ORIGINAL ARTICLE

Functional and Novel Foods

Nutritional and Bioactive Profile of Gitumon: An Indonesian Traditional Herbal Beverage

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ABSTRACT

Background: In regions with limited access to or expensive conventional medical facilities, herbal remedies frequently serve as crucial healthcare alternatives. represents an innovative blend derived from two renowned traditional Indonesian *Jamu* preparations, *Kunyit Asam* and *Jamu Jahe*, enhanced with a subtle cinnamon flavor. Previous studies into Gitumon have primarily focused on its potential hepatoprotective, blood glucose-regulating, antioxidant, and anti-inflammatory properties. However, the specific ingredients and preparation methods inherently influence its nutritional value.

Aims: This study aimed to thoroughly characterize the nutrient content of Gitumon, including its energy, protein, fat, carbohydrate, and fiber composition, as well as the levels of key vitamins such as β-carotene and ascorbic acid, and minerals including iron and zinc. Furthermore, the study sought to quantify its curcumin content and assess its antioxidant activity.

Methods: All analytical techniques and measurements adhered to the guidelines established by Chem-Mix Pratama Laboratory. Specifically, the gravimetric method was employed for ash and moisture determination; the Soxhlet technique for fat extraction; the Kjeldahl method for protein quantification; the by-difference method for carbohydrate estimation; and multi-enzyme complexes for fiber analysis. Total energy content was calculated using Atwater factors. Ascorbic acid levels were determined via iodometric titration. Iron, zinc, β-carotene, and curcumin concentrations were measured using spectrophotometry. Antioxidant activity was assessed using the DPPH (2,2-diphenyl-1-picrylhydrazyl) scavenging assay, with results expressed as IC50 values. Descriptive statistical analysis techniques were applied to all generated data to identify the main features of the dataset.

Results: In each 250 mL serving, all tested varieties of Gitumon provided over 100 kcal of energy. Gitumon samples also exhibited high concentrations of vitamin C (exceeding 100 mg/100 g), iron (greater than 3.6 mg/serving), and curcumin (above 20 mg/serving). Zinc levels were found to be below 10 mg/kg. Conversely, the concentrations of β-Carotene (less than 200 µg/100 g) and DPPH antioxidant scavenging activity (IC_{50} value exceeding 100 ppm) were found to be negligible.

Conclusions: Gitumon emerges as a noteworthy beverage with a remarkably high content of vitamin C, iron, zinc, and curcumin. Nevertheless, further antioxidant assays are necessary to evaluate and confirm the potential health benefits attributable to the substantial presence of curcumin in Gitumons.

Keywords: Calorie Intake; Functional Food; *Jamu*; Micro Nutrients; Traditional Medicine.

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1 INTRODUCTION

Herbal medicine is gaining considerable international attention as both a complementary and alternative approach within contemporary healthcare strategies. Across diverse cultural contexts, herbal remedies have been utilized for centuries, exemplified by Ayurvedic practices, Traditional Chinese Medicine, and *Jamu* in Indonesia (Balkrishna *et al.,* 2024). *Jamu* represents a traditional Indonesian herbal medicine system that incorporates a holistic approach to health and wellness (Shaik *et al.,* 2023). The availability of herbal remedies offers accessible and affordable options for

wellness initiatives, particularly pertinent in low to middle-income countries where conventional medical facilities may be unaffordable and limited (Yuan *et al.,* 2016). While primarily utilized for preventive purposes, promoting well-being, and reducing the prevalence of chronic diseases, herbal remedies can also accelerate recovery and enhance the quality of life for patients with chronic conditions (Tahir *et al.,* 2022).

Jamu possesses deep historical roots within Javanese culture and is widely practiced across the island, particularly in areas such as Surakarta and Yogyakarta. This traditional system incorporates a diverse array of local herbs, spices, and other natural ingredients (Elfahmi *et al.,* 2014). Common *Jamu* constituents, including turmeric, ginger, and tamarind are frequently employed, each possessing anti-inflammatory and antioxidant properties (Sumarni *et al.,* 2019). Numerous health advantages, such as immune system modulation and enhanced digestive function, are associated with *Jamu* consumption (Wijaya *et al.,* 2017). Recognizing its profound cultural significance and the traditional knowledge embedded in its composition, production, and use, UNESCO nominated *Jamu* as an Intangible Cultural Heritage of Humanity in 2011, formally inscribing it in December 2023. This recognition underscores the imperative of preserving such practices for future generations within Indonesian culture (Ronan O'Connell, 2024).

Central Java, specifically, is characterized by its tropical rainforests, which contribute to a rich diversity of plant species, including various trees, shrubs, and unique climbing plants. Furthermore, Central Java serves as a pivotal region for spice biodiversity, contributing to Indonesia's reputation as a "spice archipelago" (Rinandio *et al.,* 2022). The region is renowned for its abundant variety of spices, including turmeric, ginger, galangal, lemongrass, and chili, all of which are essential to both Indonesian cuisine and traditional medicine (Murtini & Murdianti, 2024; Utami *et al.,* 2016).

Among the several popular types of *Jamu* in Indonesia are *Kunyit Asam*, *Empon-Empon*, *Beras Kencur*, *Sari Rami*, and *Jahe*. *Kunyit Asam* prepared from turmeric (*kunyit* in Bahasa Indonesia) and tamarind (*asam* in Bahasa Indonesia), has been the subject of numerous studies investigating its therapeutic properties (Surya *et al.,* 2023). Researchers have focused on its anti-inflammatory, antioxidant, and potential hepatoprotective properties. One mechanism for enhancing antioxidants is to consume food containing antioxidant status involves the consumption of foods rich in antioxidant compounds such as vitamin E, vitamin C, and curcumin which are generally considered safe even at high doses (Casas-Grajales, 2015).

