

# Innovative Chewable Pectin and Agar-Agar Matrices for *Zingiber Officinale* Enhanced Vegan Gummies

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**Abstract** - The aim of this research was to produce natural ingredients-based gummy bear composition, evaluate the influence of the selected ingredients on the textural properties of the product and its acceptance by the consumers, and the evaluation of the gummies' quality. Gummy bears were prepared using *Zingiber officinale* powder-containing chewable gels (CGs) based on gelatin, pectin, and agar-agar gelling agents. The CGs was characterized for their dissolution time, stability, microbial quality, swelling ratio, hardness, gumminess, and chewiness, as well as the interaction between these factors. F2 which met all the required physical characteristics for chewable-gummies, exhibiting no syneresis during storage, and providing superior texture compared to other formulations.

**Keywords:** Chewable gummies, *zingiber officinale*, pectin, agar-agar, Gummies, Ginger gummies.

## I. INTRODUCTION

In the 21st century, there has been a heightened interest in the utilization of natural ingredients in the development of food supplements, pharmaceuticals, and functional products [1]. However, formulating these products poses significant challenges, particularly in creating dosage forms and effectively masking the taste of bio-actives with bitter, salty, or sour flavors, especially when catering to children [2]. This becomes an intricate task for formulation scientists. Furthermore, the formulation of liquid products containing bio-actives faces limitations due to solubility issues, necessitating the use of various additives such as sweeteners, buffers, and preservatives to ensure stability and enhance flavor [3]. A more sophisticated approach to formulation involves the use of gummy bears, crafted from natural materials and infused with active ingredients. Although typically designed for individuals without chewing disorders or dysphagia, gummy bears have the potential to expand their consumer market due to their numerous benefits. Commonly, the base of a gummy bear comprises a jellifying agent (such as pectins, modified starch, or gelatin) and sugars. This matrix allows for the dissolution of water-soluble ingredients, while insoluble ones are suspended within the viscous structure [4,5]. Our study seeks to develop a gummy bear composition

based on natural ingredients. We aim to assess the impact of these selected ingredients on the textural properties and overall acceptance of the product by consumers. Additionally, we will evaluate the overall quality of the gummy bears. The optimal gummy bear base composition, chosen with considerations for its potential positive effects on human health, holds promise for future applications in confectionery, food supplements, and pharmaceutical manufacturing.

## II. METHOD & MATERIAL

The main material used in this study was *Zingiber officinale* root powder which passed through a 500- mesh screen. The other excipients used were pharmaceutical grade (pg.) or food-grade (f.g), namely pectin, gelatin, Lactose, citric acid, sodium benzoate, propyl glycol, Agar-Agar, water and the coloring agent. The tools and instruments used were digital analytics (Mettler Toledo), mixing pan, thermometer, jelly mold, vernier caliper, Agrosta texturometer v. 2.

INGREDIENTS	FORMULA 1 (Pectin+Gelatin)	FORMULA 2 (pectin+agar- agar)	FORMULA 3 (Pectin)
<i>Zingiber officinale</i> powder(Drug)	5gm	5gm	5gm
Gelatin	15gm	-	-
Pectin	2gm	0.3gm	0.7gm
Agar-agar	-	3.9gm	-
Lactose sugar	5gm	2.5gm	3gm
Citric acid	1gm	1ml	1ml
Sodium Benzoate	0.5gm	-	0.5gm
Methylparaben	-	0.3gm	-
Colouring agent	0.5ml	0.5ml	0.5ml
Purified Water	17ml	16.5ml	19.3ml
Total	50	30	30

### ■ PREPARATION OF PECTIN BASED *Zingiber officinale* CHEWABLE-GUMMY

Gelatin and pectin-based CG made of *Zingiber officinale* root powder were prepared by heating and congealing [12]. Three formulas were developed in this study, as presented in Table 1. Formulas 1 used gelatin as a gelling agent. While formulas 2 used pectin and Agar-agar is utilized. Gelatin and pectin as gelling agents play a pivotal role in the formula. Lactose served as a sweetening agent and enhanced the 3D gel structure with gelling agent and water. Citric acid was used in

this formula as an acidulant to increase the acceptability of this product. Sodium benzoate serves as preservatives. Coloring agents were also used in this study to increase customer perception and preference.

