MEDFARM: Jurnal Farmasi dan Kesehatan, Vol. 14, No. 2, 2025, Page 306-324
e-ISSN : 2715-9957
p-ISSN: 2354-8487

Quality Evaluation and Phytochemical Screening of *Kaempferia galanga* and *Zingiber zerumbet* Rhizome Extracts

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ABSTRACT

Indonesia has rich biodiversity that provides potential sources of traditional medicine, including *Kaempferia galanga* and *Zingiber zerumbet* rhizomes, which are widely used in ethnomedicine. This study aimed to evaluate the quality parameters and phytochemical constituents of both rhizomes in accordance with pharmacopoeial standards. The research involved simplicia preparation, extraction using 96% ethanol by maceration, and subsequent quality testing, including specific, non-specific, and phytochemical screening. Macroscopic and microscopic examinations confirmed the authenticity of the rhizomes, and purity tests showed that foreign organic matter levels were within the acceptable limits (≤2%). The extractive values demonstrated that *K. galanga* had a higher water-soluble content, whereas the two species had comparable ethanol fractions. Specific and non-specific quality parameters were quantitatively determined in compliance with the Indonesian Herbal Pharmacopoeia. The water-soluble extractive value was 11.30% for *K. galanga* and 9.20% for *Z. zerumbet*, while ethanol-soluble extractive values were both 5.30%. Loss on drying and moisture content remained below 10% for both rhizomes, meeting the required threshold. Specific gravity values of 0.8367 g/mL (*K. galanga*) and 0.79 g/mL (*Z. zerumbet*) indicated proper extract concentration. These parameters confirm the extracts' quality, stability, and suitability for further phytopharmaceutical development.

Keywords: Herbal standardization, pharmacognostic analysis, secondary metabolites, traditional medicine, ethnopharmacology

Introduction

Indonesia is recognized as a country with vast biodiversity (Efrilia et al., 2024). This biological richness holds significant potential for the development of drugs derived from natural products (Aristyawan et al., 2024). The use of natural product-based medicines has been practiced empirically for generations, rooted in ancestral knowledge (Ambarwati & Chandra, 2025).

Indonesia is particularly well-known for its agricultural products and spices, a reputation supported by its tropical geographical location and consistently high annual rainfall. These natural resources offer substantial opportunities to be developed as raw materials for traditional medicines (Kepel & Bodhi, 2020)(Efrilia et al., 2024)

Among the medicinal plants widely used by the Indonesian population are Kaempferia galanga (commonly known as aromatic ginger) and Zingiber zerumbet (locally known as lempuyang gajah) rhizomes (Elianasari & Arsy Fauziah, 2023)(Wahidah et al., 2021). These plants are indigenous to Indonesia and have long been used in traditional medicine (Silalahi, 2018)(Jayani, 2023).

Research data indicate that Kaempferia galanga rhizomes have anti-inflammatory activity in carrageenan-induced animal models (Khasanah, 2024), inhibit Candida albicans growth in vitro (Annisah, 2018), and demonstrate antioxidant activity through 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging assays (Muhafidzah et al., 2010).

In contrast, Zingiber zerumbet rhizomes have been studied for their anti-ulcer activity (Cahyani, 2023), in vitro α-amylase inhibitory effect (Fathiyah, 2023), antibacterial properties against Streptococcus pneumoniae (Rohmah et al., 2022), insecticidal potential (Tafsir et al., 2015), and inhibition of heme polymerization in antimalarial screening assays (Aulia, 2024).

The use of K. galanga and Zingiber zerumbet as natural-based traditional remedies can be tailored to the public health needs and personal well-being. Therefore, research on traditional medicines as part of Indonesia's cultural heritage must be enhanced particularly in the cultivation of natural medicinal plants that are safe, effective, and of high quality (Syahidan & Wardhana, 2019).

Quality evaluation involves the determination of both specific and non-specific parameters (Hermawati et al., 2023)(Kemenkes RI, 2017). These quality tests aim to ensure consistency and therapeutic efficacy, as well as to maintain the stability and safety of simplicia and plant extracts, thereby optimizing their application (Irma, Taebe and Noer, 2023; Burhan, Hardianti and Mujilah, 2019).

Methodology

Equipment

The equipment used in this study included a vacuum rotary evaporator, oven, analytical balance, water bath, furnace, magnifying glass, crucible dish, crucible tongs, and mesh sieves. 4 and 18, an evaporating dish, a microscope, a volumetric flask, a funnel, a tweezers desiccator, a pycnometer, and other standard laboratory apparatus.

