The Effect of Solvent Type in Ginger Oleoresin (*Zingiber officinale*) Extraction on Yield and Oleoresin Quality

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ABSTRACT

Ginger is one of the export commodities that has high economic value. However, in reality, the use of ginger remains low due to limited community knowledge, resulting in significant waste. One way to increase the economic value of ginger is by producing ginger oleoresin. Oleoresin is a flavor-forming component that contains volatile compounds (essential oils) and non-volatile compounds (resins and gums) that determine taste and aroma, where the quality of oleoresin itself is greatly influenced by the type of solvent used. This study was conducted to determine the effect of different solvents on ginges oleoresin extraction and its impact on the yield and quality of the final product. The method used was to collect and review various sources on the quality of ginger oleoresin. Based on the test results, polar solvents, especially ethanol, tended to yield the highest oleoresin oil and ash contents compared with semi-polar and non-polar solvents such as acetone and hexane. This study confirms that solvent selection is crucial for producing high-quality oleoresin tailored to specific needs, especially in the food industry. The limitations of this study are differences in extraction methods across studies and the lack of complete numerical data in the journals. The novelty of this article lies in its attempt to summarize and compare various solvents in a single analysis, making it easier to see the relationship between solvent selection and ginger oleoresin quality.

Kata Kunci: Ginger, Physicochemical Parameters, Solvent Polarity

1. INTRODUCTION

Ginger (Zingiber officinale) is a spice widely used as an ingredient in food, beverages, traditional medicine, and aromatherapy. One of the high-value processed forms of ginger is oleoresin. Ginger oleoresin is a flavor-forming component containing volatile and non-volatile compounds extracted from ginger rhizomes that produce aroma and spicy taste. Oleoresin itself is widely used in the food, pharmaceutical, and flavoring industries. However, the quality of ginger oleoresin is influenced by the extraction method, especially in the use of solvents. Each solvent has a different polarity and dissolving ability, resulting in differences in the quality of the final product. Several studies have reported that polar solvents, such as ethanol, can achieve higher yields than semi-polar solvents, such as acetone, and nonpolar solvents, such as hexane.

Based on this gap, the research question is: how do solvents differ in ginger oleoresin extraction, and which solvent type yields the best quality and provides the highest yield according to the literature? This study aims to compare several solvents used in ginger oleoresin extraction, as they can affect the yield and quality of the final product. The selection of solvents is a key factor that can determine the success of extraction and the quality of the oleoresin. The scope of this study is limited to the extraction of ginger oleoresin using ethanol, with a focus on yield and other physicochemical parameters. The novelty of this study lies in the analysis of solvent use, which provides a clearer picture of the relationship between solvent type and product quality.

2. LITERATURE REVIEW

Ginger oleoresin is a brown concentrated extract containing a mixture of volatile compounds (essential oils), non-volatile oils (fixed oils), pigments, and vitamins that contribute to its aroma and spicy taste. Ginger itself contains a high amount of oleoresin (Anam, 2010; Oktora et al., 2007). According to Fakhrudin et al. (2015), ginger oleoresin, a dark brown, concentrated liquid, can be used as a flavoring agent to provide the distinctive taste and aroma of ginger obtained by extraction, for example, by solvent extraction. During solvent-based oleoresin extraction, the type of solvent and its polarity play important roles in determining yield and final quality. Polar solvents can extract additional bioactive compounds, such as antioxidants, while nonpolar solvents are known to be efficient at extracting lipids (Melani et al., 2025).

Previous studies have shown that the use of ethanol for ginger oleoresin extraction yields higher oleoresin oil content and ash content, as well as the lowest refractive index. Meanwhile, acetone tends to have higher viscosity due to its solvent properties that attract heavy compounds, but it leaves less solvent residue than ethanol. Meanwhile, hexane, a nonpolar solvent, yields lower yields than ethanol and acetone (Korua, 2019). These differences in results indicate that each solvent has unique characteristics, with advantages and disadvantages, so the choice of solvent must be adjusted to the quality parameters to be achieved. In addition, differences in extraction methods, such as immersion time, temperature, and sample particle size, affect the quality of the oleoresin, leading to variable results and making it difficult to reach a uniform conclusion.