To prepare the drug-infused gummies, begin by sieving the powdered drug through a 500-mesh screen. Take water in a beaker, weigh the powder accordingly, and mix it in the water for moistening for 5-10 minutes. Boil and dissolve the drug with water for a sufficient 20 minutes until a concentrated extract is formed. Strain the mixture with filter paper until a clear extract is obtained.

Measure the amount of drug extract in a beaker, setting it on a burner. Weigh agar and add it to the extract, stirring continuously until a desired thickness is achieved. Measure the minimum quantity of pectin in milligrams and stir until the mixture is thick. Add sodium benzoate, followed by citric acid dissolved in water at a 1:1 ratio.

Include color for appearance. Spray a citric acid solution at a 1:1 ratio onto the mold for faster setting of gummies. Pour the mixture into the molds, spray citric acid solution on top of the gummies, and let it set for 30 minutes until thick, transparent gummies with a jelly-like consistency are formed. Gently remove them and store in a sterilized glass container. This CG were then packed individually in aluminum foil paper and stored in an airtight jar for further analysis, including physical characteristics evaluation.

### III. EVALUATION

#### 1. Organoleptic tests

- Texture
  - Evaluating the gummies for their texture accessing factors such as Chewiness, softness and mouth coating properties. We evaluated the final processed gummies soft gummies grade texture was obtained.
- Appearance
  - Accessing the visual appeal including colour, transparency and shape of the gummies was obtained.
  - Consistency of colour, texture and appearance across the batches was found.
- Taste and flavour
  - Tasting of the gummies was not done according.
  - Ginger is the main flavouring agent sugar is also added for sweetness no artificial flavouring or sweetener is added ensuring a pleasant taste is obtained.
- Aroma
  - The aroma of the gummies was found appealing and in line with the intended flavour profile.

#### 2. Solubility and Dissolution

##### *Solubility in Distilled Water:*

- Place one gummy in a beaker with a known volume of distilled water.
- Record the time it takes for the gummy to completely dissolve. Observe and document any changes in colour, texture, or shape

##### *Dissolution*

- Dissolution testing for gummies involves assessing how well the active ingredients in the gummies dissolve in simulated gastric or intestinal fluids. This type of testing is crucial for understanding the bioavailability of the components, ensuring consistent quality, and predicting how the product will perform in the human body.
- To evaluate the dissolution characteristics of active ingredients in gummies and ensure consistent and effective release in simulated gastrointestinal conditions.

#### 3. Swelling ratio test

- The swelling ratio test is a simple method of determining the water absorption capacity of a gel structure.
- The gummies from the final formulation were first weighed and then immersed in 100 ml purified water for 30 minutes removed and the excess water on the gummy surface was wiped using filter paper. The gummies were weighed for a second time and calculate the swelling ratio by dividing the weight difference before and after immersion by the initial gummy tablet weight.

#### 4. Stability test

- The gummies were evaluated for the stability test under various conditions including temperature and humidity
- A batch of gummies was kept at room temperature and another in a preheated oven maintaining a temperature of 98.60F (370C) equal to the body temperature.
- Gummies were constantly monitored for changes in appearance taste and texture over time.

#### 5. pH

- Testing the pH of gummies involves a similar process to other liquids:

##### *1. pH Strips:*

If the gummies are in liquid form, you can dip a pH strip into the liquid and compare the color to the pH chart.

2. pH Meter:

If the gummies are solid, you might need to dissolve them in a small amount of water to test the pH using a meter.

IV. RESULT AND DISCUSSION

This research involved the formulation of *Zingiber officinale* powder-containing chewable gels (CG) using diverse gelling agents. gelatin, pectin, and agar-agar. Organoleptically, all CGs exhibited a triangle shape, a dark green hue, a pleasing aroma, and a sweet taste. This uniform appearance positively influenced consumer perception and acceptance. The texture, characterized by being non-sticky, elastic, and chewy with adequate gel strength, was impacted by the concentration of the gelling agent. Higher concentrations resulted in greater mechanical strength and a less elastic texture, a trend observed in both gelatin-based and pectin-based CGs.