Materials

The materials included simplicia, Kaempferia galanga (*Kaempferia galanga* L.) and Zingiber zerumbet rhizome (*Zingiber zerumbet* (L.) Roscoe ex Sm.,) 96% ethanol, 10% HCl, chloral hydrate reagent, distilled water, filter paper, Mayer's, Wagner's, and Dragendorff's reagents, magnesium powder and HCl, ferric chloride, gelatin, diphenylamine, and other reagents.

Plant Determination

The botanical identity of *Kaempferia galanga* and *Zingiber zerumbet* rhizomes used in this study was confirmed through a plant determination process to ensure sample authenticity (Ekayani, Juliantoni and Hakim, 2021; Chandra, Laksmitawati and Rahmat, 2022).. Determination was performed at the Herbal Materia Medica Laboratory, Batu, Malang City, Indonesia.

Preparation of the Simplicia Formula

Fresh rhizomes were obtained from a rhizome plantation in Jatinegara, East Jakarta, Indonesia. The preparation involved cleaning (wet sorting), washing, slicing to a thickness of 2 mm, drying, and dry sorting (Irma, Taebe and Noer, 2023; Rakhmawatie and Marfu'ati, 2023). The dried material was powdered to a fine degree corresponding to mesh sizes of 4/18, as specified in the *MMI.* The resulting powder was stored in clean, airtight containers.

Extract Preparation

A total of 183.12 g of *Kaempferia galanga* powdered simplicia and 242.16 g of *Zingiber zerumbet* powdered simplicia were subjected to maceration using 96% ethanol as the solvent, with a ratio of 1 g of powder to 10 mL of (Kemenkes RI, 2017)(Handayani et al., 2024). The extraction involved intermittent stirring during the first 6 hours, followed by soaking for 18 hours and extension for up to 5 days (Panca et al., 2022)(Kemenkes RI, 2017). The liquid extract was filtered, concentrated using a vacuum rotary evaporator, and evaporated in a water bath to yield a viscous extract.

Purity and particle size of Simplicia optical system

Foreign Organic Matter (FOM)

Simplicia were spread on white paper, and the visible foreign organic matter was manually separated and weighed. The FM percentage was then calculated (Harpina et al., 2022).

Powder Fineness

Powdered simplicia was sieved using mesh no. 4, and the passing material was re-sieved using mesh no. 18. The proportion of powder retained or passed through each mesh was calculated based on the weight of the original sample (Depkes RI, 2000).

Evaluation of the specific parameters

Identity

Includes the naming of the simplicia and extract, the Latin name of the plant, the plant part used, and the common Indonesian name (Depkes RI, 2000).

Organoleptic Evaluation

The form, odor, taste, and color were assessed. Descriptive terms such as "odorless," "slightly characteristic," or "distinctive" were used after exposing the sample to air for 15 min, using up to 25 g in a 100 mL evaporating dish (Depkes RI, 2000; Depkes RI, 2008).

Macroscopic Examination

Morphology and color specificity of rhizome simplicia were observed with or without magnification (Utami et al., 2017).

Microscopic Examination

Microscopic analysis of powdered simplicia was performed using chloral hydrate reagent to identify characteristic rhizome fragments (Depkes RI, 2008; Utami *et al.*, 2017).

The water-soluble extractive value

Five grams of simplicia and extract were macerated with 100 mL chloroform-saturated water, shaken for 6 h, left for 18 h, filtered, evaporated to dryness, and heated to constant weight at 105°C. The percentage yield was calculated as follows (Kemenkes RI, 2017).

Ethanol-soluble extractive value

Similar to the water-soluble test but with 96% ethanol as the solvent (Kemenkes RI, 2017).

Evaluation of the nonspecific parameters

Loss on drying

Each sample (2 g) was placed in pre-weighed porcelain crucibles, dried in an oven to a constant weight at 105°C, and cooled in a desiccator. The test was replicated three times, and the percentage was calculated (Kemenkes RI, 2017).

Moisture Content

Same procedure as for loss on drying (Kemenkes RI, 2017).

Specific Gravity

Each extract (5 g) was diluted to 100 mL in 96% ethanol and then weighed. The specific gravity was determined by comparing the extract density with that of water at 25°C (Kemenkes RI, 2017).

Phytochemical Screening

Mayer's Reagent: 1.36 g $HgCl_2$ in 60 mL distilled water mixed with 5 g KI in 10 mL distilled water, diluted to 100 mL.

Dragendorff's Reagent: 8 g of KI in 20 mL of water mixed with 0.85 g of bismuth subnitrate in acetic acid and water, stored in a brown bottle.

Wagner's Reagent: 1.27 g I_2 and 2 g of KI in 5 mL of water, diluted to 100 mL.

Liebermann-Burchard's reagent: Acetic anhydride and concentrated sulfuric acid in a 3:1 ratio (Julianto, 2019).

