Section 4. Chemistry

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PRODUCTION OF BLACK PEPPER AND GINGER OLEORESIN USING ULTRASOUND EXTRACTION METHOD

Abstract. New and interesting extraction methods can be created when ultrasound is used in conjunction with conventional extraction methods. Ginger and black pepper oleoresins were extracted using ultrasound in this study. The extraction yield and efficiency of black pepper and chilli were also studied using propane and dimethyl ether, respectively. The pungency of the extracts was determined using an NMR technique developed specifically for this project. Extracts of ginger and black pepper were also tested for their volatile content. Acetone was used to extract all of the different types of spices so that the yields could be compared. Subcritical dimethyl ether was just as effective as supercritical carbon dioxide in extracting the pungent components from the spices, but it also extracted a significant amount of water. When ultrasonics was used, the extraction was done with ethanol as the solvent and the temperature was set to 60 degrees Celsius. The oleoresin that was extracted had a distinct ginger flavour and was a dark, thick liquid. Ginger oleoresin was found to be unaffected by ultrasound use, according

to GC–MS analysis. Zingerone was the primary ingredient in ginger and black pepper oleoresin that had been extracted. Detection of gingerol, one of the pungent components of ginger oleoresin, was not possible because gingerol decomposes at temperatures above 45 degrees Celsius. Ultrasound-assisted extraction had an extraction rate that was 1.75 times faster than a conventional soxhlet system. An additional piece of evidence for ultrasound's mechanical effects can be found in the images taken with a scanning electron microscope, which show the destruction of cells and the subsequent release of their contents.

Keywords: ginger volatile oil ingredient solvent ultrasound filtration black pepper extract of s. aromatic oils.

Introduction

Throughout history, herbs and spices have been used extensively in traditional medicine and as a colourant, flavorant, and aroma enhancer in human diets. EOs derived from aromatic plants have a wide range of biological properties and have been used in a variety of products for the pharmaceuticals, agronomy, food and sanitary products industries, cosmetics and fragrance industries [1].

Among the Piperaceae family of plants, black pepper (Piper nigrum L.) stands out as a significant agricultural crop that has numerous health and medicinal benefits. South East Asia and China are home to the plant, which is a perennial climber. However, it is widely grown in tropical regions, including India, Brazil, Indonesia, Sri Lanka, Vietnam, and Malaysia. In Asian countries, black pepper is a common spice for flavouring food. Exports from Vietnam account for about a third of the world's total black pepper production, and nearly all of that pepper is consumed in North America, Europe, and India [2].

Additionally, black pepper's anti-inflammatory, antioxidant, antimicrobial, anti-cancer, and anti-inflammatory properties make it a valuable health supplement for preventing chronic illnesses and providing physiological benefits outside of nutrition and flavour. Folk medicine has extensively investigated and utilised these benefits. Piperine, which is primarily found in black pepper essential oil, is one of the compounds responsible for the pungency. As a bioactive component, piperine has been shown to be effective in the treatment of musculoskeletal pain, digestive problems, and respiratory infections. Components that contribute to flavour and aroma include limonene, myrcene, linalool, linalool, myrcene, sabinene, sabinene, germacrene-D, and -caryophyllene. Cosmetics and the food and beverage industries both use black pepper essential oil [3].

Figure 1. Ginger oleoresin

As a cooking spice and medicinal plant, ginger is widely used around the world. Zingiber officinale, a perennial herb in the family Zingiberaceae, is the source of this rhizome. Known to have originated in Asia, the ginger plant spread to India, Southeast Asia, West Africa and the Caribbean over the centuries. Essential oils and oleoresins derived from ginger are widely used in the food and pharmaceutical industries around the world. Gingerols and shogaols are the main pungent compounds in the oleoresin, which is characterised by monoterpenes and sesquiterpenic compounds. Throughout the last few years, researchers have discovered more and more medicinal properties in ginger. In addition to its many other uses, it is an aphrodisiac, digestive aid, rubifacient, anti-asthmatic, and anti-inflammatory. Stomachaches, cardiovascular and motor diseases, and other aches and pains are among the many ailments for which ginger is traditionally used. It also has anti-inflammatory properties, regulates bacterial growth, and protects people with immune system disorders like HIV [1].

