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# Characteristics of bioactive compounds and natural antibacterial activity in commercial galangal powder spice sachets

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## Abstract

Galangal was widely used as a spice and medicinal ingredient, and it gave dishes a distinctive flavor and aroma. Fresh galangal or wet ground spices spoil quickly and cannot last long. In its wet condition, it supports the growth of several damaging microbial pathogens that can reduce the quality of ginger commodities. One alternative was the drying process of galangal-to-galangal powder spices sachets (GPSS). This study explored the characteristics of the bioactive components, composition, and natural antimicrobial properties of powdered galangal spice in sachets. The study was conducted experimentally with three repetitions to ensure reliable results. The results data were analyzed descriptively. Research showed that galangal extract was primarily composed of oleic acid (44.62%), hexadecanoic acid, and octadecenoic acid groups via gas chromatography-mass spectrometry analysis. The galangal antibacterial test showed that galangal extract was able to inhibit *Escherichia coli* (diameter = 7.37 mm) and *Staphylococcus aureus* (diameter = 8.00 mm). It was indicating the galangal powder had potential as a natural antibacterial agent. Additionally, FT-IR analysis identified the presence of Heptadecene-(8)-carbonic acid and Octadecanoic acid (Stearic acid) in the extract. The extract's antioxidant activity was remarkably high, with a percentage inhibition of 78.47%, showing its potential to be used as an oxidative stress agent. Proximate analysis showed that galangal powder has a protein content of 15.67% and a fat content of 1.32%, which could be a source of protein.

## 1. Introduction

Galangal (*Alpinia galanga* L.) was a member of the Zingiberaceae family that was commonly found in Indonesia. It was a spice native to Southeast Asia and has long been used by the people of Indonesia and Southern China. The part of the lengkuas plant that was often utilized was its rhizome. The rhizome of lengkuas has a hard, fibrous, shiny texture, measuring 2-4 cm, and is bright red or pale yellow (Silalahi, 2017). The rhizome contains various components from the flavonoid, phenol, and terpenoid groups (essential oils). The essential oil of lengkuas consists of eugenol, sesquiterpenes, pinene, methyl cinnamate, kaempferide, galanga, galangol, saponins, polyphenols (flavonols, isoflavones, anthocyanidins, catechins, biflavones, curcumin, quercetin, and tannins), as well as unsaturated fatty acids that are easily oxidized. All of these components contribute to its natural antibacterial effects (Allu and Nuryanti, 2022).

Galangal was widely used as a cooking spice and medicinal ingredient. The addition of galangal as an ingredient imparts a distinct taste and aroma (Sartika *et al.,* 2024), such as in the preparation of fish floss (Fadli *et al.,* 2024). Adding galangal to food or drinks not only enhances the flavor but also boosts the body's immune system. The compounds gingerol and curcumin in ginger have benefits as antioxidants and anti-inflammatory agents to counteract free radicals, thereby enhancing the body’s immunity (Nurlila and La Fua, 2020). Galangal contains bioactive components that are not only potentially natural antimicrobials but also safe for continuous consumption in certain amounts (Hamad *et al.,* 2023). In addition to boosting immunity, galangal also has benefits as a traditional medicine for treating skin diseases, digestive disorders, diarrhea, and as a functional beverage (Budiman *et al.,* 2013). Galangal

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was typically used in its fresh or wet form.

The lack of fresh galangal or wet ground spice quickly deteriorates and cannot be distributed for long periods. In its wet condition, it supports the growth of several damaging microbial pathogens that can reduce the quality of ginger commodities, including *Fusarium oxysporum*, *F. solani*, *F. zingiber*, and *Pythium graminicolum* (Rosangkima *et al.,* 2018). Therefore, an alternative was needed to extend the shelf life of galangal spice. One alternative was to create galangal powder through a drying process. Drying significantly affects the quality of dried ginger (Deshmukh *et al.,* 2014). Haryanto *et al.* (2022) reported that besides drying temperature and air humidity, the thickness of ginger slices during drying also affects the outcome of dried ginger. In this study, in addition to drying, the creation of powder was also performed to make ginger easier to utilize.