3. METHODS

This study is a literature review that analyzes the effects of different solvents on the yield and quality of ginger oleoresin. The study was conducted by reviewing previous research results and was descriptive in nature. The data used were obtained from journal articles discussing the extraction of ginger oleoresin using ethanol, acetone, and hexane solvents, and the final results, including yield and product quality parameters.

4. FINDINGS

The literature review showed that the type of solvent significantly affects the yield and quality of ginger oleoresin. Where solvents with different levels of polarity will produce different oleoresin characteristics, both in terms of the yield produced and the quality of the compounds contained therein. The solvents most widely used in research are ethanol (polar), acetone (semi-polar), and hexane (nonpolar).

Korua (2019) results show differences in the yield and quality of ginger oleoresin between solvents. As shown in Table 1, ethanol solvent produced the highest yield, namely 9.80%, followed by acetone at 8.37% and hexane at 6.93%. In terms of oleoresin oil content, ethanol solvent also produced the highest value, 43.55%, followed by acetone at 40.52% and hexane at 34.99%. In addition, another quality parameter, ash content, showed the highest value in ethanol extraction (0.58%), followed by acetone (0.41%) and hexane (0.19%). However, differences in the essential oil content parameter were observed. Based on the data in Table 1, hexane solvent produced the highest essential oil content (27.52%), followed by acetone (20.93%), while ethanol showed the lowest (17.95%). As for the refractive index, hexane solvent also showed the highest average value of 1.5%, followed by acetone at 1.497%, and ethanol with the lowest value of 1.488%. Meanwhile, color observation showed that ethanol produced a reddish dark brown color, acetone produced a dark brown color, while hexane produced a yellowish brown color.

Table 1. The effect of solvent type on the yield and quality of ginger oleoresin

Solvent Type	Yield (%)	Oleoresin Oil (%)	Essential Oil (%)	Ash Content (%)	Refractive Index
Ethanol	9,8	43,55	17,95	0,58	1,488
Acetone	8,37	40,52	20,93	0,41	1,497
Hexane	6,93	34,99	27,52	0,19	1,5

Results were also relatively similar in a study by Anam (2010). In Table 2, the use of ethanol solvent produced a ginger oleoresin yield of 20-22.8% (average 21.52%), while acetone solvent produced a yield of 19.45-22.1% (average 20.81%) under extraction conditions of 50°C for 5 hours. The essential oil content of oleoresin produced using ethanol solvent was in the range of 18-20.79% (average 19.51%), while that produced using acetone was in the range of 17.47-20.12% (average 18.86%). Meanwhile, the refractive index values obtained were 1.49 for ethanol-extracted oleoresin and 1.52 for acetone-extracted oleoresin.

Table 2. Quality test values of ginger oleoresin extracted using ethanol and acetone solvents

Solvent Type	Yield (%)	Oleoresin Oil (%)	Refractive Index
Ethanol	20,0 – 22,8	18–20,79%	1,49
Acetone	19,45 – 22,1	17,47–20,12%	1,52

Based on the results of the two studies above, ethanol solvent yields a higher oleoresin yield than other solvents. This is due to ethanol's higher polarity, which makes it easier to dissolve the active compounds in ginger oleoresin, which are also polar. The yield with ethanol solvent tends to be high, while that with acetone is relatively high but still lower than with ethanol. Meanwhile, hexane, as a nonpolar solvent, produces the lowest yield due to its limited ability to dissolve the active compounds in ginger oleoresin.

5. DISCUSSION

The results of the study show that the type of solvent plays an important role in determining the yield and quality of ginger oleoresin. The difference in the final results is not only seen in the oleoresin content, but also in the composition of the compounds and their quality. In general, polar solvents such as ethanol will produce higher oleoresin yields than semi-polar solvents (acetone) and nonpolar solvents (hexane). Meanwhile, according to Kirk and Othmer (1978) in Anam (2010), ethanol has higher polarity than acetone. Hence, the values obtained are not much different but still lower than those obtained with the ethanol solvent.