Figure 2. Black pepper oleoresin

Ginger has been found to contain a wide range of active ingredients. Because ginger's active ingredient has a high added value, researchers are working to improve extraction methods in order to produce higher-quality extracts with increased yields. Solvent extraction and soxhlet extraction are two examples of techniques that can be used for this purpose. Many studies have found that ultrasound-assisted extraction (UAE) can yield higher extraction yields in a shorter period of time and at lower temperatures for a variety of plant species. UAE is a brand-new technique for obtaining chemical constituents from plant materials. It's safe and efficient. The bubble of cavitation inducing the majority of ultrasonic effects within a material generates intense pressures, shear forces, and temperature gradients, which can produce physical, chemical, and mechanical effects, allowing the chemical constituents to dissolve in the solvent without heating. Plant material solvation can also be facilitated by ultrasound, which causes cell swelling and the expansion of the cell wall pores. Improved swell ability will increase the rate of mass transfer, which will result in a faster healing time [3].

Because of the oil's many applications and the abundance of useful components, extractions are more efficient and take less time because of this. There are numerous benefits to this new method, including a faster dissolution rate of plant constituents, a greater penetration of the solvent, and a higher extraction yield due to the increased movement of the molecules, all of which can be facilitated by ultrasound. For example, the extraction of hemicellulose from buckwheat hull, the extraction of sensitive aroma compounds in garlic, the extraction of essential oil in olives, and the extraction of phenolic compounds from coconut (Cocos nucifera) shell powder have all been reported in recent years. Thermally sensitive constituents used in food, healthcare products, cosmetics, and pharmaceuticals can be extracted using this method. Bioactive principles extracted from plants using ultrasonic extraction have also been reviewed. An alternative to conventional extraction methods such as supercritical fluid and microwave assisted extraction, UAE is a fast, inexpensive, and effective option in many analytical situations.

Literature is becoming increasingly interested in the production of black pepper. A lot of attention has been paid to determining the best extraction methods and operating conditions to maximise spice yields. It was determined that the Zingiberaceae family's ginger and black pepper (Zingiber officinale R.) oleoresin extraction was affected by ultrasound. In addition, a soxhlet extraction method was compared to the UAE extraction method.

Literature Review

Because it is made from finely ground powder, oleoresin can retain the scent and flavour of the plant from which it was derived. Each of these oils has its own distinct flavour. High-pungency Most of the world's supply of Capsicum oleoresin is sourced from India, Africa, and China, where chilli production is concentrated. Many regions produce red pepper oleoresin with a medium heat level. Spain, Ethiopia, Morocco, Israel, India, the United States, Mexico, and South Africa are among the countries that produce paprika oleoresin that is not pungent (Govindarajan, 1986). Chilli or paprika powder is finely ground to extract the oleoresin. The material is thoroughly wetted with a volatile non-aqueous solvent such as hexane, ether, or ethylene dichloride [4].

Micelles are formed when the oleoresin is dissolved in the solvent. Thereafter, fresh solvent is added to continue the extraction process. To prevent the loss of aromatic volatile compounds, the solvent is subsequently evaporatively removed from the extract. First, the solvent is removed in a standard film evaporator, and then a partial vacuum is used to remove all of the remaining solvent and make oleoresin from concentrated micella. Very high vacuum is used to recover any solvent still present in the extracted powder mass. The typical yield of oleoresin ranges from 11.5–16.5 percent depending on the solvent used. The pungency of the oleoresin is determined by the original powder's pungency. Color and flavour are the primary purposes of paprika oleoresin, while CAPS levels in capsicum oleoresin can reach 10%, making it a more potent source of heat [6].

Oleoresins are a type of natural spice extract that can be either liquid, semisolid, or solid, depending on how they were extracted. To make an oleoresin, you'll need a variety of different substances, including essential oils, pigments, volatile compounds, and antioxidants. Essential oil and non-volatile components that are desirable and contribute significantly to the flavour profile are extracted during the oleoresin extraction process. Using a vacuum, a concentrated extract of the oleoresin is removed from the solvent. Oleoresins come in a variety of viscosities and textures, from thin, liquid oils to thick, sticky pastes. These components can't be added directly to food because of this.