Interestingly, despite curcumin possesses low bioavailability, a combination of curcumin (90 mg/kg) and piperine (20 mg/kg) may exert antidiabetic and antioxidant effects (Arcaro *et al.,* 2014). Curcumin has also demonstrated hepatoprotective actions in both acute and chronic liver injuries by suppressing levels of pro-inflammatory cytokines, including TNF-α, IL-1β, and IL-6 (Reyes-Gordillo *et al.,* 2007; Wang *et al.,* 2012). Additionally, a previous study stated that *Kunyit Asam* can function as a probiotic carrier for *Lactobacillus plantarum* BP102, facilitating the development of fermentation-based functional food products and suggesting its potential for promoting digestive health (Adhawati & Jatmiko, 2023).

Jamu Jahe, primarily prepared from ginger (*Zingiber Officinale*), is recognized for its diverse health benefits. Previous studies have suggested that ginger can improve insulin sensitivity and reduce blood glucose levels (Khandouzi *et al.,* 2015). The compounds 6-shoagol, zingerone, and 8-shoagol in ginger exhibit beneficial effects in both animal and human models by mitigating key indicators of inflammatory diseases such as arthritis (Bischoff-Kont & Fürst, 2021). Specifically, 6-gingerol has shown a preventive effect in lupus by decreasing neutrophil extracellular trap that is released in response to phosphodiesterase inhibition. Furthermore, ginger has been shown to reduce NF-kappaβ activity in psoriasis, and its short-term administration may serve as an alternative synergetic treatment. Hence, ginger supplementation may also offer protective effects against carcinogenesis (Ballester *et al.,* 2022).

Gitumon represents an innovative fusion of two renowned traditional Indonesian *Jamu* which are *Jamu Jahe* and *Kunyit Asam*—enhanced with the addition of cinnamon. The name "Gitumon" itself derives from the primary ingredients: ginger, turmeric, and cinnamon, reflecting its formulation the combined therapeutic properties of these herbs. Cinnamon (*Cinnamomum Burmannii*) is incorporated due to its content of essential oils and bioactive compounds such as cinnamaldehyde, cinnamic acid, and cinnamate, which exhibit antioxidant, anti-inflammatory, antidiabetic, antimicrobial, anticancer, lipid-lowering, and cardioprotective effects (Pagliari *et al.,* 2023).

Gitumon is categorized into three distinct types, differentiated by the variety of ginger used: Gitumon Emprit (GE), prepared with *Zingiber officinale* var. Amarum, Gitumon Gajah (GG), using *Zingiber officinale* Roscoe, and Gitumon Merah (GM) by using *Zingiber officinale* var. Rubrum. In addition to ginger, the formulation includes turmeric (*Curcuma Longa*), cinnamon (*Cinnamomum Burmannii*), tamarind (*Tamarindus Indica*), palm sugar, and water.

This study aimed to comprehensively analyze the nutritional content of Gitumon, including carbohydrate, fats, proteins, fibers, moisture, ash, and energy value, alongside key

micronutrients such as ascorbic acid and β-Carotene, iron (Fe), (Zn), curcumin concentration, and antioxidant activity. The growing global interest in functional foods and natural health products underscores the relevance of investigating the nutritional value and bioactive components of Gitumon. As public health awareness increases there is a rising demand for food products that offer benefits beyond basic nutrition. Understanding the nutritional profile and health-promoting properties of Gitumon may therefore contribute meaningfully to addressing this emerging consumer need.

2 Samples and Methodological Approaches

2.1 Study Design

This study employed a true experimental design utilizing a one-factor completely randomized design (CRD). The experimental approach involved the random assignment of Gitumon into different types, distinguished by the specific ginger extract juice used in their formulation: Gitumon Emprit (employing *Zingiber officinale* var. *Amarum*), Gitumon Gajah (employing *Zingiber officinale* Roscoe, and Gitumon Merah (utilizing *Zingiber officinale* var. *Rubrum*). The objective was to determine the effects of these variations on the nutritional values (total energy, ascorbic acid amount, iron content, and zinc quantity) as well as their potential antioxidant activity. Each Gitumon type was subjected to two replications for every analysis.

2.2 Preparation of Samples

As displayed in Table 1, Gitumon preparation commenced by pouring 1,000 mL of water into the pan, followed by the addition of 500 mL of turmeric-extracted juice (obtained via juicer) and 100 mL of ginger-extracted juice. Subsequently, 25 g of pre-washed cinnamon stick, 50 g of ripe tamarind, and 150 g of palm sugar were added. The mixture was then gently heated over low heat, stirred continuously, and gradually brought to a moderate boil, reaching a temperature of 100 °C. To facilitate complete infusion of the ingredients' flavor, the pan was covered, and the mixture was maintained at 100 °C for 15 minutes. Following boiling, the Gitumon mixture was allowed to cool naturally to room temperature without removing the lid. Once cooled, the Gitumon mixture was strained through a fine mesh screen or multiple layers of cheesecloth to remove particulate matter and sediment.

2.3 Procedures

All procedures and measurements conducted in this study were officially authorized and based on the established protocols by Chem-Mix Pratama Laboratory at Kretek Kidul, Jambidan, Banguntapan, Bantul, Yogyakarta, Indonesia (Postal Code: 55195). This study has received the necessary ethical clearance by the Institutional Ethics Committee of Faculty of Medicine, Universitas Diponegoro No. 634/EC/KEPK/FK-UNDIP/XI/2024, ensuring full compliance with all applicable regulations and standards for research integrity. Each sample (Gitumon Emprit, Gitumon Gajah, or Gitumon Merah) was analyzed in duplicate for every measurement.

Table 1. Gitumon Ingredients for Six Servings Every 250 mL (Source: primary research data)

No.	Ingredients	Amount
1	Drinking water	1.000 mL
2	Turmeric (*Curcuma Longa* Linn) extracted juice	500 mL
3	Ginger extracted juice GE: *Zingiber officinale* var. *Amarum* GG: *Zingiber officinale* var. *Roscoe* GM: *Zingiber officinale* var. *Rubrum*	100 mL
4	Cinnamon (*Cinnamomum Burmannii*) stick	25 g
5	Ripe tamarind (*Tamarindus Indica*)	50 g
6	Palm sugar	150 g

2.3.1 The Gravimetric Method for Moisture and Ash Content

The gravimetric method involves weighing a sample both prior and following specific drying and ashing processes. Through meticulous control of experimental conditions, this method yields reliable data on the moisture and ash content of the sample (Liang *et al.,* 2013). The moisture content reflects the amount of water contained within Gitumon, which can significantly influence its physical and chemical properties. Meanwhile, the ash content indicates the inorganic residue remaining after the sample has been completely incinerated, offering insights into its mineral composition.