Based on the yield results and oleoresin oil content, ethanol solvent produced the highest yield among the three solvents. This is because most compounds in ginger oleoresin, such as gingerol, capsaicin, lecithin, and farnesol, are polar so that polar ethanol can extract more oleoresin than semi-polar acetone and nonpolar hexane solvents (Amir et al., 2013). This makes ethanol a solvent that produces higher yields than other solvents. The difference in yield results is due to differences in the solvents' ability to extract, the extraction time to obtain active substances in the crude drug, and the solubility of active substances in different solvents, meaning that the amount of yield produced will depend on the properties of the solvent and the solubility of bioactive components in the material (Sayuti, 2017). According to Keenan et al (1990) in Yuliani & Rasyid (2019), solvents tend to dissolve active compounds of the same group, while semi-polar solvents can dissolve some of the active compounds from both the polar and nonpolar groups. Research by Wijaya & Satriawan (2023) shows that the use of polar solvents produces low metabolite compounds with high yields, while nonpolar solvents produce high metabolite compounds with low yields. This is because ethanol solvents have OH hydroxyl groups that are classified as polar, and the use of polar solvents provides a higher concentration than nonpolar solvents (Hastuti et al., 2018).

In addition, the highest ash content was obtained with ethanol as the solvent. This is because minerals, which are inorganic substances, are also polar, so ethanol, a polar solvent, produces a higher ash content than other solvents. Thus, it can be said that solvents with polarity close to the polarity of the target compound will provide more optimal extraction efficiency.

On the other hand, the use of hexane (nonpolar) solvent produces higher essential oil content and refractive index, although the yield and oleoresin content are lower. This is because the essential oil content is dominated by nonpolar volatile compounds, which are more easily soluble in nonpolar solvents such as hexane. Whereas nonpolar hexane solvent will attract nonpolar compounds, thereby extracting nonpolar essential oils (Dianasari et al., 2020). The essential oil content in ginger oleoresin consists of zingiberene hydrocarbons, which are classified as nonpolar compounds because they do not have hydroxyl or carbonyl groups (Korua, 2019). This is why hexane solvent produces oleoresin with a higher essential oil content than ethanol and acetone. However, due to the limitations of hexane as a solvent in dissolving resin compounds and active oleoresin compounds, it tends to produce a smaller amount of oleoresin.

Based on these results and discussions, polar solvents, especially ethanol, yield better oleoresin and provide better quality. At the same time, semi-polar (acetone) and nonpolar (hexane) solvents also have distinct advantages. Thus, the choice of solvent should be adjusted to the final purpose of the oleoresin product. Thus, this study further reinforces the importance of solvent polarity in the oleoresin extraction process. The relationship between solvent properties and the solubility of compounds in oleoresin provides a basis for more efficient extraction. This study is expected to contribute to the description of the effect of solvent properties on the quality of ginger oleoresin, which can assist further research and the Development of industrial-level extraction processes.

However, this study has several limitations: the data used come from multiple studies with different extraction conditions, such as variations in temperature, extraction time, and particle size of the material, so the results cannot be directly compared. In addition, not all journals provide complete quantitative data for each parameter of ginger oleoresin quality. Therefore, in future studies, it is recommended to conduct analyses using journals or to perform direct experiments under more controlled process conditions to more accurately assess the effect of solvent type on ginger oleoresin quality.

6. CONCLUSION

Based on the analysis, the solvent plays an important role in determining the yield and quality of ginger oleoresin. Differences in the type of solvent with varying degrees of polarity in extraction will affect the solvent's ability to extract compounds in ginger oleoresin. Polar solvents (ethanol) tend to produce higher yields, oleoresin oil content, and ash content due to the polar nature of ginger oleoresin compounds. In contrast, nonpolar solvents such as hexane are more effective in extracting essential oil components with high refractive indices, even though they produce lower yields. This study shows that the choice of solvent must be adjusted to the desired end product of the oleoresin. Ethanol is the best solvent for producing oleoresin with better yield and quality, while the use of other solvents can be considered to produce specific characteristics. For further research, it is recommended to conduct experiments under more controlled, equivalent extraction conditions to accurately analyze the effect of solvent type on the yield and quality of ginger oleoresin, especially in process Development at the industrial level.

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