Pectin was chosen as the primary gelling agent for all three formulations due to its superior temperature stability and microbial stability. Other gelling agents tend to melt faster, which gives less stability to the gummies Our research aimed to create herbal and vegan-friendly gummies, addressing the growing demand for plant-based alternatives and providing environmental sustainability. Pectin, being plant-derived, not only aligns with vegan principles but also resonates with consumers seeking natural and environmentally friendly products.



The swelling ratio, denoting the fractional weight increase due to water absorption, assessed the CGs' ability to absorb water molecules within their structure. Variances in gelling agent type and concentration significantly affected the swelling ratio across all formulations. Notably, pectin and agar-agar-based CGs exhibited a higher swelling ratio than other formulations.

Conducting a dissolution time test provided insights into how rapidly the CGs dissolved in aqueous media, ensuring timely dissolution upon contact with saliva. The dissolution times for all CGs ranged between 5 and 25 minutes, indicating efficient release of active ingredients and a quick absorption process.

To assess stability, gummies underwent testing under diverse conditions, including temperature and humidity variations. One batch was kept at room temperature, while another was subjected to a preheated oven at 98.6°F (37°C), equivalent to body temperature. Continuous monitoring revealed that F2 exhibited greater stability compared to other formulations, showcasing resilience in appearance, taste, and texture over time.

This research has successfully formulated *Zingiber officinale* containing chewable gels, emphasizing the pivotal role of pectin as the primary gelling agent. The achieved organoleptic and textural attributes, coupled with the commitment to vegan and herbal formulations, position this CGs as a promising addition to the nutraceutical market. This research gave the way for further exploration in the market of herbal gummy formulations, encouraging innovation and sustainability in the development of consumer-friendly, plant-based alternatives.

Table 2: Gelatin and pectin-based *Zingiber officinale* chewable-gummy Evaluation results

Parameters		F1(pectin+Gelatin)	F2(pectin agar- agar)	F3(pectin)
Organoleptic	Texture	Sticky &elastic	Non-sticky, elastic	Melted
	Colour	green	green	green
	Appearance	Melted	No Distortions	Melted
	Taste & Flavor	Ginger	Ginger	Ginger
	Aroma	pleasant	pleasant	pleasant
Solubility& Dissolution	-	Soluble (3.5min) Dissolve(5 min)	Soluble(5min) Dissolution(7min)	Soluble(15min) Dissolution(8min)
	Swelling ratio (%) 100ml/60min	57ml/60min (57%)	70ml/60min (70%)	79ml/60min (79%)
Stability	-	Stable (7days)	Stable (2months)	Stable (9days)
pH	-	6.92	6.88	6.50

## V. CONCLUSION

The dissolution time, stability, microbial quality, swelling ratio, hardness, gumminess, and chewiness of *Zingiber officinale* chewable-gummy are significantly influenced by both the type and concentration of gelling agents, as Parameters F1(pectin+ Gelatin) F2(pectin agar agar) F3(pectin) Organoleptic Texture Sticky & melted Sticky & elastic Non-sticky, elastic Melted Appearance Melted Triangle Melted Taste & Flavor Ginger Aroma unpleasant pleasant Solubility& Dissolution(T) - Soluble,(8 min) Did not dissolve(25min) Soluble (3.5min) Dissolve(5 min) Soluble(5min) Dissolution(7min) Soluble(15min) Dissolution(17min) Swelling ratio(%) 100ml/60min - 96ml/60min (96%) 57ml/60min (57%) 70ml/60min (70%) 79ml/60min (79%) Stability(T) - Unstable (2days) Stable (7days) Stable (2months) Stable (9days) Microbial quality (T) - Mold formation (1day) Microbial safe (7days) Microbial safe (2 months) Mold formation (9days) Batch to batch (mg) - Varied (3.2mg-3.9mg) Equal (3.2mg-3.2mg) Equal (3.2mg-3.2mg) Varied (3.2mg-4mg. Pectin and agar-agar, when used as gelling agents, F2 result in chewable gummies that are less sticky and moderately elastic. Consequently, chewable gummies based on pectin and agar-agar exhibit higher dissolution times, as well as gumminess and chewiness values. Optimal formulations are achieved with 10% pectin and 1.5% agar-agar, meeting all the required physical characteristics for chewable gummies, exhibiting no syneresis during storage, and providing superior texture compared to other formulations.

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