Alkaloid Identification

The samples were treated with chloroform and ammonia, followed by H_2SO_4. The upper layer was tested using the Mayer, Wagner, and Dragendorff reagents. The formation of a white, orange-red, or brown precipitate was a positive result.

Flavonoid Identification

The filtrate from boiling the extract in water was reacted with Mg powder and concentrated HCl. A red, yellow, or orange color indicates flavonoids.

Saponin Identification

Foam Test: Persistent foam after shaking and HCl addition indicated saponins.

Color Test: Heat treatment of the extract in chloroform with Liebermann-Burchard reagent resulted in brown/violet (triterpenoid) or green/blue (steroidal) color (Harborne, 1987).

Tannin Identification

Ferric chloride test: Greenish black or bluish-black color.

Gelatin test: White precipitate formation.

Ferricyanide-Ammonia Test: Deep red color indicates tannins (Harborne, 1987). (Nasyanka, 2020).

Glycoside Identification

The extract was mixed with diphenylamine, HCl, and GCA. Heating at 110°C for 30-40 minutes, followed by TLC or color observation, revealed a blue spot indicating glycosides (Julianto, 2019).

Data Analysis

This study employed both qualitative descriptive and quantitative methods and laboratory-based experimental approaches.

Result and Discussion

Table 1. Yield Calculation of 96% Ethanol Extract from *Kaempferia galanga* and *Zingiber zerumbet* Rhizomes

No	Extract Parameters	Unit	*Kaempferia galanga*	*Zingiber zerumbet*
1	Fresh Simplicia Weight	Kg	1.00	1.00
2	Dried Simplicia Weight	Gram	183.12	242.16
3	Thick Extract Weight	Gram	33.99	35.48
4	Yield	%	18.56	14.65
5	DER-native	-	5.3875	6.8252

The extraction of K. galanga and Z. zerumbet rhizomes using 96% ethanol revealed notable differences in yield efficiency despite the use of the same fresh simplicia weight (1.00 kg). K. galanga produced 183.12 g of dried simplicia, whereas Z. zerumbet produced 242.16 g. This difference is primarily attributed to the distinct moisture content of the two rhizomes. Z. zerumbet generally possesses a higher initial water content and retains a higher dry mass after drying than K. galanga.

Additionally, the thicker storage tissue in Z. zerumbet rhizomes contributes to this difference in dried weight (Christian & Rahmat, 2022).

Following maceration with 96% ethanol, the concentrated extract weights of K. galanga and Z. zerumbet were 33.99 and 35.48 g, respectively. Although these values were relatively close, the yield percentages significantly differed. The extraction yield of K. galanga was 18.56%, whereas that of Z. zerumbet was only 14.65%. This finding indicates that dried simplicia of K. galanga is more efficient than Z. zerumbet in releasing ethanol-soluble secondary metabolites. This can be explained by the higher solubility of polar and semi-polar compounds such as flavonoids, phenolics, and certain alkaloids commonly found in K. galanga. In contrast, Z. zerumbet contains a higher proportion of terpenoids and essential oils, which are better extracted using less polar solvents (Christian Yulius, Rahmat Deni, 2022).

The Drug Extract Ratio (DER-native provides further insight into extract concentration. The DER-native of K. galanga was 5.3875, compared to 6.8252 for Z. zerumbet was 6.8252. A lower DER-native indicates that less raw material is required to produce a given amount of extract, indicating a higher concentration of bioactive constituents. Therefore, K. galanga extract is more concentrated and potentially richer in phytochemicals than Z. zerumbet, which requires more raw material to produce a comparable amount of extract (Christian Yulius, Rahmat Deni, 2022).

Taken together, these results demonstrate that K. galanga exhibits a higher extraction efficiency and produces a more concentrated ethanolic extract than Z. zerumbet. This suggests that K. galanga may serve as a more practical candidate for the development of standardized herbal preparations, particularly when ethanol is used as the solvent. Nevertheless, Z. zerumbet remains important due to its distinct phytochemical profile, notably the presence of saponins, which were absent in K. galanga. Such phytochemical differences highlight the complementary therapeutic potential of these two rhizomes in traditional medicine and modern phytopharmaceutical development (Saitama et al., 2024).