Research on powdered galangal as a spice has not been extensively explored. The effects of drying and the process of making powdered galangal on its bioactive components and natural antimicrobial properties were not well understood. Further exploration and research were needed.

This study aimed to explore the characteristics of the bioactive components and natural antimicrobial properties of powdered galangal spice in sachets (Figure 1). This research was valuable as a foundation for other researchers in utilizing powdered galangal for derivative products, not only as a cooking spice but also for other products, such as health drinks.


Figure 1. Galangal spice sachet.

## 2. Materials and methods

### *2.1 Materials*

The materials used in this study were galangal obtained from Pringsewu Traditional Market of Pringsewu Regency of Lampung Province, Indonesia, nutrient agar, MacConkey agar, buffered peptone water, distilled water, HgO, $K_2SO_4$, NaOH-$Na_2S_2O_3$, $H_3BO_3$, HCl, methyl red, methyl blue, DPPH solution, hexane solvent, $H_2SO_4$, 96% and 70% alcohol solutions. The tools used in this research were knives, basins, blenders, Erlenmeyer flasks, desiccator, filter paper, beaker glass, petri dish, macerator, stirrer, incubator, drop pipette, soxhlet, Kjeldahl, water-bath shaker, vernier, autoclave, vacuum rotary evaporator, porcelain cup, FT-IR spectrophotometer, gas chromatography-mass spectroscopy.

### *2.2 Research method*

This study involves two stages. The first stage aims to make powdered galangal spice in a sachet (Figure 2). The treatment in the first stage was wet galangal spices (P1), dry galangal spices (Galangal dried by using food dryer) (P2), dry galangal spices (oven-dried) (P3), and dry galangal spices (sun-dried) (P4). Observations were made at the first, 2$^{nd}$, 3$^{rd}$ and 4$^{th}$ days. All treatments were repeated 3 times. Next, the best treatment was selected. The galangal that had the highest sensory score was analyzed in the second stage. In the second stage, the pure galangal extract was identified for its chemical components using GC-MS, FT-IR, and its inhibitory activity with ethanol solvent, as well as the identification of antioxidants and proximate analysis according to SNI 01-3709-1995. The test procedure was described in the following subsection.

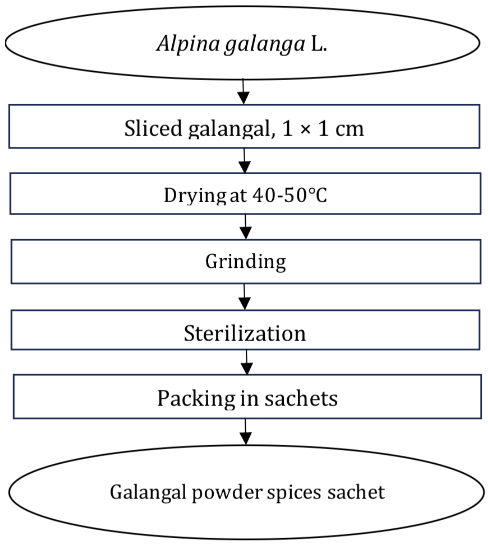


Figure 2. Galangal powder spice sachet flowchart.

#### *2.2.1 Gas chromatography-mass spectrometry analysis*

Identification was carried out to determine the chemical compound profile of the galangal extract using GC-MS (QP2010S SHIMADZU). The results obtained were chromatograms with a single graph showing several peaks. Each peak that appeared represents a different type of compound. The sample was injected into a column with dimensions of 30 m × 0.25 mm and a 0.25 µM thin film. Helium was used as the carrier gas with a flow rate of 1 mL/min, the injector was operated at 200°C, and the column oven temperature was programmed from 50-250°C with an injection mode rate of 10°C/min. The MS conditions used were an ionization voltage of 70 eV, an ion source temperature of 250°C, and a mass range of 50-600. Chromatograms and mass spectra of unknown compounds were obtained and compared with spectra of known compounds from the NIST library (Hartari *et al*., 2024).

