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The yield and quality of cassiavera (*Cinnamomum burmanii* L.) oil at different harvest ages from Malalak farmers in West Sumatra

Rendemen dan kualitas minyak cassiavera (Cinnamomum burmanii L.) pada variasi umur panen oleh petani Malalak Sumatera Barat

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ABSTRACK

This study compared the oil yield and identified the quality of cassiavera with plants ages 7 years, 18 years, and random (broken) one. Parameters measured included yield, physicochemical properties, and chemical composition. Based on the results, the oil yield was 1%, 0.9%, and 0.7% at ages 8 and 7 years of upper and lower stem parts, as well as for the broken form. This indicates that the longer plant age correlates with a higher yield. The yield at 7 and 18 years is not much different, hence the harvest can be performed at the age of 7 years considering a shorter waiting period. The physicochemical test of oil solubility in 70% ethanol showed a ratio of 1:1 and a clear appearance according to the maximum requirements of INS (Indonesian National Standard) 06-3734:2006, namely 1:3 clear. Meanwhile, the refractive index (RI) test indicated 1.56 as the best value for cassiavera scion at the age of 7 years in line with INS 06-3734:2006 conditions of 1.559 - 1.595. The chemical composition test for the oil as a whole complied with the minimum standard of INS 06-3734:2006, namely 50% cinnamaldehyde.

Kata Kunci:
cassiavera;
umur panen;
kualitas;
rendemen.

ABSTRAK

Penelitian ini membandingkan rendemen dan mengidentifikasi kualitas cassiavera dengan umur tanaman 7 tahun, 18 tahun, dan cassiavera asalan (broken). Parameter yang diukur meliputi rendemen, sifat fisika-kimia, dan komposisi kimia. Berdasarkan hasil penelitian, pada umur 18 tahun didapat rendemen minyak cassiavera sebesar 1 %, pada umur 7 tahun (bagian batang atas dan bawah) sebesar 0,9 %, dan cassiavera asalan (broken) sebesar 0,7%. Berdasarkan hasil tersebut, semakin lama umur tanaman maka semakin tinggi rendemennya. Nilai rendemen cassiavera umur 7 tahun dan 18 tahun tidak jauh berbeda sehingga panen dapat dilakukan pada umur 7 tahun dengan pertimbangan masa tunggu yang lebih cepat. Uji fisika-kimia dengan kelarutan dalam etanol 70% didapat 1:1 jernih dengan syarat maksimum SNI 06-3734:2006 1: 3 Jernih. Sedangkan uji indeks bias didapat indeks terbaik 1,56 pada umur 7 tahun bagian batang atas dengan syarat SNI 06-3734:2006 1,559 - 1,595. Hasil uji komposisi kimia parameter sinamaldehid untuk minyak cassiavera secara keseluruhan memenuhi SNI 06-3734:2006 dengan standar minimum sinamaldehid 50 %.

1. Introduction

Cinnamon (*C. burmanii*) is a species of the genus Cinnamomum in the Lauraceae family, including woody plants used by the community as a spice. This is applied for daily needs, including food spice, and as an herb in traditional medicine (Al-Dhubiab, 2012). Furthermore, it is widely distributed across Southeast Asia, China, and Australia. There are several cinnamomum species, such as *C. burmannii, C. verum, C. aromaticum,* and *C. loureiroi,* containing the same health benefits (Chen *et al.*, 2014). *C. burmanii* originates from Indonesia and is named Padang Kaneel or cassiavera ex. Padang in the trade sector (Emilda, 2018). This plant is categorized under the spice and seasoning group (Baguna and Kaddas, 2021).

The commercially available dried cinnamon bark is called cassiavera and usually used as the main ingredient in spices. This commodity is very important, specifically for societal survival, both in households and industries (Baguna and Kaddas, 2021), where the main product is used as spice raw materials. Other cinnamon parts such as stems, leaves, and twigs can be utilized and developed into various products that have economic value. The stems can be employed as a raw material for particle board, while the leaves and twigs are distilled to obtain oil for manufacturing vegetable pesticides. The plant is also used in supporting environmental conservation (Ferry, 2013).

Due to the good smell and sweetness of cassiavera, it is applied as an ingredient for syrup preparation. Additionally, the spicy taste serves as a body warmer. The wood functions include building materials, furniture, firewood, and others (Ferry, 2013). The plant's pure, powder, and oil forms are used for various purposes. Oil is obtained from the bark, twigs, branches, and leaves through the distillation process, where the quality is affected by the material type and size, as well as the distillation method and time. The bark's location on the stem affects the oil content produced due to some metabolic processes. During refining, the material is first dried probably with sunlight until the water content reaches 14% to ease oil release (Harun, 2010).

