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# Jelly Candy Formulation Made from White Galangal Infusion (*Alpinia galanga* (L.)) As A Memory Enhancement Supplement

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**Abstract:** Background: White galangal (*Alpinia galanga* L.) is a herbal plant containing bioactive compounds with potential to support cognitive function, making it a promising candidate for functional food development. Objective: This study aimed to formulate white galangal infusion into a jelly candy dosage form and to evaluate its physical quality. Methods: White galangal rhizomes were dried at 40 °C, processed into simplisia powder, and extracted using the infusion method. The obtained infusion was characterized through phytochemical screening and thin-layer chromatography, then formulated into jelly candies in three formulations with varying infusion concentrations. Physical quality evaluation included organoleptic properties, texture, moisture content, ash content, reducing sugar, pH, and weight uniformity. Results: The results showed that the white galangal infusion contained flavonoids, phenolics, terpenoids, and quinones. All jelly candy formulations met the required physical quality standards, with variations in color, aroma, moisture content, and pH influenced by infusion concentration but remaining within acceptable limits. Conclusion: White galangal infusion jelly candy has the potential to be developed as a herbal-based functional food product.

**Keywords:** Functional food; Jelly candy; Infusion; White galangal

## Introduction

Indonesia is one of the countries with rich biodiversity, particularly in terms of medicinal plant resources (Cahyaningsih et al., 2021). Herbal plants have long been utilized for the prevention and treatment of various diseases due to their diverse bioactive compounds. Theoretically, medicinal plants contain secondary metabolites such as flavonoids, alkaloids, terpenoids, and phenolic compounds, which exhibit antioxidant, anti-inflammatory, and neuroprotective activities (Harborne, 1998; Evans, 2009). It is estimated that more than 12,000 compounds have been isolated from herbal plants worldwide; however, only about 10% of these compounds have been successfully extracted and utilized optimally (Hidayanto & Ardi, 2015). This indicates that the potential of herbal plants remains largely underexplored, particularly in the fields of pharmacy and functional food development.

One herbal plant with significant potential is white galangal (Alpinia galanga L.). Theoretically, flavonoids and phenolic compounds are known to possess antioxidant activity that can protect neuronal cells from oxidative stress, which is a major factor contributing to cognitive decline (Howes & Houghton, 2013). In addition, terpenoids and essential oil components found in galangal have been reported to affect the central nervous system, including enhancing neurotransmitter activity. The mechanism of action of white galangal bioactive compounds is thought to involve increased acetylcholine levels through enzyme modulation and intracellular calcium regulation, both of which play crucial roles in learning and memory processes.

Memory impairment and cognitive disorders have become significant global health concerns, especially among the elderly population. According to the World Health Organization (WHO, 2021), more than 55 million people worldwide are living with dementia, with

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approximately 10 million new cases each year. Furthermore, about 15–20% of older adults experience mild cognitive impairment (MCI), which may progress to dementia. From a theoretical perspective, approaches based on antioxidant and neuroprotective agents derived from natural products are considered promising strategies for preventing cognitive decline (Howes & Houghton, 2013).

The use of herbal materials for cognitive health is also increasing, in line with the global "back to nature" trend and growing consumer preference for natural products (Global Herbal Market Report, 2023). However, in practice, most herbal products available on the market are still formulated as capsules or tablets, which may have limitations in terms of convenience, particularly for children and elderly individuals who experience difficulty swallowing solid dosage forms. Therefore, innovation in dosage form development is needed to create products that are more attractive, easy to consume, and have added sensory value.

Jelly candy is a semi-solid food dosage form that theoretically offers advantages in terms of consumer acceptance due to its chewy texture, variety of flavors, and ease of consumption (Imeson, 2010). The gel system in jelly candy allows for uniform distribution and stabilization of active compounds within the matrix, making it a potential delivery system for bioactive substances (Mahardika et al., 2014). Additionally, this form is preferred across various age groups compared to conventional dosage forms (Dewi & Lestari, 2017).

However, studies on the utilization of white galangal as a memory-enhancing agent remain limited, particularly in innovative dosage forms such as jelly candy. Previous studies have shown that white galangal extract can improve memory function in experimental animals (Ridwan, 2018), yet its development into ready-to-consume products is still not optimal. This indicates a research gap between the pharmacological potential ofherbal materials and their practical application in consumer-friendly products.