Prior to the gravimetric procedure for moisture determination, the constant mass of an empty crucible was recorded (A grams). Subsequently, the sample was placed within the crucible, and their combined mass was determined (B grams). For complete drying, the crucible containing the sample was placed in a preheated oven at 105 °C for six hours. Upon completion of the drying period, the crucible was removed from the oven and allowed to cool. Finally, the crucible with the dried sample was reweighed to determine its constant weight (C grams) employing this formula:

$$Moisture\ (\%) = \frac{(A+B)-C}{B}\ X\ 100\%$$

Procedure for Ash Content:

- Weigh a clean, constant-weight crucible to determine its initial mass (A grams).
- Place the sample into the crucible and weigh the combined mass (B grams).

- Place the crucible containing the sample in a muffle furnace preheated to between 400 °C and 600 °C.
- Incinerate the sample for three hours, or until the entire sample has been completely converted to ash.
- Remove the crucible from the furnace and allow it to cool in a desiccator.
- Weigh the crucible with the ash to determine its constant mass (C grams).

Calculation for ash content

$$Ash\ (\%) = \frac{C - A}{B}\ X\ 100\%$$

2.3.2 The Soxhlet method for fat content

The Soxhlet method is based on the principle of continuous solvent extraction, where the selected solvent dissolves the fat components from a food sample (Vibala et al., 2020). The Soxhlet extractor facilitates the continuous cycling of the solvent: it evaporates, condenses over the sample, and then condenses back into the flask, thereby maximizing fat extraction efficiency. This process effectively isolates fats from other components within the sample. Following extraction, the solvent is evaporated, leaving a concentrated fat residue for precise gravimetric measurement. This method is renowned for its efficiency and reliability in determining fat content in food products.

Procedure:

- Homogenize the sample by blending or mashing until smooth.
- Place the homogenized sample into a weighing sleeve and cover it with cotton. Record the initial mass of the sample and sleeve (A grams).
- Dry the sleeve containing the sample in an oven until a constant weight is achieved. Record this weight as B grams.
- Transfer the sleeve with the dried sample into a Soxhlet apparatus. Perform extraction for six hours, allowing for approximately fifteen cycles of solvent circulation.
- After the extraction, remove the sleeve and dry the sample again in an oven until a constant weight is achieved. Record this final weight as C grams.

Calculation for Fat Content:

The fat content was calculated using the following formula:

$$Fat\ (\%) = \frac{B - C}{A}\ X\ 100\%$$

2.3.3 The Kjeldahl Method for Protein Content

The Kjeldahl method is a well-established technique for quantifying protein content, a critical nutritional parameter. This method involves three-step approach: digestion, distillation, and titration (Sáez-Plaza *et al.,* 2013). Initially, the sample is digested with concentrated sulfuric acid, which breaks down organic matter and converts nitrogen from proteins into ammonium sulfate. Subsequently, the resulting mixture is neutralized with a strong base, typically sodium hydroxide, to liberate ammonia gas. The ammonia is then distilled and collected in a known volume of acid, enabling precise quantitative analysis. By measuring the amount of nitrogen derived from the proteins, the total protein content can be calculated using an appropriate conversion factor.

Procedure:

- Weigh 0.2 grams of the mashed sample and transfer it into a Kjeldahl flask.
- Add 4 mL of concentrated H2SO4 and 0.7 grams of catalyst N (composed of 250 grams of Na2SO4, 5 grams of CuSO4, and 0.7 grams of Selenium/TiO2).
- Heat the flask in a fume hood until the mixture undergoes a distinct color change to green, indicating complete digestion.
- Allow the flask to cool after digestion is complete.
- Add 10 mL of distilled water to the cooled mixture.
- Proceed with distillation: add 20 mL of NaOH-Tio solution (a mixture of 40% NaOH and 5% Na2S2O3) to the flask. Collect the distillate in a receiving flask containing 4% H3BO3 pre-mixed with Mr-BCG indicator.
- Continue distillation until the distillate volume reaches 60 mL, observing the color shift from red to blue in the receiving flask.
- Stop the distillation process once 60 mL of distillate is collected.
- Titrate the distillate with a standard 0.02 N HCl solution. Continue titration until the color changes from blue to pink, indicating the endpoint.
- Record the volume of titrant used.

Calculation for Nitrogen Content:

$$Nitrogen\ (\%) = \frac{Titration\ Volume\ X\ HCl\ (0{,}02\ N)\ X\ Nitrogen\ Weight\ (14{,}008)}{Sample\ Weight\ (mg)}\ X\ 100\%$$

Protein content is then typically calculated by multiplying the nitrogen content by a specific conversion factor (e.g., 6.25 for general food protein).

2.3.4 The By-Difference Method for Carbohydrate Content

This approach enables the estimation of carbohydrate content by subtracting the sum of protein, fat, moisture, ash, and fiber from the total weight of the food sample (McCleary & McLoughlin, 2021). This method is widely used in nutritional analysis and food composition studies, particularly

when direct measurement of all carbohydrate components is impractical.

Calculation for Carbohydrate Content:

The carbohydrate content in Gitumon was calculated using the following formula:

$$Carbohydrate\ (\%) = 100\% - (Moisture + Ash + Protein + Fat + Fiber)$$

2.3.5 Atwater System for Total Energy Content

The Atwater System, also known as Atwater Factors, was employed to determine the total energy content of Gitumon (Novotny *et al.*, 2012). This method assigns specific caloric values to the macronutrients (proteins, carbohydrates, and fats), enabling the calculation of total energy (caloric) content in food based on its macronutrient composition.

Calculation for Energy Content:

The total energy in Gitumon was calculated using the following formula:

$$Energy\left(\frac{Kcals}{100g}\right) = (Protein\ X\ 4{,}27) + (Fat\ X\ 9{,}05) + (Carbohydrate\ X\ 3{,}85)$$

2.3.6 The Multi-Enzyme Complexes Method for Fiber Content

This technique utilizes a sophisticated combination of enzymes to effectively degrade various non-fiber components of the sample, thereby enabling the accurate measurement of dietary fiber. This method was utilized to gain a comprehensive understanding of Gitumon's nutritional properties, especially its dietary fiber content.