Table 2. Purity Testing of *Kaempferia galanga* and *Zingiber zerumbet* Rhizome Simplicia

No	Quality Test Type	Unit	*Kaempferia galanga*	*Zingiber zerumbet*	Quality Standard (FHI & MoH RI)
1	Foreign Organic Matter	Gram	2.32	3.54	-
2	Initial Simplicia Weight	Gram	183.12	242.16	-
3	Foreign Organic Matter	%	1.27	1.46	≤ 2%

The purity test of K. galanga and Zingiber zerumbet rhizome simplicia was conducted to determine the foreign organic matter level, which is an essential

parameter to ensure the quality, safety, and consistency of herbal raw materials. K. galanga contained 2.32 g of foreign organic matter, equivalent to 1.27%, while Z. zerumbet contained 3.54 g of foreign organic matter, equivalent to 1.46%. Both values fall below the maximum limit of 2% of the Indonesian Herbal Pharmacopoeia and the Ministry of Health of the Republic of Indonesia, confirming that both samples meet the required quality standards (Chandra Panca et al., 2023).

The slight difference in percentages between the two simplicia can be explained by several factors. First, the morphological differences of the rhizomes: Z. zerumbet is generally larger, with rougher and more fibrous surfaces, making it more prone to retain soil particles, fibers, or other plant debris during harvesting and post-harvest handling. In contrast, K. galanga has relatively smaller and smoother rhizomes, which tend to accumulate less contamination. Second, environmental and cultivation factors, such as soil type, harvesting techniques, washing methods, and wet and dry sorting processes, also influence the amount of FOM detected (Saitama et al., 2024) (Chandra Panca et al., 2023).

The low level of foreign organic matter in this study indicates that GACP principles were followed during harvesting and processing. Excessive contamination can reduce extract quality, interfere with standardization, and compromise the safety and efficacy of the final product.

In conclusion, K. galanga and Z. zerumbet simplicia were found to meet the official purity requirements (≤2%) and are suitable for use as raw materials for extraction, phytochemical screening, and further development in phytopharmaceutical research (Julianti et al., 2024)(Efrilia et al., 2025).

Table 3. Particle Size Evaluation of *Kaempferia galanga* and *Zingiber zerumbet* Rhizome Simplicia

No	Quality Test Type	Unit	*Kaempferia galanga*	*Zingiber zerumbet*	Quality Standard (FHI & MoH RI)
1	Initial Simplicia Material	Gram	180.80	238.62	-
2	Powder Passed Through Mesh No. 4	Gram	180.80	238.62	-
3	Powder Passed Through Mesh No. 18	Gram	70.00	93.76	-
4	Powder Passing Mesh No. 4	%	100	100	100%
5	Powder Passing Mesh No. 18	%	38.72	39.28	≤ 40%

The particle size of Kaempferia galanga and Zingiber zerumbet rhizome simplicia was determined to ensure compliance with the pharmacopoeial requirements for powder fineness, which is crucial in ensuring extraction efficiency,

uniformity, and quality control of herbal raw materials. The results show that both K. galanga (180.80 g) and Z. zerumbet (238.62 g) powders passed entirely through mesh No. 4, meeting the standard requirement of 100% passage at this sieve size. Furthermore, the proportion of powder passing through mesh No. 18 was 38.72% for K. galanga and 39.28% for Z. zerumbet. These values are within the acceptable limit of not more than 40%, as specified in the Indonesian Herbal Pharmacopoeia (FHI) and by the Ministry of Health of the Republic of Indonesia (MoH RI) (Chandra Panca et al., 2023).

The compliance of both samples with these particle size requirements indicates that the milling process was properly performed, producing consistent fine powders. Particle size plays a significant role in extraction, as finer powders increase the surface area available for solvent penetration, thereby enhancing the yield of the active constituents. However, excessively fine powders may lead to agglomeration or filtration difficulties, whereas coarser powders may reduce extraction efficiency. The balance demonstrated by both rhizomes in this study suggests optimal particle size distribution for subsequent extraction and phytochemical analysis (Subaryanti et al., 2024).

Overall, the findings confirm that the simplicia powders of both Kaempferia galanga and Zingiber zerumbet conform to official standards for particle size quality, ensuring their suitability for use in standardized extraction procedures and further development into phytopharmaceutical products (Evan & Setiawansyah, 2025).

Table 4. Botanical Identification of *Kaempferia galanga* and *Zingiber zerumbet* Rhizomes

No	Identity Description	Result (*K. galanga*)	Result (*Z. zerumbet*)
1	Name of Simplicia	*Kaempferia galanga* simplicia	*Zingiber zerumbet* simplicia
2	Latin Name	*Kaempferia galanga* L.	*Zingiber zerumbet* (L.) Roscoe ex Sm.
3	Plant Part Used	*Kaempferia galanga* Rhizome	*Zingiber zerumbet* Rhizome
4	Indonesian Name	Rimpang Kencur	Rimpang Lempuyang Gajah

The botanical identification of herbal raw materials is a critical step in pharmacognostic evaluation to ensure the research results' authenticity, traceability, and reproducibility. In this study, K. galanga (commonly known as kencur) and Zingiber zerumbet (commonly known as lempuyang gajah) were subjected to proper botanical determination. Identity verification confirmed that the simplicia used were correctly identified as Kaempferia galanga simplicia and Zingiber zerumbet simplicia. The Latin nomenclature was consistent with standard taxonomical references: Kaempferia galanga L. for incur and Zingiber zerumbet (L.) for incur. Roscoe ex Sm. for emptying the gajah. Rhizomes, which are widely recognized as the primary medicinal organs for both species, were the specific plant parts used in this study. The Indonesian common names of Rimpang Kencur and

Rimpang Lempuyang Gajah further validate their relevance in traditional medicine (Christian Yulius, Rahmat Deni, 2022).