Based on the above considerations, several reasons underlie this study: (1) the high prevalence of cognitive disorders requiring natural preventive alternatives, (2) the underutilized bioactive potential of white galangal as a neuroprotective agent, (3) limitations of conventional herbal dosage forms in terms of consumer acceptability, and (4) the need for innovative functional food products that are practical, appealing, and easy to consume. Therefore, this study aims to formulate white galangal infusion into a jelly candy dosage form and to evaluate its physical quality as an initial step toward the development of innovative and applicable herbal-based products.

## Method

*1. Preparation of Simplisia Powder*

Fresh white galangal rhizomes were washed, sliced into thin sections, and dried in an oven at 40 °C for 2–8 days until a constant weight was achieved. Low-temperature drying was applied to preserve thermolabile bioactive compounds, particularly flavonoids and essential oils (Harborne, 1998; Ministry of Health of the Republic of Indonesia, 2008). The dried material was ground using a blender and sieved through a 60-mesh sieve to obtain a uniform particle size, in accordance with herbal material quality standards (WHO, 2011).

*2. Preparation of White Galangal Infusion*

The infusion was prepared using the infusion method as described in the Indonesian Herbal Pharmacopoeia. The powdered simplisia was mixed with hot distilled water (approximately 90 °C) and heated for 15 minutes with occasional stirring. The mixture was then filtered to obtain a clear infusion. The infusion method was selected because it is suitable for extracting polar compounds that are stable under short-term heating conditions (Anief, 2007; Ministry of Health of the Republic of Indonesia, 2017).

*3. Quality Evaluation of Raw Materials and Infusion*
*Specific Parameters*
*Phytochemical Screening*

Phytochemical screening was performed to identify the presence of secondary metabolites such as flavonoids, phenolic compounds, terpenoids, and quinones. This screening is essential to confirm the presence of bioactive constituents responsible for pharmacological activity (Harborne, 1998; Evans, 2009).

*Thin Layer Chromatography (TLC)*

Thin layer chromatography was conducted to characterize the chemical profile of the white galangal infusion and to compare it with reference data reported in the literature. TLC is widely used as a qualitative analytical method for herbal material standardization (Wagner & Bladt, 1996)

*Non-Specific Parameters*
*Loss on Drying*

Loss on drying was determined to evaluate the amount of moisture and volatile substances removed during the drying process and to ensure simplisia stability (Ministry of Health of the Republic of Indonesia, 2008).

*Moisture Content*

Moisture content was determined using a gravimetric method. This parameter is critical to prevent microbial growth and to maintain the quality and shelf stability of herbal raw materials (AOAC, 2016; WHO, 2011).t al., 2010).

*4. Formulation of White Galangal Infusion Jelly Candy*

Jelly candy was formulated by combining white galangal infusion as the active ingredient with gelatin (gelling agent), sucrose (sweetener), citric acid (acidulant), methyl paraben (preservative), and distilled water (solvent). The mixture was heated at 90–100 °C until a homogeneous viscous solution was obtained, poured into molds, and cooled under refrigeration for 24 hours. This procedure followed standard jelly candy manufacturing methods reported in previous studies (Mahardika et al., 2014; Dewi & Lestari, 2017).

Three formulations with different concentrations of white galangal infusion were prepared to evaluate the effect of active ingredient concentration on the physical quality of the jelly candy, following a graded formulation approach commonly applied in pharmaceutical product development (Lachman et al., 2013).

**Table I.** Formulation of White Galangal Infusion Jelly Candy

| Ingredients | F I | F II | F III | Uses |
|---|---|---|---|---|
| White Galangal Infusion | 1,551.6g | 3,103.2g | 6,206.4g | Active Ingredients |
| Gelatin | 12g | 12g | 12g | Binder |
| Sucrosa | 12g | 12g | 12g | Sweetener |
| Citric Acid | 0,18g | 0,18g | 0,18g | Acidity Regulator |
| Nipagin | 0,084g | 0,084g | 0,084g | Preservative |
| Aquadest | Ad 60g | Ad 60g | Ad 60g | Solvent |

*5. Physical Quality Evaluation of Jelly Candy*

*Organoleptic Evaluation*

Organoleptic properties, including color, odor, and texture, were evaluated. Texture analysis was performed using a Texture Analyzer (maximum load 5000 N; maximum extension 1000 mm) to determine jelly candy elasticity and chewiness. Texture evaluation is essential for assessing consumer acceptability (Stone & Sidel, 2004).

*Moisture Content*

Moisture content was determined gravimetrically by drying samples at 100–105 °C for 6 hours until constant weight was achieved. According to quality standards, the moisture content of jelly candy should not exceed 20% (AOAC, 2016; SNI 3547.2:2008).