*2.2.2 Fourier-transform infrared spectroscopy analysis*

FT-IR testing was conducted to determine the active functional groups of galangal. Observations were made using FT-IR spectroscopy with a TGS detector. Fourier Transform Infrared spectroscopy can identify functional groups in galangal, which were presented in the form of a spectrum. The FT-IR 6800 can measure from the visible range (25,000 $cm^{-1}$) to the far-infrared range (50 $cm^{-1}$). FT-IR testing was carried out to gather information about the chemical bonds present. These chemical bonds were indicated by peaks at different wavelengths. The specimen used for the FT-IR test was a small sample of the material made (Pancapalaga *et al.,* 2023), which in this study was galangal.

*2.2.3 Antibacterial activity analysis*

The disc diffusion method was employed to determine the antibacterial activity of galangal extract. *Escherichia coli* and *Staphylococcus aureus* were obtained from Agriproduct Technology Laboratory, Indonesia. MacConkey Agar was used to confirm *E. coli*, while SA selective media was used to confirm *S. aureus*. Microbial suspensions of $10^8$ CFU/mL were prepared in nutrient broth. The suspensions were standardized by turbidity, equivalent to McFarland standards. An aliquot of the suspension was transferred into the petri dish and supplemented with nutrient agar. Then, a disc (ø 5.5 mm) soaked in galangal extract was placed at the center of the agar plate. The plates were incubated for 24 h at 37°C. The diameter of the inhibition zone, indicating the antimicrobial activity, was measured by assessing the clear zone around the disc using a vernier caliper.

*2.2.4 Antioxidant analysis*

The antioxidant content test was conducted using DPPH solution, a blank, and galangal extract. All solutions were incubated for 30 min, and their absorbance was measured using a UV-Vis spectrophotometer at a wavelength of 517 nm (Sukardi *et al*., 2023). The antioxidant analysis can be calculated using Equation 1.

$$\%\text{Inhibition} = \frac{(AControl - ASample)}{AControl} \times 100\% \quad (1)$$

The regression curve was created by using the sample content as the x-axis and % Inhibition as the y-axis. The $IC_{50}$ value was calculated using the regression equation that was created.

*2.2.5 Quality testing of galangal powder spice sachet*

Further testing was carried out with SNI 01-3709-1995 standards, including proximate testing. In this study, galangal dried spice sachet samples were tested, and the data were then expressed descriptively. The detailed method was described in the following section.

*2.2.5.1 Protein content analysis*

The Kjeldahl technique was used to determine the protein content. Protein content was calculated using Equation 2.

$$Protein\ content\ \% = \frac{(Va - Vb)HCl \times NHCl \times 14{,}007 \times 6{,}25}{W} \times 100\% \quad (2)$$

Where *VA* was the volume for titration sample (mL), *VB* was the volume for titration blank (mL), *N* was the normality of HCl, and *W* was the sample weight (g).

*2.2.5.2 Ash content analysis*

The gravimetric method was used to measure the amount of ash. The ash content was calculated using the following Equation 3.

$$Ash\ content\ \% = \frac{C - A}{B - A} \times 100\% \quad (3)$$

Where *A* was the empty porcelain cup weight (g), *B* was the weight of the evaporating cup (g), and *C* was the weight of the porcelain cup that contained the sample after heating (g).

*2.2.5.3 Water content analysis*

The gravimetric method was used to measure the water content. Calculation of water content was done with the following Equation 4.

$$Water\ content\ \% = \frac{B - C}{B - A} \times 100\% \quad (4)$$

Where *A* was the empty porcelain cup weight (g), *B* was the weight of the evaporating cup GPSS (g), and *C* was the weight of the porcelain cup containing the sample after heating (g).

*2.2.5.4 Crude fiber content analysis*

The gravimetric method was used to measure the crude fiber content. Calculation of water content was done with the following Equation 4.

The calculation of ash content used Equation 5.

$$Crude\ fiber\ content\ \% = \frac{W2 - W1}{W} \times 100\% \quad (5)$$

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Where $W_1$ was the weight of blank filter paper (g), W was the weight of GPSS (g), and $W_2$ was the weight of blank filter paper and sample after heating (g).