Procedure:

- Weigh 0.5 g of the homogenized sample and transfer it into an Erlenmeyer flask.
- Add 50 mL of pH 7 phosphate buffer and 0.1 mL of alpha-amylase enzyme.
- Heat the mixture in a water bath at 100 °C for 30 minutes with intermittent agitation.
- Remove the flask from the water bath and allow it to cool.
- Add 5 mL of 1 N HCl and 20 mL of distilled water.
- Add 1 mL of 1% pepsin enzyme and heat the mixture in a water bath for an additional 30 minutes.
- Remove the flask from the water bath, and add 0.1 mL of beta-amylase enzyme and 5 mL of 1 N NaOH.
- Seal the flask and incubate it in a water bath for one hour.
- Filter the mixture using a pre-weighed filter paper (for insoluble dietary fiber).
- Wash the retained sample on the filter paper twice with 10 mL of ethanol and twice with 10 mL of acetone.
- Dry the sample in an oven set to 105 °C overnight.
- Allow the dried sample to cool in a desiccator, then weigh it to determine the final weight of the insoluble dietary fiber.
- For soluble dietary fiber, adjust the volume of the filtrate (from step 9) to 100 mL.
- Add 400 mL of warm 95% ethanol to the filtrate.
- Allow the mixture to settle for one hour, then filter it through ash-free filter paper.
- Wash the filtrate twice with 10 mL of ethanol and twice with 10 mL of acetone.
- Dry the sample in an oven set to 105 °C overnight.
- Allow the dried sample to cool in a desiccator, then weigh it to determine the final weight of the soluble dietary fiber.

Calculation for Total Dietary Fiber:

$$Total\ Dietary\ Fiber = Insoluble\ Dietary\ Fiber + Soluble\ Dietary\ Fiber$$

2.3.7 The Iodometric Titration Method for Ascorbic Acid Levels

Iodometric titration is a sensitive and specific method for quantifying ascorbic acid (Vitamin C) levels, which is crucial for assessing its nutritional contribution in food products (Georgescu *et al.*, 2019). This technique allows for accurate measurement with minimal interference from other compounds and is relatively rapid, facilitating efficient analysis of multiple samples.

Procedure:

- Homogenize the sample by mashing or blending.
- Weigh 5–10 g of the homogenized sample and transfer it into a 100 mL Erlenmeyer flask.
- Add deionized water (Aquadest) to a measuring flask until the total volume reaches 100 mL.
- Filter or centrifuge the mixture to obtain 25 mL of clear filtrate.
- Add 2 mL of a 1% starch indicator solution to the filtrate.
- Titrate the solution using a standard 0.01 N iodine solution. The titration should be paused when the color of the solution turns blue, indicating the endpoint.
- Record the volume of iodine solution consumed during the titration.

Calculation for Vitamin C content:

Given that 1 mL of 0.01 N Iodine Solution corresponds to 0.88 mg of Vitamin C, the Vitamin C content is calculated as follows:

$$Vitamin\ C\ (mg/100g) = \frac{Titration\ Volume\ X\ Diluent\ Factor\ X\ 0{,}88}{Sample\ Weight} X\ 100$$

2.3.8 The Spectrophotometric for Iron, Zinc, β-Carotene, and Curcumin Content

Iron Content

This method involves measuring the absorption of light by the iron-containing compounds in the sample, enabling for precise determination (Alabidi *et al.*, 2021). Spectrophotometry was employed to accurately assess the iron content in Gitumon and its potential nutritional implications.

Procedure:

- Weigh 5 g of the homogenized sample and transfer it into a porcelain crucible.
- Incinerate the sample in a muffle furnace until a white ash is obtained.
- Pulverize the ash in a porcelain mortar and dissolve it in 50 mL of 1:3 HNO3.
- Filter the solution through filter paper, collecting the filtrate in a 100 mL Erlenmeyer flask.
- To 1 mL of the clear filtrate, add 2 mL of a 1.5 M ammonium thiocyanate solution. The solution will turn red if iron (Fe) is present.
- Adjust the volume to 10 mL with deionized water.
- Measure the absorbance using a spectrophotometer at a wavelength of 510 nm.
- Record the absorbance data and calculate the iron content using a pre-established standard curve for iron (Fe).

Zinc Content

Atomic Absorption Spectrophotometry (AAS) is utilized to determine the zinc concentration in food products, ensuring compliance with nutritional standards. AAS is capable of detecting low quantities of zinc, making it suitable for trace analysis, and the technique allows for the selective measurement of zinc without significant interference from other elements.

Procedure:

- Prepare a series of standard zinc solutions that encompass the expected analytical range of the samples.
- Prepare the sample solutions and a blank solution according to established protocols.
- Estimate the sample concentration to ensure it falls within the acceptable detection range of the instrument. If the concentration is unknown or outside the range, prepare appropriate dilution variations (e.g., 5X, 10X, 50X dilutions).
- Measure the absorbance of the standard, sample, and blank solutions using an atomic absorption spectrophotometer set to a wavelength of 215 nm.
- Calculate the zinc content based on the absorbance readings and the standard curve.

β-Carotene Content

β-Carotene, a precursor to vitamin A, possesses significant antioxidant properties. Quantifying its content is essential for assessing the nutritional quality of foods, particularly fruits and vegetables, and supports dietary recommendations. β-Carotene in Gitumon is measured using a spectrophotometric method.