Oleoresins are extremely stable in storage and can be kept for up to one year without losing any of their quality. In addition, there are other advantages, such as the fact that they require only 1% to 10% of the space of ground spices. Temperature and humidity-controlled storage isn't always necessary [1].

In the food industry, Sri Lankan black pepper oleoresin is used as a flavouring and colourant. Uses for it include food preservation and flavouring. When it comes to beverages, orange juice is one of those that can take advantage of its ability to preserve. Black pepper oleoresins, rather than synthetic preservatives, are preferred by most juice manufacturers. Also, it can be used to preserve pork and reduce the activity of organisms that cause meat spoilage.

The oleoresin is also known for its aromatic values. Inhaling its strong aroma helps to soothe tightened emotions. It helps to relieve anxious feelings. A few drops of the liquid can be added to a diffuser to experience these benefits. Black pepper oleoresin contains natural chemicals such as monoterpenes and sesquiterpenes that support the immune system. These chemicals help the body to avoid any uncomfortable symptoms during a cold season.

Black pepper oleoresin is a yellowish-brown liquid with a pungent, slightly biting aroma. Its goodness runs deeper into its nutritional value. It is a good source of nutrients such as Thiamine, Riboflavin, Vitamin C, E, B_6, and K. Similar to the spice, the oleoresin of black pepper also contains high amounts of piperine, an alkaloid that is responsible for its sharp taste and pungency. With all its goodness, black pepper can benefit the human body in many ways.

Free radicals naturally created are unstable molecules. They damage cells. Exposure to cigarette smoke, pollution, and sun rays can create these free radicals that eventually lead to health problems such as inflammation, premature ageing, heart disease, and cancer. The intake of antioxidants delays and reduces any harm done by free radicals. Just like any other black pepper product, black pepper oleoresins also contain high amounts of piperine.

Antioxidants can be found in this ingredient. To protect against oxidative damage, in vitro studies have shown that piperine can inhibit the formation of free radicals and reactive oxygen species by quenching them. Black pepper oleoresins or black pepper as a spice, for example, can be consumed on a daily basis. can help an individual to avoid any infections.

Weight gain is a result of both eating behaviour and lifestyle. Eating fatty foods lead to gaining weight. It is followed by many health issues. Adding some black pepper oleoresin to your food can help you lose some weight. The spice itself is a rich source of Vitamins A, C, and K, minerals, and fatty acids. It works as a natural metabolic booster that makes it the reason for a lot of health benefits including weight loss [10].

Consuming food that contains black pepper helps to burn calories hours after eating. It prevents the creation of new fat cells, suppressing fat accumulation. Black pepper oleoresin also promotes gut health. Its nutrients increase the good bacteria present in the gut. This is linked to immune function, mood, chronic diseases, and more.

Black pepper oleoresin's high piperine content protects against the majority of cancers. Selenium, beta-carotene and B vitamins in the intestines can also be absorbed more effectively with this supplement. Preventing colon cancer may be possible with piperine, according to a study in Canada. Additionally, it backed efforts to lower the risk of prostate cancer. Prostate cancer chemotherapy medication docetaxel was found to benefit from the alkaloid [4].

The spice oleoresin's piperine content can also have a positive effect on the health of the brain. It prevents the breakdown of the calming neurotransmitter serotonin by inhibiting an enzyme. Melatonin, a hormone that regulates the sleep-wake cycle, is degraded by this enzyme. The oleoresin of black pepper can also help prevent Parkinson's disease. The feel-good hormone, dopamine, is disrupted by another enzyme that is inhibited by this medication. Dopamine is missing in everyone with Parkinson's disease. These symptoms may be alleviated by consuming black pepper. It's also a good way to stay out of a slump. The piperine content of this supplement is also helpful in preventing cognitive decline and Alzheimer's disease. It also boosts the brain's nerve activity.

Materials and Methods

Materials

Guilin's Chu Se District, in Gia Lai Province (13°49′21″ N108°2′37″ E), provided both the black pepper and ginger seeds used in the research. Using a grinder, black pepper seeds were first picked, dried, and screened (Sunhouse SHD5323, Hanoi, Vietnam). Pre-milling, the pepper was chilled in an Alaska LC-743H refrigerator for two hours at 10 °C in order to minimise the loss of essential material. After that, a wire mesh was used to filter the ground pepper particles (with sizes ranging from 20 to 160 mesh). It was necessary to cool and re-mill any seeds that did not make it through the sifting process. It is necessary to pre-cool materials after milling in order to reduce volatile odors and undesirable smells. An evaporator was used to dissolve sodium chloride (NaCl) in water, which was then added to the flask containing the material. The brine/material suspension was gently shaken before being removed from the flask.