*Ash Content*

Ash content was determined using a gravimetric method by incineration at 550 °C for 6 hours. The ash content of jelly candy should not exceed 3%, indicating acceptable mineral content and product purity (AOAC, 2016; SNI 3547.2:2008).

*Reducing Sugar Content*

Reducing sugar content was determined using the Luff–Schoorl titration method, a standard analytical technique for sugar determination in food products. The reducing sugar content of jelly candy should not exceed 25% (Sudarmadji et al., 2010; AOAC, 2016).

*pH Measurement*

The pH value was measured using a calibrated pH meter. Measurements were performed in triplicate, and the mean value was recorded. The acceptable pH range for jelly candy is 4.5–6, in accordance with Indonesian National Standards (SNI 3547.2:2008).

*Weight Uniformity Test*

Weight uniformity was evaluated by weighing ten individual jelly candies. No more than two units were allowed to deviate significantly from the average weight. This test ensures consistency and homogeneity of the dosage form (Ansel et al., 2011).

*6. Data Analysis*

The data collection method obtained from this study was carried out descriptively, describing a condition objectively expressed in the form of tables or explanations. Descriptive data processing was obtained from observations of phytochemical screening, TLC, drying shrinkage, air content, and organoleptics. In the visual organoleptic examination, namely direct observation including color, odor, and dosage form. Data Analysis The organoleptic results of texture, ash content test, water content, reducing sugar, pH, and weight uniformity used quantitative data that was analyzed statistically using the SPSS statistical data processing program (One-Way ANOVA).

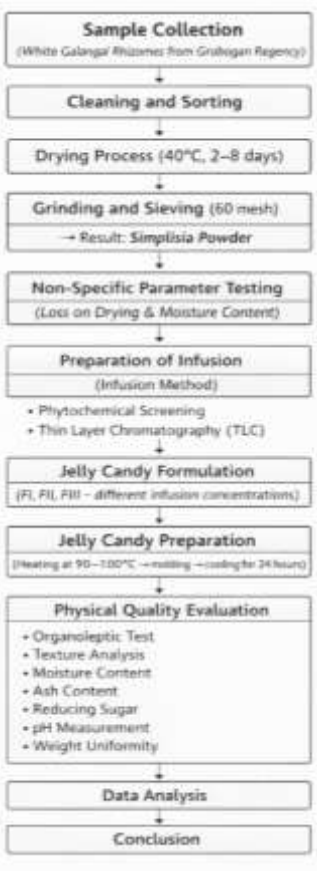



**Figure 1.** Research Diagram

## Result and Discussion

*Preparation and Characterization of White Galangal Simplisia Powder*

The drying process of white galangal rhizomes at 40 °C for 2–8 days resulted in dried simplisia characterized by a light brown color, a distinctive galangal aroma, and a firm texture. The use of relatively low drying temperatures is a critical strategy to minimize the degradation of thermolabile bioactive compounds, particularly flavonoids and essential oil constituents, thereby preserving the phytochemical integrity of the material (Harborne, 1998; Kuntorini, 2018). This approach is strongly supported by findings from Azmir et al. (2013), who demonstrated that high-temperature drying can significantly degrade phenolic and volatile compounds, leading to a reduction in biological activity. Similarly, Chan et al. (2009) reported that moderate drying temperatures are more effective in maintaining the antioxidant capacity of plant materials compared to high-temperature treatments. Therefore, the drying conditions applied in this study can be considered optimal for preserving the functional properties of white galangal.

Following drying, the material was pulverized and sieved through a 60-mesh sieve to obtain a uniform particle size distribution. Particle size uniformity plays a crucial role in extraction efficiency, as smaller and more homogeneous particles increase the surface area available for solvent interaction, thereby enhancing mass transfer and diffusion of bioactive compounds (Azwanida, 2015). This observation is consistent with the study by Cacace and Mazza (2003), which demonstrated that reduced particle size significantly improves the extraction yield of phenolic compounds from plant matrices. Thus, the particle size reduction applied in this study is expected to contribute positively to the efficiency of the infusion process.

**Figure 2.** White Galangal & Simplisia Powder

The results of non-specific parameter testing indicated that the moisture content and loss on drying of the simplisia powder were within acceptable limits for herbal raw materials. Low moisture content is essential to prevent microbial growth and degradation reactions during storage (World Health Organization [WHO], 2011); therefore, the simplisia was considered to meet quality requirements and suitable for subsequent formulation stages.