Botanical identification is essential because misidentification or substitution of medicinal plants can lead to variability in phytochemical composition, reduced therapeutic efficacy, and potential safety risks. This study establishes a strong foundation for subsequent phytochemical screening, quality testing, and pharmacological evaluation by ensuring the presence of K. galanga and Z. zerumbet. Thus, the proper identification of these rhizomes provides scientific assurance of the reliability of the study results and supports the standardization of herbal raw materials for further development into traditional medicines or phytopharmaceutical products (Efrilia et al., 2025).

Table 5. Macroscopic and Microscopic Examination of *Kaempferia galanga* and *Zingiber zerumbet* Rhizome Simplicia

No	Quality Test Type	*Kaempferia galanga* (Rimpang Kencur)	*Zingiber zerumbet* (Rimpang Lempuyang Gajah)
1	Macroscopic Test	Round to elongated shape, irregular, edges wrinkled and rough, color ranges from brown to reddish-brown	Swollen and slightly round shape, rough surface, hairy texture, color is yellowish-brown
2	Microscopic Test	Presence of starch granules, periderm, and parenchyma cells	Presence of sclerenchyma cells and parenchyma with visible starch granules

Macroscopic and microscopic examinations are fundamental pharmacognostic evaluations that authenticate and characterize crude drugs. These analyses help distinguish between plant species and ensure that the simplicia used in herbal medicine preparations is genuine and uncontaminated. Macroscopic evaluation of Kaempferia galanga (rimpang kencur) revealed rhizomes with round to elongated shapes, irregular forms, wrinkled and rough edges, and brown to reddish-brown coloration. In contrast, Zingiber zerumbet (rimpang lempuyang gajah) exhibited rhizomes that were more swollen and slightly round, with a rough and hairy texture and characteristic yellowish-brown coloration. These morphological differences provide key diagnostic markers for the identification of the two species during the selection of raw materials (Faizal et al., 2025).

Microscopically, K. galanga showed starch granules, periderm tissue, and parenchyma cells, which are consistent with the Zingiberaceae family rhizome structure. Sclerenchyma cells and parenchyma containing visible starch granules in Z. zerumbet. The presence of sclerenchyma in Z. zerumbet indicates structural rigidity, whereas the abundance of starch granules in both rhizomes indicates their storage function.

These macroscopic and microscopic features are highly relevant in pharmacognosy because they act as diagnostic criteria for ensuring the authenticity of plant materials. Correct identification is crucial because adulteration or

substitution with morphologically similar species could lead to variability in phytochemical composition, reduced therapeutic efficacy, or safety concerns.

In conclusion, both macroscopic and microscopic examinations confirmed that the tested simplicia corresponded to authentic K. galanga and Zingiber zerumbet rhizomes. These findings strengthen the basis for further analyses, including specific and non-specific parameter testing, phytochemical screening, and pharmacological evaluation (Muzakki et al., 2025).