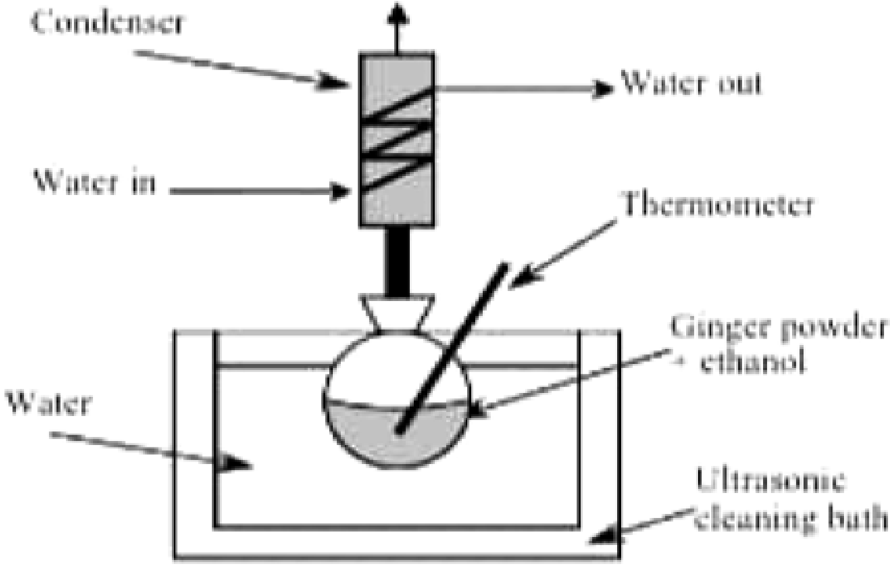

Figure 3. Apparatus used for this experiment

An Indonesian market near the city of Bireun in Aceh province sold fresh ginger rhizomes. There were no small stones or sand or plant leaves left behind after harvesting and transporting the produce. ‘ Afterwards, the ginger rhizomes were cleaned and then peeled. A laboratory grinder was used to grind the peels to a fine powder after they had been sun-dried for more than two days. Particle sizes of ginger powder were evenly distributed on a stainless steel screen with a mesh size of 2 mm. It was then stored in a paper bag at 20 ° C for future use. Analytical-grade chemicals were used for the rest of the experiments. Ultrasonic cleaning baths Bransonic 8510 with a 42 kHz frequency and a digital timer were used in the UAE experiments.

Table 1.– For the Composition of Black pepper and Ginger oleoresin

	CO_2-E1			CO_2-E2			CO_2-E3			CO_2-E4		
	Psd2	Psd3	Psd4	Psd2	Psd3	Psd4	Psd2	Psd3	Psd4	Psd2	Psd3	Psd4
	Composition (mass %)			Composition (mass %)			Composition (mass %)			Composition (mass %)		
2-heptanol	1.00	1.30	1.68	-	-	-	-	-	-	-	-	-
α-pinene	7.29	7.85	3.36	-	-	-	-	-	-	-	-	-
camphene	19.16	20.18	8.91	-	0.45	-	-	-	-	-	-	-
β-myrcene	4.09	4.19	3.20	-	-	-	-	-	-	-	-	-
β-pinene	18.62	19.64	16.91	1.08	1.46	0.51	-	-	-	-	-	-
limonene	2.86	3.05	2.06				-	-	-	-	-	-
m-diethyl benzene	5.01	6.15	3.88	-	-	-	-	-	-	-	-	-
o-diethyl benzene	2.26	2.35	1.62	-	-	-	-	-	-	-	-	-
nonanal	-	-	-	-	-	-	4.20	3.74	4.38	8.56	5.33	13.16
neral	1.43	0.98	2.49	2.80	3.00	3.10	1.62	2.46	1.81	1.01	2.08	1.27
geranial	3.60	2.39	4.47	9.01	6.76	6.64	8.50	7.41	5.46	6.38	6.45	4.01
ar-curcumene	2.48	1.64	3.64	6.12	5.92	6.05	3.64	3.91	3.71	2.63	2.36	1.60
α-zingiberene	17.88	16.94	27.30	45.81	43.72	44.86	35.88	33.93	32.22	26.34	23.76	19.14
farnesene	7.96	7.43	10.72	17.30	18.33	18.60	14.20	12.47	13.44	11.03	9.77	7.53
β-sesquiphellandrene	6.36	5.91	8.50	14.97	14.62	15.32	12.39	10.32	11.00	10.05	8.38	6.30
mixture of gingerols	-	-	-	0.70	0.36	1.10	19.57	25.76	27.98	34.00	36.61	37.74
not identified	-	-	1.26	2.21	5.38	3.82	-	-	-	-	5.26	9.25