*2.2.5.5 Fat content analysis*

The determination of fat content was calculated by Equation 6.

$$Fat\ content\ \% = \frac{C-A}{B} \times 100\% \quad (6)$$

Where *A* was the empty flask fat weight (g), *B* was the weight of galangal powder (g), and *C* was the weight of the fat flask containing the sample after heating (g).

## 3. Results and discussion

### *3.1 Identification of gas chromatography mass spectrometry*

The benefits of galangal powder spice sachet (GPSS) can be seen based on its GC-MS content. The compound readings of GPSS were presented in Figure 3 and Table 1.

Based on Figure 3 and Table 1, there were dominant peak points of galangal compounds seen at the 26.904, 23,895 and 27,364 retention times. The three highest compounds were Oleic acid (44.62%), n-hexadecanoic acid (32.94%), and 9-octadecenoic acid (Z)-, oxiranymethyl ester (21.09%). The lowest component of galangal was 5-Eicosene (E). Based on the GC-MS reading data, it was known that the main components contained in galangal rhizomes were components of the oleic acid, hexadecanoic acid, and octadecenoic acid groups, with the highest percentage (peak) being oleic acid. This component has potential as a natural antimicrobial.

The fatty acid component contained in galangal rhizome has the ability to act as a natural antimicrobial. Unsaturated fatty acids (oleic acid) showed greater inhibition than saturated fatty acids (hexadecanoic acid and octadecanoic acid). Long-chain saturated fatty acids have weaker antibacterial activity than unsaturated fatty acids. Unsaturated fatty acids have branched chains that can help them attract other compounds or elements on their branched chain arms. Oleic acid is a long-chain unsaturated fatty acid that has been known for many years to have antibacterial activity. Unsaturated fatty acids with the amount of C18 can damage the structure of cell DNA, resulting in changes in cell function and enzymes (Hardoko and Abigail, 2013). Oleic acid has bactericidal properties against pathogenic microorganisms such as *Candida albicans*, *Helicobacter pylori*, Methicillin-resistant *S. aureus,* and more (Hendy *et al.,* 2020). In addition, based on information from Karunia *et al* (2017), Fatty acids that disrupt the construction of cell walls and membranes, such as hexadecanoic acid (palmitic acid), 9¬octadecenoic acid (oleic acid), and octadecanoic acid (stearic acid), might prevent the growth of microorganisms.

### *3.2 Main compounds of galangal gas chromatography mass spectrometry test results*

The main compounds of the galangal powder spice sachet (GPSS) from GC-MS test results are shown in Table 2.

Through the table of the main compounds produced in GC-MS readings, several compounds were found to have antimicrobial and antioxidant properties, namely: [E]-5-eicosene, was a fatty acid that has antimicrobial properties (Lulamba *et al.,* 2021). heptadecene-(8)-carbonic compounds were fatty acids that can interact with other compounds to provide antioxidant, antibacterial, and antiproliferative effects (Saputri and

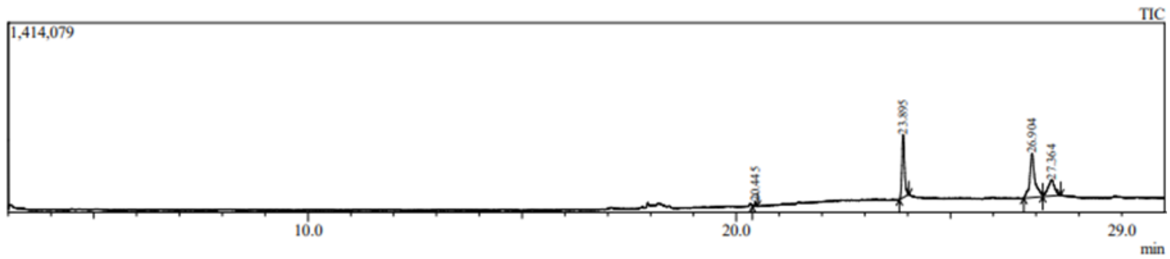


Figure 3. Galangal powder chromatogram.