Procedure for Total Carotenoids:

- Weigh 5 g of Gitumon and transfer it into an Erlenmeyer flask.
- Homogenize the sample using a 1:1 ratio of petroleum ether and acetone, with carotenoid-free sand to facilitate smooth grinding.
- Continue grinding and adding petroleum ether and acetone until the yellow carotene extract is completely removed.
- Collect the filtrate in a flask.
- Pour 50 mL of distilled water into a separating funnel, shake, and allow to settle for five minutes. The carotene, being soluble in petroleum ether, will form the upper layer, while water-soluble acetone will be in the lower layer.
- Collect the upper layer in a fresh Erlenmeyer flask and discard the bottom layer.
- Add anhydrous Na2SO4 to absorb any residual water, then adjust the volume with petroleum ether to achieve the required volume.
- Measure the absorbance at 450 nm using a spectrophotometer.
- Record the data and calculate the total carotenoid or total carotene content.

Procedure for β-Carotene Specific Quantification:

- Perform steps 1–5 as described for Total Carotenoids.
- Transfer the filtrate into a chromatography column packed with cotton, glass wool, Al2O3, and anhydrous Na2SO4.
- Activate the column at 180 °C for two hours.
- Wash the column with acetone and petroleum ether.
- Add the filtrate to the column and collect the fraction containing β-Carotene as it elutes.
- Dilute the obtained β-Carotene filtrate with petroleum ether.
- Measure the absorbance at 450 nm using a spectrophotometer.
- Record the data and calculate the amount of β-Carotene.
- A reference β-Carotene standard curve should be prepared for accurate quantification.

Curcumin Content

Curcumin content can be analyzed using UV-Vis spectrophotometry, typically at a wavelength of approximately 425 nm, where it exhibits strong absorbance.

Procedure:

- Weigh 1 g of Gitumon and transfer it into a 100 mL Erlenmeyer flask.
- Mill the mixture in a porcelain mortar after adding 100 mL of 96% ethanol.
- Transfer 1 mL of the solution into a test tube.
- Add 9 mL of 96% ethanol to the test tube.
- Vortex the solution thoroughly.
- Measure the absorbance using a spectrophotometer at a wavelength of 427 nm.
- Record the absorbance reading.
- Prepare a standard curve using pure curcumin as a reference.

Calculation for Curcumin Levels:

The curcumin content is calculated using the following formula:

$$Curcumin\ Levels(\%) = \frac{X\ x\ Diluent\ Factor}{Sample(mg)} X\ 100\%$$

$$X = \frac{y - a}{b}$$

2.3.9 Molyneux's Method (DPPH) for Antioxidant IC_{50}

The DPPH (2,2-diphenyl-1-picrylhydrazyl) assay, following the Molyneux's method, was utilized to assess antioxidant activity. This method relies on the deep violet color of the DPPH radical, which changes to yellow upon reduction by antioxidants, allowing for straightforward quantification of their free radical scavenging ability (Molyneux, 2004).

Procedure:

- Prepare sample solutions at various concentrations, such as 100, 200, 300, 400, and 500 parts per million (ppm).
- Pipette 1 mL of each sample solution into separate test tubes.
- Add 1 mL of a 200 µM DPPH solution to each test tube.
- Incubate the tubes in a dark room for 30 minutes.
- After incubation, dilute each sample with 5 mL of ethanol.
- Prepare a blank solution by combining 4 mL of ethanol with 1 mL of DPPH solution.
- Measure the absorbance of each sample and the blank at 517 nm using a spectrophotometer.

Calculation for Inhibition Percentage:

The percentage of inhibition is calculated using the following formula:

$$Inhibition\ (\%) = \frac{OD\ Blank - OD\ Sample}{OD\ Blank} X\ 100\%$$

Where OD Blank is the optical density of the blank solution and OD Sample is the optical density of the sample solution.

Determination of IC_{50} Value:

- Plot a linear regression graph with the sample concentration (ppm) on the X-axis and the percentage of inhibition on the Y-axis.
- Obtain the straight-line equation (y=a+bx) from the graph.
- Set 'y' to 50 (representing 50% inhibition) and solve for 'x' to determine the IC50 value. The IC50 value represents the antioxidant concentration required to achieve a 50% reduction in free radicals.
- Compare the determined IC50 value of the sample to that of a recognized antioxidant standard, such as vitamin C.

2.4 Statistical Analysis

All data were subjected to descriptive statistical analysis to summarize the key characteristics of the dataset. This approach provides a comprehensive overview of the results. The findings are expressed as averages (means), indicating the typical values observed, along with standard deviations to illustrate the variability within the data.

3 Results

3.1 Nutrient Content

Table 2 summarizes the nutritional composition of Gitumon, including moisture, ash, fats, proteins, carbohydrates, total fibers, soluble fibers, insoluble fibers, and energy content. As presented in the table, the calorie content of Gitumon exhibits slight variations across its different formulations. In each 250 mL serving, Gitumon Merah yielded the highest total energy at 115.70 kcal, while Gitumon Emprit provided 111.07 kcal, and Gitumon Gajah offered 103.67 kcal. All Gitumon types contained less than 10% carbohydrates (GE: 8.41%, GG: 8.55%, and GM: 9.33%). Furthermore, protein content was recorded as 1.24% for GE, 0.90% for GC, and 1.09% for GM. Fat content was 0.75% for GE, 0.52% for GG, and 0.63% for GM. Additionally, GE demonstrated the highest fiber content, followed by GM, and then GG. It is important to acknowledge that variations in nutritional content may occur based on ingredient variations.

Table 2. Proximate Composition Analysis of Gitumon Types (Source: primary research data)

Gitumon Types	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Carbohydrate (%)	Total Fiber (%)	Soluble Fiber (%)	Insoluble Fiber (%)	Energy (kcal/100 g)
GE mean ± SD	87.21 ± 0.01	0.61 ± 0.00	0.75 ± 0.06	1.24 ± 0.05	8.41 ± 0.20	1.79 ± 0.07	0.25 ± 0.00	1.53 ± 0.07	44.43 ± 0.00
GG mean ± SD	88.08 ± 0.10	0.55 ± 0.07	0.52 ± 0.03	0.90 ± 0.06	8.55 ± 0.00	1.40 ± 0.12	0.19 ± 0.01	1.21 ± 0.10	41.47 ± 0.49
GM mean ± SD	87.20 ± 0.10	0.30 ± 0.07	0.63 ± 0.03	1.09 ± 0.08	9.33 ± 0.03	1.44 ± 0.12	0.24 ± 0.02	1.21 ± 0.10	46.28 ± 0.23

3.2 Ascorbic Acid Amount

Figure 1 illustrates the varying ascorbic acid (Vitamin C) content across the different Gitumon types. Gitumon Merah exhibited the highest of vitamin C (153.30 mg per 250 mL serving), compared Gitumon Emprit (121.72 mg), and Gitumon Gajah (113.80 mg) for the same serving size.