Method

A 500 mL flask was filled with 50 g of ginger powder and 150 mL of ethanol was used as a solvent. During the extraction, the temperature was maintained at 60 degrees Celsius. Controlled by a water bath thermometer, temperatures were kept stable. In order to maintain a constant temperature in the bath during ultrasound experiments, cold water had to be added on a regular basis. During the replacement, make sure that the bath water level remains constant. The internal extraction vessel's temperature was monitored and found to be constant to within 1 degree Celsius. The extract was cooled to room temperature after extraction. A water pump was used to filter the extract, and then it was concentrated in a rotary evaporator. HP G 1800C Series II GCD system was used for GC–MS analysis of HP-5MS column with 30 m × 0.25 mm and 0.25 m film thickness (Hewlett-Packard, Palo Alto, USA). Carriage gas was Helium [7].

The injector and detector were both set to 260 degrees Celsius. Comparing mass spectra of the extract to those from Wiley 275 and NIST/NBS libraries identified the components. Calibrated Done by robots Mass Spectral Systemic disease and Identification Software Application (AMDIS ver.2.1.) was used to compare the experimental retention index values to published literature, and this data was then used to confirm the validity of the MS findings. A field emission scanning electron microscope, the Hitachi S-3500N, was used to image ginger particles. One mm thick slices of ginger were used for this purpose. Duplicates of each sample were prepared and analysed. Soxhlet was used to perform the conventional extraction in the same manner as described previously for the United Arab Emirates. For comparison, this was used as a control [7].

Using the Heating Mantle User Manual heater, 20 g of black pepper was heated with the Clevenger gear (Bach Được Ltd., Ho

Chi Minh City, Laos) after it being immersed in water in NaCl solution for the required time (1000.EU.05, 300 W, Glassco Laboratory Equipment Pvt. Ltd., Ambala Cantt, India). The extraction stage experimental set-up is shown. As soon as the first drop of shortened crude extract is dropped into the oil extraction system, the extraction timer begins. To preserve the essential oil, sodium sulphate (Na_2SO_4) is used to dehydrate it and store it in a storage tank at 10 °C after the harvesting process has been completed.

Figure 4. Methodology of experiment

Black pepper essential oil extraction was examined in this study, which looked at factors such as material size, preservation conditions, NaCl solution concentration and time, and distillation conditions. In the first place, whole seeds, mesh 40, and mesh 160 were all taken into consideration as material sizes, with the latter two representing filtration after grinding at 40 and 160 mesh sizes, respectively. Afterwards, the effect of raw material preservation was also examined by taking into account various conditions, such as heat flux (° c and cold storage of 10 °C), lid state, and time of preservation (24–72 h). The NaCl solution concentration and soak time ranged from 1–5 percent and from 1–5 hours, respectively, and were also investigated. Also examined were factors such as extraction time (1–6 h) and temperature (130–200 °C) as well as the ratio of raw material to solvent (0.5–1/35 g/mL). The response surface and single-factor methods were used to fine-tune these experimental conditions (RSM).