Up to the present, cassiavera essential oil is widely used as a food and beverage flavor, cosmetic ingredient, and perfume, as well as an antiseptic and antimicrobial agent in the medical field. It is produced commercially through distillation (Yuliarto *et al.*, 2012) and known to be volatile (Hananta *et al.*, 2020). The chemical components include cinnamic alcohol, coumarin, cinnamic acid, cinnamaldehyde, anthocyanins, and essential oils containing sugar, protein, simple fats, pectin, and others (Al-Dhubiab, 2012).

Cassiavera is possibly applied as an alternative treatment for cancer, since the bark contains essential oils, safrole, cinnamaldehyde, eugenol, tannins, flavonoids, and saponins (Herdwiani and Rejeki, 2015). Besides, the key phytochemical constituents include trans-cinnamaldehyde and coumarin (Sakti *et al.*, 2019). According to Dian et al. (2013), the oil's main component is cinnamaldehyde (42-75%), consisting of an aldehyde group that can be converted into an ester group often used as an antidiabetic agent. Ervina *et al.* (2019) verified the distinctive characteristics of cassiavera content with LCMS analysis of the optimum extract. The plant contains active components capable of complementing diabetes mellitus therapy due to the anti-diabetic activity possessed. The current potential can be utilized as an antimicrobial and antioxidant (Ju e*t al.*, 2018; Sun *et al.*, 2018).

Identification by GC-MS and LC-MS showed that the main components of the essential oil are cinnamaldehyde and several polyphenols, particularly proanthocyanidin and epi-catechin. Also, the active compounds may change depending on the extraction method used (Emilda, 2018). Of the 54 cinnamon species (*Cinnamomun sp*) in the world, 12 exist in Indonesia, where *C. burmanii* is widely cultivated as a smallholder plantation business, specifically in West Sumatra, Jambi, and North Sumatra. Globally, Indonesia remains the top exporter of *C. burmanii* majorly in form of bark rolls or quills (Silfia, 2013; Khasanah *et al.,* 2021).

West Sumatra is one of the provinces cultivating cassiavera, which is spread across various regencies including Agam with a plant area of 3,270,000 (Ha) and production of 20,0406.56 tons in 2019. According to Agam Agriculture Office, 2019, the dominant producer in this regency is Malalak Sub-district with a land area of 1,192.30 (Ha) and production of 17,343.00 tons. Farmers in this area usually harvest barks after the plants are 12 years old, even up to 18 years because they think barks below 12 are still young and thin, leading to the need for further investigation. Determining a late harvest time tends to affect the economic value or profit generated because a longer wait will be required. It is necessary to identify the yield and quality of cassiavera based on plant age and part to establish the ideal harvest time for farmers in the Malalak Sub-district. Therefore, this research aims to compare cassiavera yield and identify the oil quality at different ages of 7 and 18 years (bottom and upper stem parts), as well as in the broken form.

2. Method

2.1. Materials and tools

In this research, cinnamon (Cassiavera) bark obtained from the Malalak Sub-district, Agam Regency, West Sumatra Province was used as the main material in oil production, and water was applied for distillation. A steam distillation system with a high-pressure method was employed during the separation process to enable water vapor's entry into the plant cell material to produce more essential oil. The tools used included a steam boiler distiller which has a support in the form of a plate containing holes similar to a boiler for cooking rice. The distiller was equipped with a kahobasi system, in which condensate water coming out of the separator would automatically re-enter into the boiler to minimize water loss. The distillate results were tested with Refractometer and GC-MS (Gas Chromatography-Mass Spectroscopy).

2.2. Method

This research used various samples of the plant, including:

1) Bark aged 18 years old
2) Lower stem aged 7 years
3) Upper stem aged 7 years
4) Broken cassiavera (shards of twigs and bark)

Before distillation, cassiavera samples were first cut using a knife into 1-2 cm (coarse) sizes. Steam-water distillation was conducted, where the plant material was placed in a rack, then oil was collected with one shelf according to the experimental results obtained.

2.3. Distillation procedure

Distillation was carried out through evaporation with water vapor, and the condensation process was based on differences in boiling points. The chopped material was placed above the boiler holes and then the boiler was heated using gas until the boiling point of water was reached. Afterward, water vapor came out of the plate holes through the cassiavera material, then exited into the cooler and re-entered the steam boiler from the cooler. The oil mixed with water vapor was collected by the separator. The distillation process is presented in Figure 1.