*Preparation and Evaluation of White Galangal Infusion*

The white galangal infusion obtained was yellowish-brown in color, clear, and exhibited a characteristic galangal aroma. These organoleptic properties indicate that polar to semi-polar bioactive compounds were successfully extracted into the aqueous solvent through the infusion process. The infusion method was selected due to its suitability for extracting water-soluble compounds and its practicality and safety for the development of functional food products or oral herbal preparations (Ansel *et al*., 2011). In addition, aqueous extraction techniques such as infusion are widely reported to be effective for isolating phenolic and flavonoid compounds due to their polarity and compatibility with water-based solvents (Azmir et al., 2013; Dai & Mumper, 2010).


**Figure 3.** White Galangal Infusion

Phytochemical screening of the infusion revealed the presence of several classes of secondary metabolites with potential pharmacological activity, including flavonoids, phenolics, terpenoids, and quinones (Table 2).

**Table 2.** Phytochemical Screening Results of White Galangal Infusion

| Compound Class | Result |
|---|---|
| Flavonoids | Positive (+) |
| Phenolics | Positive (+) |
| Terpenoids | Positive (+) |
| Quinones | Positive (+) |
| Alkaloids | Negative (–) |
| Saponins | Negative (–) |

The presence of flavonoids and phenolic compounds is particularly significant, as these compounds are widely recognized for their antioxidant and neuroprotective activities, which play important roles in maintaining cognitive function and memory (Kusriani & Zahra, 2015; Wu *et al*., 2014). These compounds act by scavenging free radicals, reducing oxidative stress, and modulating neuronal signaling pathways associated with memory formation (Spencer, 2010; Dai & Mumper, 2010). Furthermore, phenolic compounds have been reported to contribute to the prevention of neurodegenerative diseases through their ability to inhibit lipid peroxidation and improve synaptic plasticity (Do et al., 2014).

Terpenoids have also been reported to exhibit pharmacological effects on the central nervous system, including anti-inflammatory activity and enhancement of cerebral perfusion (Howes & Houghton, 2013). Several studies have demonstrated that terpenoid-rich plant extracts can modulate neurotransmitter systems and improve cognitive performance by influencing cholinergic transmission and neuroinflammatory pathways (Perry et al., 2012). In addition, quinone compounds are known to possess redox-active properties that contribute to biological activity, including neuroprotection and antimicrobial effects (Bolton et al., 2000).

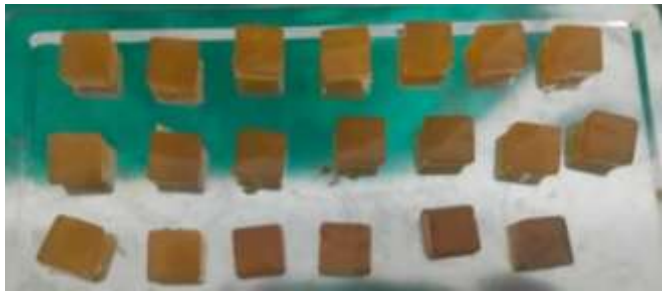
The absence of alkaloids and saponins suggests that the extracted compounds were predominantly polar to semi-polar in nature, consistent with the aqueous extraction method employed. This finding aligns with previous studies indicating that solvent polarity plays a crucial role in determining the class of phytochemicals extracted from plant materials (Ngo et al., 2017; Azwanida, 2015).

Thin Layer Chromatography (TLC) analysis showed the presence of spots with Rf values corresponding to flavonoid and phenolic compounds previously reported in white galangal (Wu et al., 2014). TLC remains a reliable and widely used technique for the qualitative identification of phytochemical constituents in herbal extracts (Wagner & Bladt, 1996). These findings confirm that the infusion process effectively and consistently extracted the target bioactive constituents. Moreover, similar chromatographic profiles have been reported in studies evaluating Alpinia galanga, further supporting the reproducibility and validity of the extraction method used (Wu et al., 2014; Chan et al., 2009).

*Formulation of White Galangal Infusion Jelly Candy*

White galangal infusion jelly candies were successfully formulated into three formulations with varying concentrations of infusion, namely Formula I (FI), Formula II (FII), and Formula III (FIII). Visually, all formulations produced jelly candies with uniform shape, smooth surfaces, and no evidence of sugar crystallization or phase separation. This indicates that the combination of gelatin as a gelling agent, sucrose as a sweetener, and water as a solvent was capable of forming a stable gel system (Mahardika *et al*., 2014). Gelatin-based gel systems are widely recognized for their ability to form thermoreversible three-dimensional networks that entrap water and solutes, thereby contributing to the structural stability and desirable texture of jelly products (Imeson, 2010; Karim & Bhat, 2009).