Table 1. Area and height of galangal powder compound peaks.

| Peak Report TIC | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Peak# | R.Time | I.Time | F.Time | Area | Area% | Height | Height% | Name |
| 1 | 20.445 | 20.375 | 20.490 | 83123 | 1.35 | 32206 | 3.39 | 5-Eicosene, (E)- |
| 2 | 23.895 | 23.805 | 24.030 | 2033795 | 32.94 | 468481 | 49.35 | n-Hexadecanoic acid |
| 3 | 26.904 | 26.710 | 27.155 | 2754290 | 44.62 | 326696 | 34.42 | Oleic Acid |
| 4 | 27.364 | 27.155 | 27.570 | 1302199 | 21.09 | 121842 | 12.84 | 9-Octadecanoic acid (Z)-, oxiranylmethyl ester |
| | | | | 6173407 | 100.00 | 949225 | 100.00 | |

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Table 2. Compound constituents, formula, molecular weight, and molecular shape.

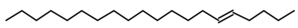
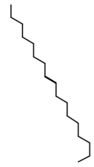
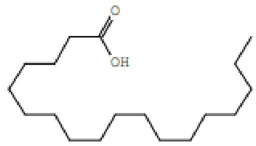
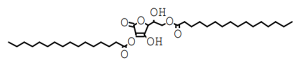
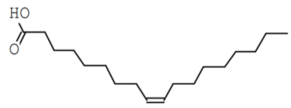
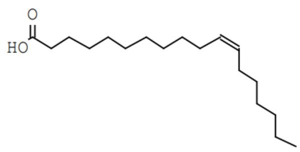
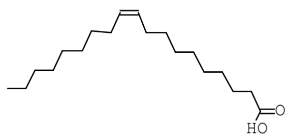
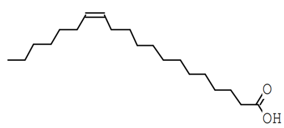
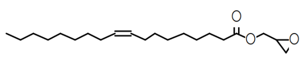
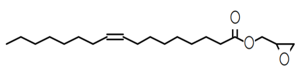
| No | Compound constituents | Formula | Molecular weight | SI | Molecular form |
|---|---|---|---|---|---|
| 1 | 5-Eicosene, (E)-<br>(5E)-5-Icosene<br>[E]-5-Eicosene | $C_{20}H_{40}$ | 280 | 93 |  |
| 2 | 8-Heptadecene<br>(8E)-8-Heptadecene | $C_{17}H_{34}$ | 238 | 92 |  |
| 3 | n-Hexadecanoic acid Hexadecanoic acid<br>n-Hexadecoic acid<br>Palmitic acid<br>Pentadecanecarboxylic acid<br>1-Pentadecanecarboxylic | $C_{16}H_{32}O_2$ | 256 | 95 |  |
| 4. | - Octadecanoic acid<br>- Stearic acid<br>- n-Octadecanoic acid<br>- Humko Industrene R<br>- Hydrofol Acid 150<br>- Hystrene S-97<br>- Hystrene T-70 | $C_{18}H_{36}O_2$ | 284 | 92 |  |
| 5 | l-(+)-Ascorbic acid<br>2,6-dihexadecanoate | $C_{38}H_{68}O_8$ | 652 | 92 |  |
| 6 | Oleic acid<br>9-Octadecenoic acid (Z)-<br>.DELTA.9-cis-Oleic acid<br>cis-Oleic acid<br>cis-9-Octadecenoic Acid<br>Emersol 211<br>Emersol | $C_{18}H_{34}O_2$ | 282 | 96 |  |
| 7 | cis-Vaccenic acid<br>11-Octadecenoic acid, (Z)-<br>(Z)-11-Octadecenoic acid | $C_{18}H_{34}O_2$ | 282 | 94 |  |
| 8 | cis-10-Nonadecenoic acid | $C_{19}H_{36}O_2$ | 296 | 94 |  |
| 9 | cis-13-Eicosenoic acid | $C_{20}H_{38}O_2$ | 310 | 94 |  |
| 10 | 9-Octadecenoic acid (Z)-, oxiranylmethyl ester<br>Glycidol oleate<br>Glycidyl octadecenoate<br>Glycidyl oleate<br>Oleic acid glycidyl ester | $C_{21}H_{38}O_3$ | 338 | 89 |  |
| 11 | Glycidyl (Z)-9-Heptadecenoate<br>Oxiran-2-ylmethyl (Z)-heptadec-9-enoate | $C_{20}H_{36}O_3$ | 324 | 87 |  |