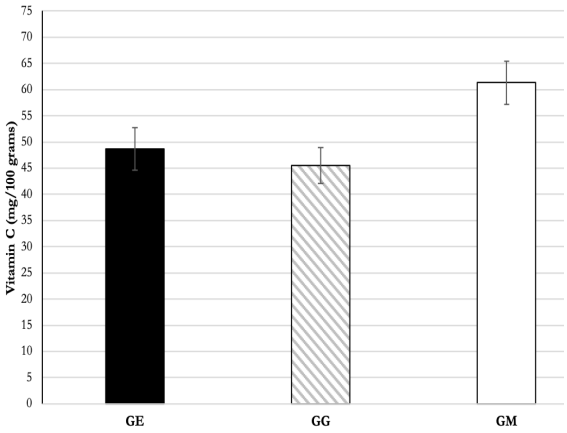

Figure 1. Vitamin C in All Types of Gitumon (*Source: primary research data*)

3.3 Iron Content

Figure 2 demonstrates that all Gitumon types contained a relatively high iron (Fe) content. Based on a 250 mL serving, Gitumon Gajah presented the highest iron content (13.25 mg), followed by Gitumon Emprit (12.17 mg), and Gitumon Merah (10.92 mg).

3.4 Zinc Quantity

Figure 3 indicates that Gitumon Emprit contained the lowest zinc content among the three kinds examined, at 1.85 ppm. In contrast, Gitumon Merah exhibited 2.22 ppm of zinc, while Gitumon Gajah displayed a higher content at 2.55 ppm. These results emphasize the potential nutritional contributions of Gitumon.

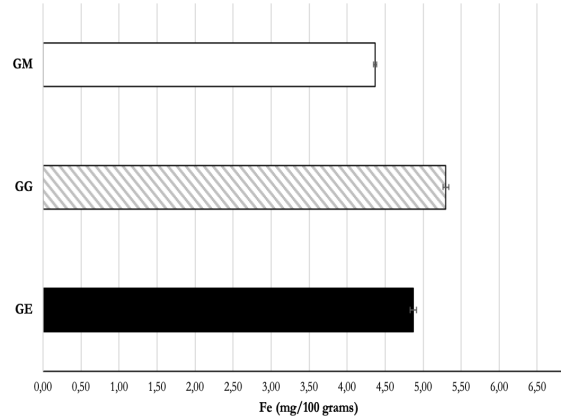

Figure 2. Iron (Fe) in All Types of Gitumon (*Source: primary research data*)

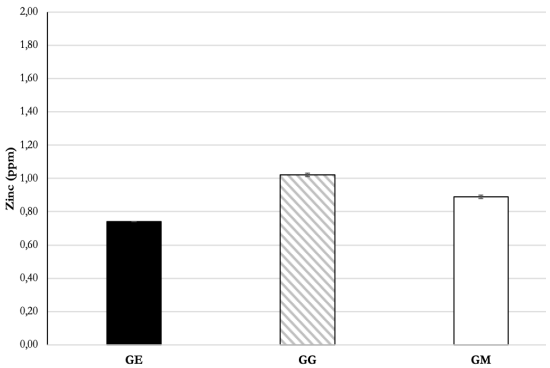

Figure 3. Zinc Quantity in All Types of Gitumon (*Source: primary research data*)

3.5 3.5 β-Carotene, Curcumin, and Antioxidant-IC50

Based on the data presented in Table 3, all Gitumon types exhibited low levels of β-Carotene per 100 mL (GM: 51.43 µg/100 g, GG 29.60 µg/100 g, and GE: 22.19 µg/100 g). The curcumin levels for GE and GG were found to be 11%, which translates to 27.5 g (or 27.500 mg) per 250 mL, a concentration considered high. Meanwhile, the curcumin amount in GM (10%) was marginally less compared to GE

and GG, equating to 25,000 mg per 250 mL. DPPH antioxidant scavenging activity data revealed that GM recorded the lowest IC_{50} value (2499.23 ppm), indicating higher antioxidant potency, followed by GE (2986.01 ppm), and then GG (3452.00 ppm).

Table 3. Antioxidants Activity in All Gitumon Types (Source: primary research data)

Gitumon Types	β-Carotene (µg/100g)	Curcumin (%)	Antioxidant-IC_{50} (ppm)
GE mean ± SD	22.19 ± 1.35	0.11 ± 0.00	2986.01 ± 11.68
GG mean ± SD	29.60 ± 1.34	0.11 ± 0.00	3452.00 ± 26.57
GM mean ± SD	51.43 ±1.48	0.10 ± 0.00	2499.23 ± 10.30

4 Discussion

The primary objective of the current study was to comprehensively evaluate the nutritional composition of Gitumon, including its energy, carbohydrate, fat, protein, fiber, moisture, and ash content, alongside its micronutrient profile (ascorbic acid and β-Carotene, iron (Fe), and zinc (Zn)), curcumin concentration, and antioxidant activity.

The observed high moisture levels in Gitumon are directly attributable to its liquid formulation. Moisture content is a critical determinant of a food product's texture and shelf life (Ansari *et al.,* 2014). Similarly, fat content can significantly influence the sensory properties of food (Forde & de Graaf, 2022). The ash content in Gitumon, representing the inorganic residue after combustion, indicates the presence of mineral components and soluble metal parts (Yesilyurt *et al.,* 2020), which may be correlated with the detected iron and zinc levels.

The fiber content in Gitumon was found to be relatively low. Dietary fiber is recognized for its role in reducing total and low-density lipoprotein cholesterol (Soliman, 2019). Soluble dietary fibers, owing to their high fermentation efficiency, are particularly advantageous in enhancing gut microbiota health (Guan *et al.,* 2021). Concurrently, insoluble fibers contribute to the maintenance of regular bowel movements, thereby softening stool and facilitating easier passage, which helps prevent constipation. Additionally, they also add bulk to stools, preventing them from becoming loose (Fardet, 2010).