FI



FII

FIII

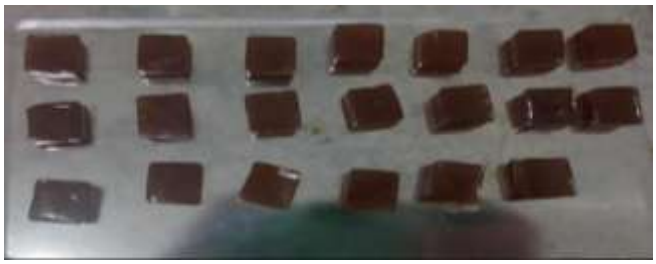


**Figure 3.** White Galangal Infusion Jelly Candy

Differences in infusion concentration influenced the color intensity and aroma of the jelly candies. Higher infusion concentrations resulted in darker coloration and a stronger characteristic galangal aroma. This phenomenon is likely associated with the increased presence of phenolic and flavonoid compounds, which are known to contribute to pigmentation and characteristic plant-derived aromas (Dai & Mumper, 2010; Do et al., 2014). Additionally, thermal processing during jelly preparation may induce mild Maillard reactions or pigment concentration effects, further enhancing color intensity in formulations with higher bioactive content (Nursten, 2005).

This observation suggests that the bioactive compounds from the infusion were uniformly distributed within the jelly matrix and retained their characteristic properties in the final dosage form, supporting its potential use as a functional confectionery product (Dewi & Lestari, 2017). The incorporation of plant extracts into gel-based confectionery systems has been widely reported to enable homogeneous dispersion of bioactive compounds while maintaining product stability and consumer acceptability (Pérez-Burillo et al., 2018; Martins et al., 2016). Furthermore, gel matrices such as jelly candies can act as effective delivery systems for phytochemicals, protecting them from degradation and enhancing their stability during storage (McClements, 2020).

*Physical Quality Evaluation of Jelly Candy*

- *Organoleptic Evaluation*

Organoleptic evaluation demonstrated that all formulations exhibited acceptable color, odor, and texture. Formula I displayed a pale yellow color with a mild galangal aroma, Formula II showed a yellowish-brown color with a moderate aroma, while Formula III exhibited a darker brown color and the strongest galangal aroma. These differences directly reflect the influence of infusion concentration on the sensory characteristics of the preparation. Sensory attributes such as color and aroma are strongly influenced by the concentration of phytochemical compounds, particularly phenolics and volatile constituents, which contribute to both pigmentation and characteristic odor profiles (Dai & Mumper, 2010; Martins et al., 2016).

Texture analysis using a Texture Analyzer indicated that all formulations possessed elasticity characteristics consistent with jelly candy standards. However, formulations with higher infusion concentrations tended to exhibit slightly softer textures. This phenomenon is likely attributed to the increased water content introduced by the infusion, which may weaken the gelatin gel network and reduce gel strength, as previously reported in gelatin-based confectionery systems (Imeson, 2010). Gelatin forms a three-dimensional network stabilized by hydrogen bonds, and the presence of excess water can disrupt these interactions, leading to reduced firmness and elasticity (Karim & Bhat, 2009; Gómez-Guillén et al., 2011).

- *Moisture Content Determination*

The results of moisture content determination showed that all formulations met the standard requirements for jelly candy, with moisture content below 20%. Moisture content increased proportionally with increasing infusion concentration (Table 3).

**Table 3.** Moisture Content Determination

| Formula | Moisture Content (%) |
|---|---|
| FI | 14.8 ± 0.3 |
| FII | 16.2 ± 0.4 |
| FIII | 18.5 ± 0.5 |

The increase in moisture content is associated with the higher amount of infusion added to the formulations. Nevertheless, the obtained moisture levels remained within acceptable limits and did not adversely affect the physical or microbiological stability of the jelly candies, in accordance with national quality standards for jelly products (BSN, 2008). Moisture content is a critical parameter affecting shelf life, as higher water content can promote microbial growth and physicochemical instability; however, controlled moisture levels combined with low water activity can maintain product stability (Fellows, 2009; McClements, 2020).