2.4. Parameters

The parameters measured and observed in this research are as follows:

1) Distillation Yield

Yield is one of the parameters for determining the oil quantity produced. The essential oil obtained from various samples was measured for each volume, then weighed and compared with the dry matter weight to calculate the yield percentage.

2) Physicochemical properties

Physicochemical properties included solubility in ethanol and refractive index (RI). The solubility in 70% concentration of ethanol applied the visual method while the RI was determined with a refractometer.

3) Chemical composition analysis

The chemical composition parameters measured consisted of Benzaldehyde (CAS) Phenylmethanol, 3-Cyclohexen-1-methanol, alpha,alpha,4-trimethyl, 2-Propenal, 3-phenyl-(CAS) Cinnamaldehyde, 2-Propenal, 3-phenyl-(CAS) Cinnamyl alcohol, and 2-Propen-1-ol, 3-phenyl-, acetate (CAS) Cinnamyl acetate.

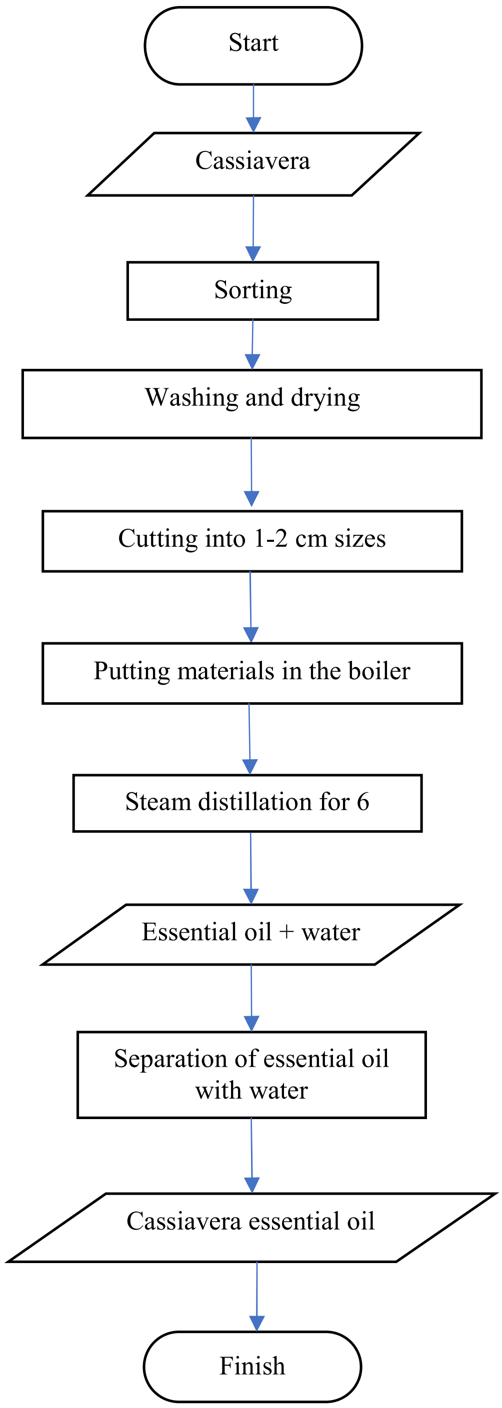

Figure 1. Flow chart of the distillation process

3. Result and discussion

3.1. Distillation yield

Yields can be obtained by the distillation process as demonstrated in Figures 2 and 3. Figure 2 (a) shows chopped and dried cassiavera, while 2(b) indicates the preparation of tools for the distillation process. Figure 3(a) shows the distillation process, while the separation of cassiavera essential oil with water is described in 3(b). The yield results are presented in Table 1.

Table 1.
Distillation Yield

No	Cassiavera	Yield (%)
1	Upper stem aged 7 years	0.9
2	Lower stem aged 7 years	0.9
3	Bark aged 18 years old	1.0
4	Broken cassiavera	0.7

Yield is expressed in volume per weight of the material. Table 1 shows that the highest oil yield is obtained from cassiavera bark aged 18 years, followed by 7 years old lower and upper stem, and broken cassiavera. In detail, the lower part or bottom of a cassiavera stem is 1.5 m from the ground and the upper part is 1.5 m from the bottom. According to Harun (2010), the higher location of branches on the stem and their smaller size leads to greater yield. Meanwhile, Yuliarto et al. (2012) found that the branches' size and distillation method affected the yield quality. Based on Table 1, the yield values of cassiavera aged 7 and 18 years are not much different, namely 0.9% and 1%, hence harvesting can be carried out at 7 years considering a shorter waiting period.