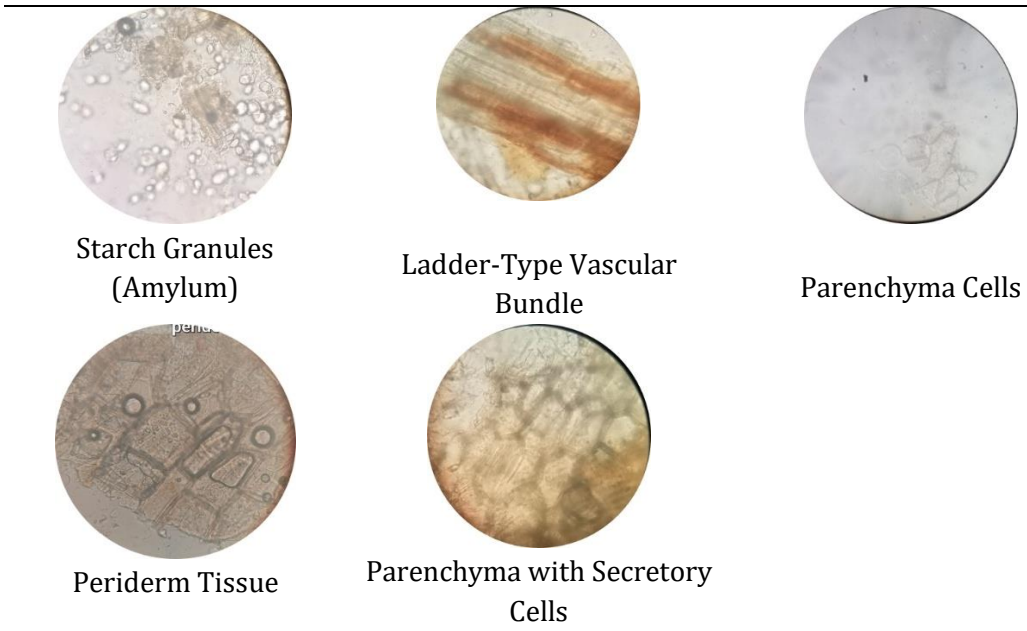


Figure 1. Microscopic Fragment Images and Identification of *Kaempferia galanga* Simplicia (40× Magnification)

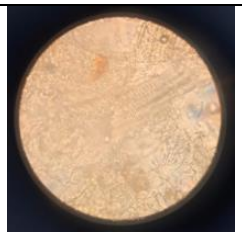
Microscopic examination provides essential diagnostic characteristics for crude drug pharmacognostic evaluation. Powder microscopy of Kaempferia galanga simplicia at 40× magnification revealed several distinctive anatomical fragments typical of rhizomatous structures in the Zingiberaceae family. Starch granules (amylum) were observed as rounded to oval structures distributed within parenchymal tissues, indicating the primary role of the rhizome as a storage organ. Ladder-type vascular bundles, characterized by transverse lignified thickenings resembling ladder rungs, which serve as supportive tissue and are typical of dicotyledonous xylem elements, were observed. The parenchyma cells were clearly visible as thin-walled, isodiametric cells that function in storage and basic metabolism (Muzakki et al., 2025).

The examination also revealed periderm tissue, which forms the protective outer covering of the rhizome and is essential for defense against physical damage and microbial contamination. Furthermore, secretory cells were observed in the parenchyma cells, reflecting the accumulation of oil globules or other secretory products, such as terpenoids and volatile compounds, which are responsible for the characteristic aroma and therapeutic properties of K. galanga. Together, these microscopic features provide reliable diagnostic markers for K. galanga rhizome

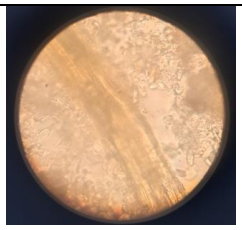
powder identification. Such markers are highly significant in preventing adulteration or substitution with morphologically similar species, which could compromise the quality, efficacy, and safety of herbal preparations (Muzakki et al., 2025).

Microscopic fragment analysis confirmed the authenticity of KGS, thereby establishing a robust basis for subsequent phytochemical, pharmacological, and standardization studies.

Microscopic Fragment Images and Structural Identification of *Zingiber zerumbet* Rhizome Simplicia (40× Magnification)

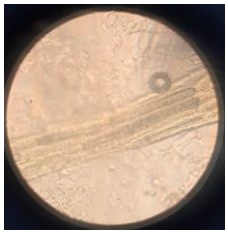


Vascular Bundle with Ladder-Type Thickening



Sclerenchyma Cells

Sclerenchyma Cells



Vascular Bundle with Spiral-Type Thickening

Figure 2. Microscopic Fragment Images and Structural Identification of *Zingiber zerumbet* Rhizome Simplicia (40× Magnification)

Microscopic examination of Z. zerumbet rhizome simplicia at 40× magnification revealed several diagnostic anatomical fragments characteristic of Zingiberaceae rhizomes. These structures are essential for the pharmacognostic identification and quality assurance of herbal raw materials.

Vascular bundles with ladder-type thickening were observed, indicating typical ladder-like transverse wall thickening of lignified xylem elements. These features are important markers of the organization of vascular tissue. In addition, we identified vascular bundles with spiral-type thickening, representing xylem vessels where lignin is deposited in spiral patterns. This type of thickening is associated with structural flexibility and water conduction (Julianti et al., 2024).

The presence of abundant sclerenchyma cells, which are thick-walled supportive tissues providing rigidity and mechanical strength to the rhizome, was another significant microscopic feature. Sclerenchyma distinguishes Z. zerumbet from Kaempferia galanga, which is richer in parenchyma and secretory cells. These differences highlight variations in structural composition that may also correlate with differences in phytochemical storage and bioactive compound distribution.