Result and Discussion

Each experiment yielded a dark, thick liquid with a distinct ginger flavour, which was consistent across all samples. With the help of GC–MS, we were able to identify a wide range of components in the extract. Here we can see a typical total-ion chromatogram from a GC–MS analysis of components extracted from ginger oleoresin. Table 1 displays the GC–MS results of the oleoresin components analysis. Only five of the composition's major constituents are highlighted. The results from the soxhlet as well as those from Zancan et al. are included in the table as well. Component zingerone was the most abundantly detected by GC–MS analysis, as shown in Table, whether it was extracted using UAE or conventionally using a soxhlet. Soxhlet and UAE were able to identify 113 and 112 components, respectively, in the GC–MS results. These findings suggest that the GC–MS difference was small, indicating that ultrasonication had little effect on changes in ginger oleoresin components. Gingerol, one of the pungent ingredients in ginger oleoresin, was not detected by the results of GC–MS.

Essential oils and oleoresins derived from ginger are widely used in the food and pharmaceutical industries around the world. Gingerols and shogaols are the main pungent compounds in the oleoresin, which is characterised by monoterpenes and sesquiterpenic compounds. Throughout the last few years, researchers have discovered more and more medicinal properties in ginger. In addition to its many other uses, it is an aphrodisiac, digestive aid, rubifacient, anti-asthmatic, and anti-inflammatory. Stomachaches, cardiovascular and motor diseases, and other aches and pains are among the many ailments for which ginger is traditionally used. It also has anti-inflammatory properties, regulates bacterial growth, and protects people with immune system disorders like HIV [1].

Ginger has been found to contain a wide range of active ingredients. Because ginger's active ingredient has a high added value, researchers are working to improve extraction methods in order to produce higher-quality extracts with increased yields. Solvent extraction and soxhlet extraction are two examples of techniques that can be used for this purpose. Many studies have found that ultrasound-assisted extraction (UAE) can yield higher extraction yields in a shorter period of time and at lower temperatures for a variety of plant species. UAE is a brand-new technique for obtaining chemical constituents from plant materials. It's safe and efficient. The bubble of cavitation inducing the majority of ultrasonic effects within a material generates intense pressures, shear forces, and temperature gradients, which can produce physical, chemical, and mechanical effects, allowing the chemical constituents to dissolve in the solvent without heating. Plant material solvation can also be facilitated by ultrasound, which causes cell swelling and the expansion of the cell wall pores. Improved swell ability will increase the rate of mass transfer, which will result in a faster healing time [3].

Table 2. – Yield of Ginger and black pepper oleoresin

Time (min)	**Oleoresion yield(%)**	
	UAE	**Soxhlet**
1	**2**	**3**
30	5.50	–
60	6.50	–

1	2	3
120	6.80	–
180	7.28	–
240	7.43	–
300	7.81	–
420	–	7.48

At higher temperatures (above 45 degrees Celsius), gingerol will decompose into zingerone and shogaol, which reduces the amount of gingerol present. In addition, the thermal degradation of gingerols to shogaols makes it difficult to identify and quantify the compounds using gas chromatography. Meanwhile, significant amounts of the ginger oleoresin's other pungent constituents, zingerone and shogaol, were found. The yield of oleoresin from ultrasonic and conventional soxhlet extraction processes is shown in the table below. Table shows that the UAE yielded 7.43 percent in 240 minutes, while soxhlet extraction yielded almost the same in 420 minutes. In the UAE, extraction rates of oleoresin were 1.75 times faster than with a conventional soxhlet system. Additionally, this shows that the UAE is 50% more efficient in terms of time than soxhlet extraction. Ji et al. state that the solvent diffusion in a substance can be enhanced by ultrasound, and that the ultrasound cavity's influences extend beyond the particles themselves to the substance's core. Ultrasonic extraction of fat from plant seeds takes less time and yields a similar amount of product than soxhlet extraction, according to Garcia and Castro. Hesperidin extraction from Citrus reticulata peel has also shown a similar trend, according to Ma et al. This is due to the fact that a longer extraction time increases the likelihood of solvent contact with the material.

The peeling process was necessary because the outer peels of the black pepper were so thick and hard that the extraction process could be hindered. As a result, treatment must be tailored to fit each patient's unique needs. Figure shows that as the size of the black pepper decreased, the amount of oil it produced increased. With no peeling, the lowest yield of 0.25 percent was achieved; with peeling, the yields were 1.6 percent and 1.8 percent, respectively [9].

