vitamins deficiency and diseases

3. Material and methods:

3.1 Ingredients Table

Sr. No	Ingredients	Role
1	Starfruit	API
2	Jaggery	Sweetner
3	Citric acid	Preservative
4	Sodium benzoate	pH adjuster
5	Sorbitol	Laxative
6	Gelatin	Structural agent
7	Purified water	Vehile / Solvent

Tab 1.2 Ingredients and their role

A. Starfruit - Starfruit is a highly nutritious. Low-calorie tropical fruit packed with fiber, vitamin C and potent antioxidants like quercetin and gallic acid. It supports immune function, aids digestion, promotes heart health and help reduce inflammation[55].

Starfruit also known as Carambola, is a fruit of Averrhoa carambola, a species of tree native to tropical Southeast Asia. The edible fruit has distinctive ridges running down it's sides. When cut in cross-section it resembles a 'star' giving it the name of starfruit. The entire fruit is edible, usually raw and may be cooked or made into relishes, gummies, and also juices[40].

Fig 2.3 Starfruit Juice

B. Jaggery - Jaggery is a nutrient-rich, unrefined sugar alternative providing iron, magnesium, improve digestion and combat anemia. Often used in winter, it act as a natural cleanser for the liver and respiratory tract, helping to alleviate coughs and congestion [60].

Jaggery is a a traditional, unrefined, non-centrifugal sugar made by concentrating sugarcane juice or palm sap, commonly used in Asia and Africa as a healthier alternative to refined sugar.It retains natural molasses, offering mineral like iron and potassium and a caramel-like flavor. It is widely used for digestion and as a sweetener[23].

C. Citric acid - Citric acid is a weak organic acid naturally found in citrus fruit like lemon and orange. It has a sour taste and widely used infood, pharmaceutical; and cosmetic industry[45].

D. Sodium benzoate - Sodium benzoate is a widely used food pH adjuster and food preservative. It is the sodium salt of benzoic acid and is effectives in preventing the growth of bacteria, yeast and fungi[26].

E. Sorbitol - Sorbitol is a type of sugar alcohol used as a laxative and humectant in food and pharmaceutical products. It provides softness and moisture in the formulation[55].

F. Gelatin - Gelatin is a protein derived from collagen that support skin hydration, joint health, and gut integrity. Rich in amino acids like glycine, it helps reduce wrinkles, strengthens hair and nails, improves sleep quality ad may aid in managing blood sugar levels. It is versatile, low-calorie and fat-free source of nutrients[12]. Gelatin is a protein obtained by partial hydrolysis of collagen, which is derived from animal connective tissues like skin, bones and cartilage[22].

G. Purified water – Purified water is a critical excipient in gummy formulation. It plays multiple roles throughout preparation, texture formation, and final product quality. Purified water act as a solvent, hydrating agent, texture modifier, and processing aid, playing a vital role in gel formation, consistency and overall quality of gummies [45].

3.2 Formulation Table

No	Ingredients	Quantity
1	Starfruit	25ml
2	Jaggery	10g
3	Citric acid	1.5g
4	Sodium benzoate	0.5g
5	Sorbitol	2ml
6	Gelatin	10g
7	Purified water	Q.S

Tab 1.3 Ingredients and their Quantity

3.2.1 Method:

i. Collection of necessary ingredients
ii. Collection of all required apparatus
iii. Take out the juice of starfruit
iv. Heated the juice till required temperature is obtained
v. Added jiggery to the heated juice and mixed until jiggery dissolved
vi. Added all required excipients and mixed properly until a uniform mixture is formed
vii. Added gelatin in the mixture
viii. Once the mixture is formed poured it into the mold, Let it cool
ix. Once the gummies are properly set remove them from the mold
x. Packed I required container and store in cool and dry place.

3.2.3 Formulation process:

i. Take 100 ml beaker and add 25 ml of starfruit juice and 10ml of purified water.
ii. Add 15g of jiggery in the juice and heat it until jiggery is completely dissolved.
iii. Add 1.5g citric acid, 0.5g sodium benzoate and 2ml of Sorbitol and mixed properly.
iv. Add 10g of gelatin and mix it until homogenus mixture is formed.
v. Transfer the mixture in the mold and let it set for 45min- 1hr.

vi. Once the gummies are formed remove them from mold.
vii. Packed the gummies in proper container.