The identification of these microscopic markers serves as an important diagnostic tool in preventing adulteration or substitution of Z. zerumbet with other morphologically similar rhizomes. It also provides a scientific basis for ensuring the authenticity and consistency of the raw materials used in traditional medicine and phytopharmaceutical formulations . Microscopic analysis confirmed the authenticity of Z. zerumbet rhizome simplicia by identifying key anatomical fragments, such as vascular bundles with ladder- and spiral-type thickening and sclerenchyma cells. These findings establish its pharmacognostic profile and support further phytochemical and pharmacological investigations (Julianti et al., 2024)(Subaryanti et al., 2024).

Table 6. Specific Parameters of *Kaempferia galanga* and *Zingiber zerumbet* Rhizome Extracts

No	Quality Test Type	Result (% w/w)	
		K. galanga	*Z. zerumbet*
1	Water-Soluble Extract	11.30 ± 0.45	9.20 ± 0.36
2	Ethanol-Soluble Extract	5.30 ± 0.40	5.30 ± 0.20

According to the Indonesian Herbal Pharmacopoeia (FHI, 2017), the minimum standard for *Kaempferia galanga* extract is not less than 10.6% for water-soluble extractives and not less than 4.6% for ethanol-soluble extractives, while for *Zingiber zerumbet* rhizome, the minimum requirement is not less than 8.8% for water-soluble extractives and not less than 4.9% for ethanol-soluble extractives. In this study, *K. galanga* showed a water-soluble extract content of 11.30 ± 0.45% and an ethanol-soluble extract content of 5.30 ± 0.40%, whereas *Z. zerumbet* demonstrated a water-soluble extract content of 9.20 ± 0.36% and an ethanol-soluble extract content of 5.30 ± 0.20%. These values indicate that both extracts successfully meet the specific quality parameter standards set by the FHI, confirming their suitability as standardized raw materials for herbal medicine development. These findings suggest that K. galanga contains a higher proportion of water-soluble polar compounds, such as phenolic acids, flavonoids, and certain glycosides. The higher water-soluble extractive value of K. galanga indicates greater potential for antioxidant, anti-inflammatory, and antimicrobial activities, as many polar bioactive compounds contribute to these pharmacological properties (Chandra Panca et al., 2023).

The ethanol-soluble extractive values were 5.30 ± 0.40% for K. galanga and 5.30 ± 0.20% for Z. zerumbet, showing no significant difference between the two species. Ethanol is a semipolar solvent that is effective in extracting several phytochemicals, including alkaloids, flavonoids, terpenoids, and glycosides. The comparable ethanol-soluble values between the two rhizomes suggest that both plants possess similar levels of ethanol-soluble metabolites, despite differences in their water-soluble fractions.

The determination of these extractive values is critical for the standardization of herbal drugs, as it provides a means of assessing the quantity of active constituents present and ensures batch-to-batch consistency. Extractive

values that meet the quality standards of the Indonesian Herbal Pharmacopoeia (FHI) confirm the suitability of both K. galanga and Z. zerumbet as raw materials in the preparation of traditional medicines and phytopharmaceutical products.

In conclusion, K. galanga exhibited higher water-soluble extractives, whereas both species demonstrated similar ethanol-soluble extractive values. These results indicate complementary phytochemical profiles, supporting their ethnomedicinal uses and potential application in the development of standardized herbal formulations (Christian Yulius, Rahmat Deni, 2022).

Table 7. Non-Specific Parameters of *Kaempferia galanga* and *Zingiber zerumbet* Rhizome Extracts

No	Quality Test Type	Unit	*K. galanga*	*Z. zerumbet*	Quality Standard (FHI)
1	Loss on Drying	%	9.07 ± 0.51	9.17 ± 0.31	Not more than 10.0%
2	Moisture Content	%	8.27 ± 0.57	8.47 ± 1.24	Not more than 10.0%
3	Specific Gravity	g/mL	0.8367 ± 0.01	0.79 ± 0.02	-

The evaluation of nonspecific parameters provides important information about the stability, purity, and physical characteristics of herbal extracts. These parameters are critical for ensuring compliance with official quality standards and maintaining the reproducibility of herbal formulations.

The results showed that the loss on drying values were 9.07 ± 0.51% for K. galanga and 9.17 ± 0.31% for Zingiber zerumbet. Both values were within the acceptable limit of not more than 10.0%, as set by the FHI. Drying loss reflects the amount of volatile matter present in the extract, including water. Values below the threshold indicate proper drying and low residual moisture, which are important for preventing microbial growth and ensuring long shelf-life stability (Efrilia et al., 2025).