The total energy content of each 250 mL serving of Gitumon, exceeding 100 kcal, classifies it as a high-energy beverage according to the Standard Nasional Indonesia for energy drinks (SNI 01-6684-2002) issued by The National Standardization Agency of Indonesia. This energy profile is likely attributed to its carbohydrate content. This nutritional composition positions Gitumon competitively within the contemporary market of commercial energy drinks (Al-Shaar *et al.,* 2017). While some energy drinks primarily rely on high caffeine or sugar content for rapid energy boosts, Gitumon's balanced macronutrient profile may appeal to customers seeking a moderate energy release f without the excessive sugar often found in conventional brands (Bailey *et al.,* 2014).

The inclusion of palm sugar in Gitumon contributes a natural source of carbohydrates, essential for energy production (Srikaeo *et al.,* 2019). Palm sugar's relatively low glycemic index, compared to refined sugars, facilitates a more sustained energy release without inducing rapid spikes in blood glucose levels (Kempe *et al.,* 2005). Additionally, tamarind contributes natural sugars, dietary fiber, and essential vitamins, such as vitamin C, B vitamins (B1, B2, B3, B9), and a minor amount of vitamin A. The organic acids present in tamarind may also contribute to energy metabolism (Hamacek *et al.,* 2013).

Gitumon serves as an excellent complement to a balanced diet, notably due to its high ascorbic acid (Vitamin C) content. Vitamin C, a water-soluble vitamin and a potent antioxidant, is indispensable for maintaining bone and connective tissue health and aids to improve skin health, bolsters immunological function, and facilitates iron absorption (Li *et al.,* 2020). Furthermore, it functions as a coenzyme and reducing agent in several metabolic processes (Fujii *et al.,* 2022; Son *et al.,* 2018). Vitamin C content is typically categorized as low (50 mg/100 g), moderate (50 – 100 mg/100 g), or high (100 mg/100 g) (Levine *et al.,* 2001). Recommended Dietary Allowances (RDAs) for vitamin C vary based on age, sex, and life stage. Generally, daily intakes exceeding 2,000 mg can lead to gastrointestinal distress and other adverse effects (Hathcock *et al.,* 2005). The high amount of vitamin C across all Gitumon types is likely attributable to the inclusion of tamarind, which is recognized as a significant source of this vitamin (Hamacek *et al.,* 2013). While turmeric and ginger do not contribute substantially to vitamin C levels, they enhance the drink's overall nutritional profile. Turmeric provides antioxidant properties through curcumin, promoting general health, while ginger offers digestive and anti-inflammatory benefits (Unuofin *et al.,* 2021). Consequently, Gitumon's reputation as a high vitamin C beverage is likely influenced by the synergistic combination of tamarind with the complementary effects of ginger and turmeric.

Based on the research data, all Gitumon types exhibited a high iron (Fe) content. Iron is a vital mineral primarily involved in the synthesis of hemoglobin (Hb), the protein responsible for oxygen transport in the blood, and is crucial for numerous physiological processes (Rafati Rahimzadeh *et al.,* 2023). Achieving optimal iron intake for health necessitates a balanced diet incorporating diverse heme and

non-heme iron sources. Heme iron, found in meats, poultry, and shellfish, demonstrates higher bioavailability and is more readily absorbed than non-heme iron (Lesjak & Srai, 2019). Adequate iron intake contributes to preventing anemia and boosting energy levels. Furthermore, co-ingestion of non-heme iron sources with vitamin C-rich foods (e.g., broccoli, bell peppers, and citrus fruits) can significantly improve iron absorption (Li *et al.,* 2020). According to the daily value (DV) guidelines, iron content is considered high if it exceeds 20% of the DV (equivalent to > 3.6 mg per serving) moderate if it falls between 10% and 20% of the DV (1.8 mg to 3.6 mg per serving), and low if it is below 10% (< 1.8 mg per serving) (Swanson, 2003). The high iron content in Gitumon is likely predominantly due to tamarind, with ginger and turmeric contributing to a lesser extent (Hamacek *et al.,* 2013). The components of Gitumon may synergistically enhance iron absorption. For instance, tamarind's vitamin C can increase the bioavailability of non-heme iron, thereby improving the body's ability to absorb iron from plant sources. Hence, iron requirements vary based on age, sex, health conditions, and individual needs. Iron deficiency is more prevalent among pregnant women, vegetarians, and women of childbearing age. However, excessive iron intake can lead to toxicity and adverse health outcomes (Piskin *et al.,* 2022).

Zinc is another essential mineral evaluated in Gitumon. Although the zinc quantity in Gitumons is modest, zinc is indispensable for numerous physiological processes, including DNA synthesis, wound healing, and immune response (Maywald & Rink, 2022). While ginger and turmeric contribute relatively low amounts of zinc compared to tamarind, these herbs collectively enhance Gitumon's zinc content, positioning it as a good source of this mineral (Hamacek *et al.,* 2013). The human body typically contains two to three grams of zinc, and given that zinc deficiency affects approximately 25% of the global population, its prevention is essential for human health (Hashimoto & Kambe, 2022). The recommended daily zinc intake varies depending on factors such as age, sex, health status, and socioeconomic factors. For instance, the average daily zinc intake is 12.3 mg, however it can range from 11.2 mg for low-income individuals to 13.3 mg for high-income individuals, and specific recommendations exist for various demographics (e.g., older individuals: 10.2 mg/day, factory workers: 12.9 mg/day, college students: 11.5 mg/day, and kindergarten students: 8.4 mg/day) (Mai *et al.,* 2024). Additionally, zinc from animal sources generally exhibits higher bioavailability than zinc from plant sources (Freeland-Graves *et al.*, 2020). Zinc content in food is categorized as high (25–50 mg/kg raw weight), moderate (10–25 mg/kg), or modest (<10 mg/kg). Parts per million (ppm), is a frequent unit for expressing zinc quantity in food, with one ppm equivalent to one milligram per liter (mg/L) or one milligram per kilogram (mg/kg) of the substance (*Fischer et al.,* 2021; Gupta *et al.,* 2020). Zinc absorption occurs throughout the small intestine and is concentration-dependent, influenced by the presence of proteins. When zinc is administered to fasting subjects in aqueous solutions, absorption efficiency is higher (60–70%) compared to absorption from solid diets (Maares & Haase, 2020).