- *Ash Content Determination*

Ash content analysis revealed that all formulations exhibited ash values below the maximum permitted limit of 3% (Table 4).

**Table 4**. Ash Content of Jelly Candy

| Formula | Ash Content (%) |
|---|---|
| FI | 1.21 ± 0.05 |
| FII | 1.48 ± 0.06 |
| FIII | 1.76 ± 0.08 |

The slight increase in ash content with higher infusion concentrations is presumed to originate from naturally occurring mineral components present in white galangal rhizomes. The relatively low ash values indicate good product purity and the absence of excessive inorganic contaminants (WHO, 2011). Ash content is commonly used as an indicator of total mineral content and overall purity in food and herbal products (Sagar & Kumar, 2010).

- *Reducing Sugar Content Determination*

Reducing sugar content determined using the Luff–Schoorl titration method showed that all formulations contained reducing sugar levels below the maximum allowable limit of 25% (Table 5).

**Table 5**. Reducing Sugar Content of Jelly Candy

| Formula | Reducing Sugar (%) |
|---|---|
| FI | 18.6 ± 0.7 |
| FII | 19.8 ± 0.6 |
| FIII | 21.3 ± 0.8 |

The increase in reducing sugar content observed in formulations with higher infusion concentrations may be attributed to naturally occurring sugars extracted from the plant material. Additionally, partial hydrolysis of sucrose during heating may contribute to the formation of reducing sugars (Nursten, 2005). Despite this increase, the values remained within acceptable quality limits and did not compromise product quality.

- *pH Determination*

pH measurements indicated that all formulations exhibited pH values within the acceptable range for jelly candy (4.5–6), as shown in Table 6.

**Table 6.** pH Values of Jelly Candy

| Formula | pH |
|---|---|
| FI | 5.8 ± 0.1 |
| FII | 5.6 ± 0.1 |
| FIII | 5.4 ± 0.1 |

The gradual decrease in pH with increasing infusion concentration is likely influenced by the presence of phenolic compounds and organic acids in white galangal (Wu et al., 2014). This pH range supports gel stability and contributes to inhibiting microbial growth during storage (Imeson, 2010). Moreover, acidic conditions are known to enhance gel formation and improve the stability of gelatin-based systems by promoting intermolecular interactions (Gómez-Guillén et al., 2011).

- *Weight Uniformity Test*

The weight uniformity test demonstrated that all formulations met the required criteria, with no more than two jelly candy units deviating from the average weight. This result indicates that the mixing, molding, and cooling processes were performed homogeneously and consistently, ensuring uniform product quality and dosage consistency (Ansel *et al*., 2011). Uniformity of dosage units is essential to ensure consistent delivery of active compounds, particularly in functional food and nutraceutical products (McClements, 2020).

## Conclusion

The findings of this study indicate that white galangal (Alpinia galanga L.) can be successfully developed into a functional jelly candy product through an infusion-based formulation approach. The simplisia preparation process produced good-quality raw material with acceptable physicochemical characteristics, while the infusion method effectively extracted key bioactive compounds, including flavonoids, phenolics, terpenoids, and quinones. The formulated jelly candies (FI–FIII) exhibited stable physical properties and complied with quality standards in terms of organoleptic characteristics, texture, moisture content, ash content, reducing sugar levels, pH, and weight uniformity. Variations in infusion concentration influenced color intensity, aroma, moisture content, and texture; however, all formulations remained within acceptable limits, indicating good stability of the gel system. Overall, these results suggest that white galangal infusion can be effectively incorporated into jelly candy as a promising functional food product, with potential applications in herbal-based cognitive support, although further studies on biological efficacy and consumer acceptance are still required.

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**Author Contributions**

Conceptualization, Gigih Kenanga Sari and Bentar Jatmiko; methodology, Gigih Kenanga Sari; formulation development, Gigih Kenanga Sari; validation, Gigih Kenanga Sari and Bentar Jatmiko; formal analysis, Gigih Kenanga Sari; investigation, Gigih Kenanga Sari and Ning Febriani; resources, Bentar Jatmiko; data curation, Gigih Kenanga Sari; writing—original draft preparation, Gigih Kenanga Sari; writing—review and editing, Gigih Kenanga Sari and Bentar Jatmiko; visualization, Ning Febriani; supervision, Bentar Jatmiko; project administration, Gigih Kenanga Sari; funding acquisition, Gigih Kenanga Sari. All authors have read and agreed to the published version of the manuscript.

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**Conflicts of Interest**

The authors declare no conflict of interest.

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