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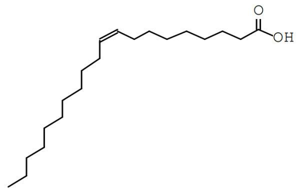
Table 2 (Cont.). Compound constituents, formula, molecular weight, and molecular shape.

| No | Compound constituents | Formula | Molecular weight | SI | Molecular form |
|---|---|---|---|---|---|
| 12 | 9-Eicosenoic acid, (Z)- | $C_{20}H_{38}O_2$ | 310 | 84 |  |

Putri, 2020). Vaccenic acid, also known as octadecanoic acid/stearic acid, is a fatty acid that has antioxidant, antibacterial, and anti-inflammatory properties (Reza *et al.,* 2021). Hexadecanoic acid is a long-chain saturated fatty acid that is most commonly produced naturally by various plants, animals, and microorganisms. Hexadecanoic acid/Emersol / Palmitic acid had anti-inflammatory, phospholipase inhibitor, antioxidant, and antimicrobial (Kim *et al.,* 2020; Johannes *et al.,* 2016). n -Hexadecanoic acid has antioxidant, anti-inflammatory, hypocholesterolemic, and cancer-prevention activities (Mazumder *et al.,* 2020).

The result showed that galangal had ascorbic acid content (Table 2). Ascorbic acid is a type of antioxidant. As a water-soluble antioxidant, ascorbic acid, also known as vitamin C, is essential for preventing oxidative stress in various body tissues. Ascorbic acid can protect several body molecules, including lipids, carbohydrates, and nucleic acids (DNA and RNA), from the harmful effects of free radicals and reactive oxygen species produced during cellular metabolism as a result of exposure to toxins and pollutants (such as cigarettes and drugs) or by immune cells. In addition, Vitamin C was also known to have a therapeutic impact on cancer. Vitamin C, acting as an antioxidant, can be one of the anticancer agents at high doses. Based on the positive antioxidant effects of vitamin C, many studies have also investigated the possible protective effects of vitamin C on cardiovascular diseases (Doseděl *et al.,* 2021). Lastly, an important application of oleic acid in the pharmaceutical field was in the production of vitamin C fatty acid esters. These natural substances act as antioxidants that can be used as adequate substitutes for synthetic ones, such as BHT (butylated hydroxytoluene) and BHA (butylated hydroxyanisole) (Whelan, 2014).

### *3.3 Identification of FT-IR galangal powder spice sachet*

FT-IR test analysis results on galangal (Figure 4 and Table 3) showed the results of wave numbers 3341.02 $cm^{-1}$; 37.61% T was a C-N bond with amine compounds, amides with strong intensity. At wave number 2925.89 $cm^{-1}$, 72.62% T was a C-H bond with a type of alkane compound with strong intensity. At wave number 2111.79 $cm^{-1}$, 94.51% T-type alkyne compounds with changing intensity. At wave number 1638.85 $cm^{-1}$, 47.40 % T was C=C with the type of alkene compound, with changing intensity. At wave number 1374.00 $cm^{-1}$, 64.45% T was a C-H bond with an alkane compound type with strong intensity. At wave numbers 1320.24 cm -1, 64.78% T; 1242.15 $cm^{-1}$, 61.92% T was a C-N bond was observed with amine compounds, amides with strong intensity. At wave number 1029.83 $cm^{-1}$, 27.18% T was a C-O bond with the type of alcohol, ether, carboxylic acid, and ester compounds. Based on the analysis of the FT-IR test results on galangal, the results showed that the galangal group had C-H, alkyne, C=C, C -H, C-N, and C-O groups.