The β-carotene levels in all Gitumon types were found to be low. β-Carotene content in food is generally classified as high (> 1,000 µg/100 g), moderate (200–1,000 µg/100 g), or low (< 200 µg/100 g) (Carazo *et al.,* 2021). Food products rich in β-carotene are typically colorful fruits and vegetables such as carrots, sweet potatoes, spinach, and kale, and are recommended to meet the vitamin A requirements (Moulick *et al.,* 2023). The recommended intake of β-carotene, as a vitamin A precursor, generally emphasizes obtaining it from a balanced diet rich in fruits and vegetables rather than supplements. The RDA for β-carotene alone is not typically provided; instead, the focus is on vitamin A intake, measured in micrograms of Retinol Activity Equivalents (RAE) (Carazo *et al.,* 2021). Given that Gitumon is composed of spices rather than fruits or vegetables, this may contribute to its β-carotene levels. A previous study indicated that extracted turmeric exhibited higher total flavonoids, phenolic contents, and total antioxidant activity than beetroot and carrot (Moulick *et al.,* 2023). However, the precise reason for the low β-carotene levels across all Gitumon types remains not fully elucidated. It is highly probable that the preparation method and the type of herbs being used (Lee *et al.,* 2018), particularly the boiling process above 60 °C, may lead to the degradation of certain nutrient contents, such as β-Carotene (Souza *et al.,* 2022).

Curcumin, a polyphenol predominantly found in turmeric, is widely utilized as a spice, coloring agent, and herbal remedy in food applications. The concentration of curcumin within food or ingredients is frequently expressed as a percentage of the overall weight (Tsuda, 2018). The optimal recommended amount of curcumin for health benefits varies based on individual health conditions, desired therapeutic effects, and the specific form of curcumin consumed (Hewlings & Kalman, 2017). The use of curcuminoids as antioxidant and flavoring agents at maximum levels exceeding 20 mg/serving in specific foods is considered safe (Balkrishna *et al.*, 2024). However, curcumin is known for its low bioavailability, meaning it is poorly absorbed by the body. To enhance absorption, it is commonly advised to consume curcumin with fats or black pepper, which contains piperine (Lopresti, 2018).

Given that ginger, turmeric, and cinnamon are the main ingredients of Gitumon, evaluating its radical scavenging

activity is of significant interest, especially considering the high curcumin content across all Gitumon types. The IC_{50} value, measured in ppm represents the concentration of a substance (e.g., food or its component) required to inhibit a particular biological or biochemical function by 50%. A low IC_{50} value indicates high potency, a moderate IC_{50} value indicates moderate potency, and a high IC_{50} value (> 100 ppm) suggests low potency (Baliyan *et al.,* 2022). All Gitumon types exhibited high IC_{50} values, implying that a comparatively high concentration of Gitumon is necessary to achieve a 50% inhibition of free radicals in the tested system. In practical terms, this could suggest that Gitumon's active compounds are not highly potent inhibitors in the DPPH assay. This outcome contrasts with a previous study that reported significantly higher radical scavenging activity for turmeric extract (IC_{50} value: 13.46 µg/mL) compared to beetroot (IC_{50} value: 380.61 µg/mL) and carrot (IC_{50} value: 1252.85 µg/mL) (Moulick *et al.,* 2023). This discrepancy may be attributed to the form of curcumin (extracted curcumin versus turmeric-extracted juice) or other factors related to the complex matrix of Gitumon. Nevertheless, given the high curcumin levels in Gitumon despite the high IC_{50} values in the DPPH assay, it is recommended that additional antioxidant activity tests, such as FRAP (Ferric Reducing Antioxidant Power) and/or ESR (Electron Spin Resonance) assays, be conducted in subsequent research to comprehensively assess Gitumon's antioxidant potential.

Although β-Carotene and DPPH antioxidant scavenging activity were not present in significant amounts, the combination of high amounts of vitamin C, iron content, and zinc offers a robust foundation for fostering health and well-being. Based on its nutritional profile, Gitumon may function not merely as a traditional herbal drink but also as an energy-boosting beverage capable of enhancing iron levels, supporting immunity, and supplying vital minerals frequently deficient in contemporary diets. These collective benefits may offer diverse health advantages depending on the target population.

This study acknowledges several limitations. Firstly, the use of sample duplicates rather than triplicates may affect data reliability and statistical confidence. Secondly, the origin of the ingredients (e.g., summer vs. winter harvest, high vs. low altitude) was not specified, which could influence nutrient content. Thirdly, the exclusive use of the DPPH assay limits the comprehensive understanding of Gitumon's antioxidant potential; incorporating other antioxidant assays such as ABTS (2,2′-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid)) and FRAP (Ferric Reducing Antioxidant Power) assays would provide more detailed insights into the bioactive compounds of Gitumon.

5 Conclusions

The examination of different Gitumon formulations reveals a spectrum of nutritional benefits. Gitumon Merah (GM) exhibited the highest caloric and vitamin C content, along with a powerful antioxidant activity. Gitumon Gajah (GG) contained the maximum iron content per serving, whereas Gitumon Emprit (GE) demonstrated the highest fiber and zinc content. These distinct nutritional profiles position Gitumon as a beneficial beverage for enhancing iron status, providing antioxidants, and supporting healthy immune function. Based on these outcomes, nutritionists, medical practitioners, and related professionals can incorporate Gitumon into various dietary regimens to potentially improve metabolic health, immunological function, and overall well-being. The bioactive components of Gitumon, such as curcumin, may offer therapeutic benefits for inflammation and oxidative stress, making it a valuable addition to both preventative and therapeutic diets. Finally, further research, particularly clinical studies, is warranted to investigate the long-term effects of Gitumon consumption on individual health outcomes and its potential role in mitigating nutritional deficiencies.

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