The moisture content was measured at 8.27 ± 0.57% for K. galanga and 8.47 ± 1.24% for Z. zerumbet, again meeting the pharmacopoeial standard of ≤10.0%. Adequate moisture control is essential for preventing enzymatic degradation, fungal contamination, and chemical instability. These findings demonstrate that the extracts were adequately processed and stored under stable and safe conditions.

The specific gravity values were 0.8367 ± 0.01 g/mL for K. galanga and 0.79 ± 0.02 g/mL for Z. zerumbet. Although no official pharmacopoeial limit is specified for this parameter, SG is a useful physical constant for extract characterization and standardization. The slightly higher specific gravity observed in K. galanga extract suggests a denser extract composition, which may correlate with higher concentrations of dissolved solids or secondary metabolites (Evan & Setiawansyah, 2025).

In summary, K. galanga and Zingiber zerumbet extracts complied with the official limits for drying loss and moisture content, indicating acceptable stability and safety. The specific gravity values further provide reference data for extract

quality assessment of extracts and batch-to-batch consistency. These non-specific parameters, along with specific parameters and phytochemical screening, contribute to the comprehensive evaluation of rhizome extract quality.

Table 8. Phytochemical Screening of *Kaempferia galanga* and *Zingiber zerumbet* Rhizome Extracts

No	Phytochemical Class	Reagent	*K. galanga* Result	*Z. zerumbet* Result
1	Alkaloids	Mayer	White precipitate (+)	White precipitate (+)
		Wagner	Brown precipitate (+)	Brown precipitate (+)
		Dragendorff	Orange-red precipitate (+)	Orange-red precipitate (+)
2	Flavonoids	Mg + HCl	Orange color (+)	Orange color (+)
3	Saponins	Foam Test	No foam (–)	Foam formed (+)
		Liebermann-Burchard	No ring formed (–)	Brown ring formed (+)
4	Tannins	Ferric Chloride	Greenish-black color (+)	Greenish-black color (+)
		Gelatin	Red precipitate (+)	Red precipitate (+)
5	Glycosides	Diphenylamine	Blue spot (+)	Blue spot (+)

Phytochemical screening provides preliminary qualitative information on the classes of secondary metabolites present in plant extracts. Such metabolites are often responsible for the pharmacological activities and traditional therapeutic uses of medicinal plants.

The results showed that both Kaempferia galanga and Zingiber zerumbet extracts tested positive for alkaloids, as indicated by the formation of white, brown, and orange-red precipitates with Mayer, Wagner, and Dragendorff's reagents, respectively. Alkaloids are associated with diverse biological activities, including antimicrobial, analgesic, and anticancer properties. Flavonoids were also detected in both species, as confirmed by the orange coloration upon Mg and HCA treatment. Flavonoids are well known for their antioxidant, anti-inflammatory, and cardioprotective effects, and their presence supports the ethnopharmacological use of these rhizomes in managing oxidative stress-related disorders (Saitama et al., 2024).

The saponin content was a key difference between the two species. K. galanga tested negative with the Liebermann–Burchard reagent, showing no foam formation and no color change. In contrast, Z. zerumbet tested positive, with stable foam formation and a brown ring, indicating saponins. Saponins possess

antimicrobial, hemolytic, and immunomodulatory properties, which may contribute to the broader pharmacological spectrum of Z. zerumbet than that of K. galanga.
Both rhizomes tested positive for tannins, as indicated by the greenish-black coloration with ferric chloride and the formation of red precipitate with gelatin. Tannins exhibit astringent, antioxidant, and antimicrobial activities, making them valuable for gastrointestinal health and infection control (Subaryanti et al., 2024).

Finally, glycosides were detected in both species, as evidenced by the appearance of blue spots with the diphenylamine reagent. Glycosides are a structurally diverse group of compounds with wide-ranging activities, including cardiotonic, anti-inflammatory, and antimicrobial effects.

Overall, the phytochemical profiles of K. galanga and Z. zerumbet demonstrate the presence of bioactive compounds that justify their traditional medicinal uses. Although both species share common phytochemical classes, such as alkaloids, flavonoids, tannins, and glycosides, the presence of saponins exclusively in Z. zerumbet highlights a distinctive phytochemical marker that may account for differences in their pharmacological activities (Gunardi et al., 2024).

Conclusion

The quality evaluation and phytochemical screening of *K. galanga* and *Zingiber zerumbet* rhizome extracts demonstrated compliance with pharmacopoeial standards, confirming their suitability as raw materials for herbal preparations. Both species contained alkaloids, flavonoids, tannins, and glycosides, whereas only saponins were present in *Z. zerumbet*. Differences in extractive and DER-native values indicate distinct phytochemical concentrations. These findings support their traditional use and provide a scientific basis for the further development of standardized phytopharmaceuticals.

Declaration of Competing Interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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