### *3.4 Inhibitory power of galangal powder spice sachet*

The results of the microbial inhibition test showed that galangal rhizome extract had antimicrobial activity against *E. coli* bacteria and *Staphylococcus aureus*

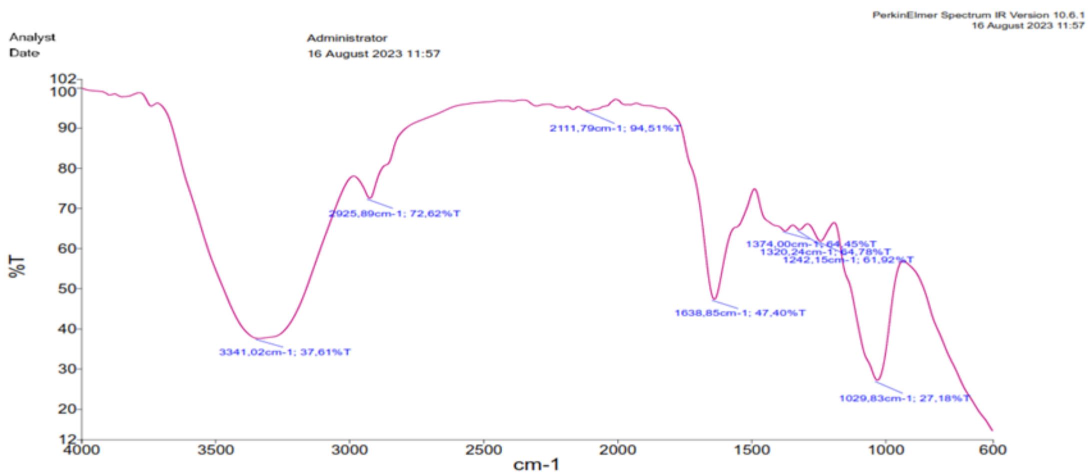



Figure 4. FT-IR Spectra of GPSS ($cm^{-1}$).

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Table 3. Identification of the functional group on galangal.

| No. | Functional group | Wave number | |
|---|---|---|---|
| | | FT-IR result | Wavelength |
| 1 | Alkyne | 94.51% | 2111.79 $cm^{-1}$ |
| 2 | C-H Alkane (strong) | 72.62 % | 2925.89 $cm^{-1}$ |
| 3 | C-N Amide (strong) | 64.78 % | 1320.24 $cm^{-1}$ |
| 4 | C-H Alkane (strong) | 64.45 % | 1374.00 $cm^{-1}$ |
| 5 | C-N Amide (strong) | 61.92 % | 1242.15 $cm^{-1}$ |
| 6 | C=C Alkane | 47.40 % | 1638.85 $cm^{-1}$ |
| 7 | C-N Amine, Amide | 37.61 % | 3341.02 $cm^{-1}$ |
| 8 | C-O Alcohols, ethers, carboxylic acids, and esters. | 27.18 % | 1029.83 $cm^{-1}$ |

bacteria. This was evidenced by the formation of a clear zone (bacteria-free zone) around the disc paper. The antimicrobial activity of plants was believed originally to be from their secondary metabolites (Ismayati *et al.,* 2021). In Figure 5a and Figure 5b, it can be seen that the inhibition zone of galangal extract against *E. coli* bacteria was 7.37 mm, and against *Staphylococcus aureus* bacteria was found to be 8.00 mm. The ability to inhibit bacteria in galangal extract was included in the medium category. Based on information from Sartika *et al.* (2019), the weak category's inhibition zone diameter was less than 5 mm, the medium category's inhibition zone diameter was between 6 and 10 mm, and the strong category's inhibition zone diameter was between 11 and 20 mm.