When black pepper is crushed, oil-containing cells are broken, making it easier for water to get into the oil-filled bags. Consequently, the Clevenger apparatus is powered by steam. It also has a natural scent and is a light green colour, as opposed to the seed size material, which is a light yellow colour as a result of prolonged heat exposure. as shown in Figure 5's examination. The emulsion was formed during the extraction process when essential oils and water were mixed together. In addition to reducing the solubility of some non-polar components of essential oil in the water medium, adding salt to the extraction mixture could prevent the loss of essential oil as emulsion. As an electrolyte, sodium chloride (NaCl) plays an important role in increasing the water's density and polarization, which makes the separation of essential oil from water more convenient [10].

Oil yield decreases as NaCl concentration rises above 2%. An osmotic pressure difference between the external environment and the oil-containing cells could be the cause of this phenomenon. Water inside the cell is effectively osmosed out, making it difficult to separate essential oils from the substance. In the same extraction conditions, a NaCl concentration of 2% yielded the best results, while a concentration of 4%–5% yielded the worst results. For this reason, 2 percent NaCl is chosen as the optimal concentration for the best yield of essential oil. When the mixture of water and material is heated, the water vapour penetrates the layer of the skin, which contains home remedies, breaks down the fundamental oils, and draws the oil by steam. Essential oil cannot escape if the colloids and salts encasing the pouch are not sufficiently dissolved by the water.

As illustrated, adding more water to the extraction process increases oil diffusion into the water, increasing solubility and increasing the yield of soluble components. Rather than emulsifying or dissolving the oil, too much water could cause it to become diluted or emulsified, reducing the amount of oil produced and the distillation's economic efficiency. Figure 7 shows that although both the 1/20 (g/mL) and 1/25 (g/mL) ratios gave the highest yield oil (2.2%), the 1/20 (g/mL) ratio could save a significant amount of water and, as a result, bring high economic value with only a marginal reduction in yield. This led to the decision to use a ratio of 1/20 (g/mL) for the next survey. The yield of black pepper essential oil increases as the extraction temperature or time increases. However, when the yield of essential oil reached an optimum level, as depicted in Figure 8, it stopped increasing. High temperature decomposition of some components resulted in the highest yield of oils at 180 °C (2.25%), and the lowest yield of 1.95% at 200 °C.

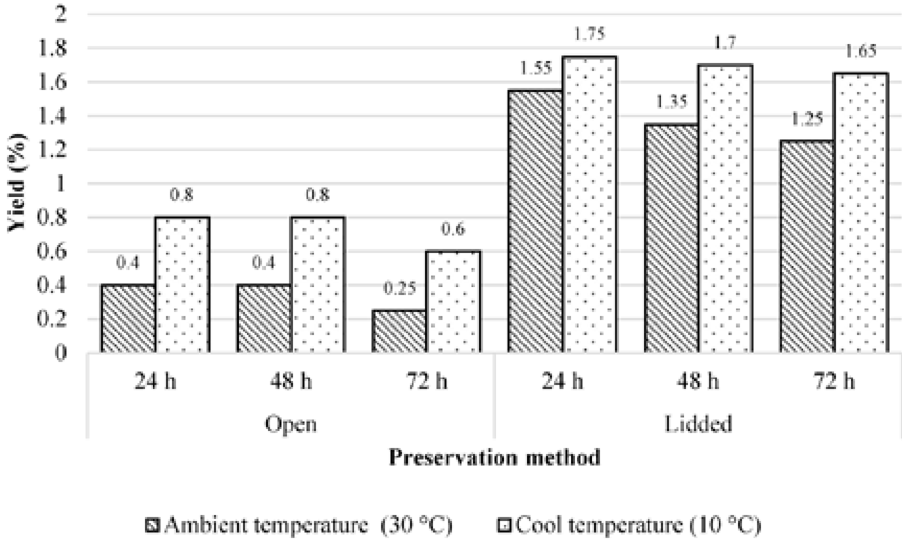

Figure 5.