4. Result:

4.1 Organolrptic peoperties

Tab 4.1 Organolrpit properties and there result

No	Parameter	Batch 1	Batch 2	Batch 3	Batch 4
1	Color	Yellow	Yellow	Yellow	Yellow
2	Taste	Sweet & Sour	Sweet & Sour	Sweet & Sour	Sweet & Sour
3	Odour	Characteristic	Characteristic	Characteristic	Characteristic
4	Texture	Soft	Soft	Soft	Soft

4.2 Physical parameters

Tab 4.2 Physical parameters and there result

No	Parameter	Batch 1	Batch 2	Batch 3	Batch 4
1	Weight Variation	4.8%	3.0%	6%	6.5%
2	Shape	Star	Star	Star	Star
3	Hardness	Soft but breakable	Soft but breakable	Soft but firm	Soft but firm
4	Stickiness	Sticky	Non-sticky	Non-sticky	Non-Sticky
5	Color Uniformity	Uniform Distribution of color	Uniform Distribution of color	Uniform Distribution of color	Uniform Distribution of color

4.3 Chemical parameters

Tab 4.3 Chemical parameters and there result

No	Parameter	Batch 1	Batch 2	Batch 3	Batch 4
1	pH	3.4	4.0	4.0	4.0
2	Assay	65%	77%	90%	93%
3	Content Uniformity	Uniform	Uniform	Uniform	Uniform
4	Moisture Content	25%	20%	18%	12%

5. Discussion

The organoleptic evaluation of the prepared vitamin C gummies was carried out for four different batches to assess key sensory parameters such as color, taste, odour and texture[35]. The results indicated a high level of uniformity across all batches, suggesting consistency in the formulation and preparation process.All batches had a uniform yellow color, a pleasant sweet and sour taste, a characteristic odour, and a soft texture. These result indicate that the formulation process was reliable and produced gummies with good appearance, palatability and overall quality, making them suitable for consumer acceptance[56].

The physical evaluation of vitamin C gummies prepared from starfruit was carried out for four batches tomassess parameters such as weight variation, shape, stickness and color uniformity. Overall batch 3 and batch 4 demonstrated better physical characteristics compared to bafch 1 and batch 2, particularly in terms of hardness and stickness[66].These results suggest that optimization of formulation components and processing conditions in later batches led to improved product quality and stability[70].

The chemical evaluation of vitamin C gummies prepared from starfruit was carried put to assess important parameters such as pH, assay, content uniformity, and moisture content across foyur batches.[44]. The pH value ranged from 3.4 to 4.0. The assay result showed a progressive increase from 65% to 93%. All batches demonstrated uniform content uniformity, indicating that the active ingredients

was evenly distributed throughout the formulation[15]. Overall batch 3 and 4 exhibited better chemical characteristics, including optimal PH, higher assay values and lower moisture content. These finding suggested that later batches achieved improved formulation stability and quality, making them more suitable for final product development[45].

6. Conclusion:

A prepared formulation of vitamin C gummies (ingredients contain starfruit, jiggery, citric acid, sodium benzoate, sorbitol, gelatin, purifird water) is used for vitamin C deficiency treatment as an supplementary.Gummies are alternative dosage form of tablets and capsules specially given to prediatrics and geriatric patients[08].The formulated vitamin C gummies from starfruit demonstrated significant nutritional enhancement, contributing to improved antioxidant activity. The gummies exhibited pleasant organoleptic properties, including acceptable taste, color and texture which enhance their oveall appeal[47]. Additionally, the formulation showed enhanced sontribute tability of vitamin C, ensuring better retention of the active ingredient. The physical evaluation parameters were found to be satisfactory, indicating good quality and consistency of the product[36]. These characteristics contribute to better patient compliance due to ease of consumption and palatability. Futhermore the gummies offer potential health benefits, including support for heart hgealth and regulation of blood sugar level, making them a promising nutraceutical formulation[38].

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