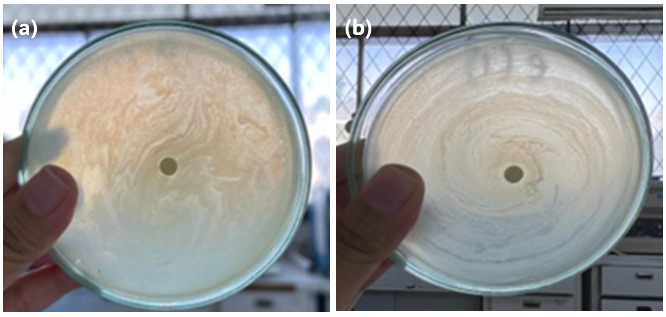


Figure 5. Zone of inhibition of galangal by disc method (a) *Staphylococcus aureus* (7.37 mm), (b) *Escherichia coli* (8.00 mm).

*3.5 Quality of galangal powder spice sachet*

Quality analysis shows that the galangal powder spice sachet suits the criteria according to SNI 01-3709-1995 (Table 4).

Based on the results, the galangal powder spice sachets had a high moisture content of 13.82%. Meanwhile, the maximum moisture content in SNI 01-3709-1995 related to powdered spices was 12%. Water activity was an important factor that affects the stability of dried food during storage. Water content affects the freshness and durability of food ingredients, but the water content also could impact the denaturation of food by bacteria, yeasts, and molds (Normilawati *et al.,* 2019). High water content can reduce the quality of spices during the storage process. Spice commodities are hygroscopic and sensitive to water (Botutihe and Rasyid, 2018).

The moisture content of the material also affects its ash content. The results showed that the spice powder galangal sachet had a high ash content of 9.15%. For further research, special treatment is necessary to reduce the ash content. That way, the water that comes out of the food would be greater. An inorganic substance that remains after burning organic material is called ash. The amount of minerals present in a material, as well as its purity and cleanliness, was directly related to the ash content measurement. Food ingredients were burned at high temperatures and became ash. The measurement of ash content aims to determine the amount of mineral content contained in food (Cicilia *et al.,* 2018).

Table 4. Results of antioxidant and proximate content on galangal.

| Observation | Observation results | SNI 01-3709-1995 |
|---|---|---|
| Antioxidant activity | 78.4704% | - |
| Protein content | 15.6752% | - |
| Ash content | 9.1547% | Maximum 7% |
| Water content | 13.82% | Maximum 12% |
| Crude fiber content | 27% | - |
| Fat content | 1.3247% | - |

Furthermore, the protein content of the galangal powder spice sachet was 15.67%. Protein content was influenced by the drying process of the sample. The lower the moisture content, the higher the protein content (dry weight). During the drying process, the effect of heat (Q) on the material causes the water component to evaporate, and the protein component is more concentrated (Normilawati *et al.,* 2019). The results prove that the amount of water content is inversely proportional to the amount of protein content.

The antioxidant test results obtained in galangal spice powder sachets amounted to 78%. Percent inhibition (% antioxidant activity) is one parameter that

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shows the ability of antioxidants to inhibit free radicals. The IC50 value was the concentration of antioxidant compounds needed to capture DPPH free radicals by 50%. If the antioxidant test result was above 50%, it means that it has a strong antioxidant ability (Pratiwi *et al.,* 2023). Then, the fat content of the GPSS product was found to be 1.3247%. Fat content is an indicator of the acceleration of rancidity and product shelf life (Botutihe and Rasyid, 2018). Also, crude fiber reading was very important in the quality assessment of foodstuffs, as it was an index that determined the nutritional value of the food. In the GPSS product, the crude fiber content was found to be quite high at 27%.

## 4. Conclusion

Based on the results of the study, it can be concluded that (a) GPSS have natural antimicrobial activity from oleic acid, hexadecanoic acid, and octadecenoic acid; (b) has the main functional group in the form of alkyne; (c) has an inhibitory activity of *E. coli* bacteria of 7.37 mm and on *S aureus* bacteria found at 8.00 mm; (d) has good protein content, fat content, antioxidants, crude fiber but still has relatively high water content and ash content. Hence, galangal has great potential as a natural antimicrobial, natural preservative, and natural antioxidant that can be beneficial for the development of food products.

## Conflict of interest

The authors declare no conflict of interest.

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