Graphical Representation of Yield

Due to a small amount of material being splashed in and burned, the essential oil is light yellow at both temperatures. Due to the oil's green colour and lack of denaturation, a temperature of 150 °C is preferred over one of 180 °C for several reasons. After 5 hours of extraction, the extraction yield stopped increasing, as shown in Figure 9. As a result, the extraction time was set at five hours. Table summarised the findings. The essential oil of black pepper contains 26 compounds that make up 99.86% of the total compounds. Other unknown compounds in the oils were insignificant. There were only trace amounts of compounds that were less than 0.5%. The major constituents of black pepper essential oil, according to our research, are 3-carene (29.21 percent), D-limonene (20.94 percent), -caryophyllene (15.05 percent), -pinene (4.69 percent), and -pinene (9.77 percent). 3-carene and Dlimonene concentrations were significantly higher than those found in other black pepper cultivars in previous studies. When extracting -caryophyllene using the same conditions as black pepper from India, the compound was found to have a lower concentration. In addition, Vietnamese black pepper oil does not contain sabinene, unlike other black pepper cultivars.

In order to extract more material, the extraction time must be increased until the solvent becomes saturated. It's also important to note that as extraction time increases, so does the amount of heat that is absorbed, which in turn speeds up the diffusion process. However, as shown in Table, the oleoresin yield does not change significantly for extraction times greater than 60 minutes. This may be due to the fact that the ultrasonic effect was at its peak about 60 minutes before extraction, so the change in extraction time did not result in a significant yield change. Ultrasonics, according to Balachandran et al., will boost mass transfer's effective diffusivity, and this effect will be at its peak within a short period of time.

SEM images of the plant cells after extraction were taken to demonstrate the disruption effect of ultrasonic vibration on the physical structure of ginger particles. SEM images of ginger particles at a magnification of 250 are shown in the figure. The results of the experiment show that ultrasonic vibration can cause cell structures to be damaged. When the solvent can reach the internal particle structure, it is easier to remove the cell's contents. Scanning electron microscopy images of ginger particles show: a) results from experiments using ultrasound and; b) results from experiments not involving ultrasound. Intra-particle dispersion will also be improved by this method. The cell disruption was smaller in scale in the experiment without ultrasound, but the SEM images show similar phenomena. A greater understanding of UAE's mechanism will necessitate more research to determine the individual effects of high-intensity ultrasound and extraction parameters such as temperature, pressure, or solvent type.

Conclusion

In the extraction of oleoresins, ultrasound has the potential to reduce processing time. A mechanical effect caused by ultrasonically induced cavitation was blamed for the results, which increased plant tissue permeability. Analyses of ultrasonicate ginger oleoresin's main components by gas chromatography did not reveal any significant changes. However, gingerol, one of the oleoresin's pungent constituents, was not detected because, at temperatures higher than 45 degrees Celsius, gingerol decomposes to zingerone and shogaol. After extracting the ginger, a scanning electronic microscopy analysis was performed. An extraction ratio of 1:21 g/mL water to material, an extraction temperature of 150 °C, and an extraction time of 5.2 hours were found to be optimal. A temperature of 10 degrees Celsius for lidded storage is also recommended for the materials.

There are numerous benefits to this new method, including a faster dissolution rate of plant constituents, a greater penetration of the solvent, and a higher extraction yield due to the increased movement of the molecules, all of which can be facilitated by ultrasound. For example, the extraction of hemicellulose from buckwheat hull, the extraction of sensitive aroma compounds in garlic, the extraction of essential oil in olives, and the extraction of phenolic compounds from coconut (Cocos nucifera) shell powder have all been reported in recent years. Thermally sensitive constituents used in food, healthcare products, cosmetics, and pharmaceuticals can be extracted using this method. Bioactive principles extracted from plants using ultrasonic extraction have also been reviewed. An alternative to conventional extraction methods such as supercritical fluid and microwave assisted extraction, UAE is a fast, inexpensive, and effective option in many analytical situations.

2.45 percent optimum efficiency was achieved under these conditions. In addition, gas chromatography-mass spectrometry was used to identify 26 essential oil compounds in black pepper (GCMS). Among the most abundant compounds in the essential oil were 3-carene (29.21 percent), D-limonene (20.94 percent), -caryophyllene (15.05%), -pinene (9.77 percent), and -pinene (4.69 percent). We can conclude from our findings that the essential oil from Vietnamese black pepper is useful in the production of insecticides and air fresheners. It's clear from the images that ultrasound works. Using high-intensity ultrasound to extract oleoresin from plant sources may reduce extraction time and thus increase production throughput in commercial processes.

References:

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