(a) (b)
Figure 2. Cassiavera that has been cut into pieces and dried for the distillation process (a), preparation of tools for the distillation process (b)

(a) (b)
Figure 3. Distillation process (a) and separation of essential oil with water (b)

3.2. Physicochemical properties

The physicochemical properties measured were the solubility of essential oils in 70% ethanol and the RI. Cinnamon oil testing was carried out based on INS 06-3734-2006 (National Standardization Agency, 2006). The results of the physical properties test are presented in Table 2. Ideas about the solubility level of cassiavera oil are detected in 70% ethanol, where more solubility indicates a higher presence of polar compounds.

Table 2.
Physicochemical properties of cassiavera oil

No	Test Parameter	Solubility in ethanol	Refractive index (RI)
1	7 years old lower stem	1:1, Clear	1.50
2	7 years old upper stem	1:1, Clear	1.56
3	18 years old	1:1, Clear	1.55
4	Broken cassiavera	1:1, Clear	1.32

Based on Table 2, the solubility of oil and ethanol with a 1:1 ratio had a clear level of appearance. Alcohol is a hydroxy group, meaning it will dissolve when mixed with cassiavera oil. The results showed many polar compounds in the oil samples. Meanwhile, lower oil solubility in 70% ethanol is directly proportional to better quality.

Referring to the RI analysis of bark oil from the four samples, the highest index value was 1.56, followed by 1.55, 1.50, and 1.32 obtained from the 7-year-old upper stem, the 18-year-old plant, lower stem, and broken cassiavera. RI is the ratio between the speed of light in air and across another substance at a certain temperature. Oil RI indicates its purity level and the value depends on the number of carbon and double bonds contained. This shows that the value is affected by the constituent components of cassiavera oil. The long carbon chain and many double bonds in the oil indicate a greater index, which is also influenced by the oil color darkness level.

RI correlates with the components of the essential oils produced. The value can increase due to a long carbon chain and multiple double bonds in the oil (Nugraheni *et al.*, 2016). A high value signifies that cassiavera oil has good quality. RI and solubility in alcohol are not affected by the material size and distillation method (Yuliarto *et al.*, 2012). Based on product quality standards in INS 06-3734-2006, solubility in 70% ethanol should be at least 1:3 and clear. Besides, the RI in this research ranged between 1.559-1595 which was close to the recommended standard.

3.3. Chemical composition analysis

In this research, several chemical compositions were measured in cassiavera samples as indicated in Table 3. The essential oil extracted through the distillation method was analyzed using Gas Chromatography-Mass Spectroscopy (GC-MS) to determine the oil compounds' content. From the GC-MS results, the compound peaks were obtained as shown in Figures 4 to 7. The peaks identified for the plant aged 7 and 18 years were 21, while up to 10 were found in broken cassiavera.

Cinnamaldehyde is the main constituent present in cassiavera as a chemical compound that gives taste and aroma (Gupta et al., 2008; Harun, 2010). The sustainable use of its compounds can be facilitated by isolation. Cinnamaldehyde has an aldehyde group and an alkene conjugated with a benzene ring. This is an aromatic aldehyde containing a carbonyl group, which can participate in a condensation reaction.

The major components of the essential oil from cassiavera stem bark are cinnamaldehyde and the terpene group, which are very dominant in number compared to other compounds (Yuliarto *et al.*, 2012). According to Table 3, cinnamaldehyde was proven as the most dominant composition in this research. The bark is the main raw material for cassiavera oil because the cinnamaldehyde content ranges from 54.03% to 73.50% and is higher than in other parts (Budiarti *et al.*, 2018). Also, Gupta et al. (2008) and Harun (2010) reported that the cinnamaldehyde content can reach 51-76%, with the best results being found in cassiavera aged 18 years and the lowest in the broken plant. All these values still fulfill the minimum requirements of INS 06-3734:2006, namely 50%.

Table 3.
Chemical composition of various cassiavera oil samples

No.	Test Parameter	Under 7 years old (%)	Above 7 years old (%)	Aged 18 years (%)	Broken (%)
1	Benzaldehyde (CAS) Phenylmethanol	1.22	1.21	1.50	11.05
2	3-Cyclohexen-1-methanol, alpha,alpha,4-trimethyl	1.04	1.22	1.28	1.59
3	2-Propenal, 3-phenyl-(CAS) Cinnamaldehyde	61.58	59.68	73.50	54.03
4	2 -Propenal, 3-phenyl-(CAS) Cinnamyl alcohol	0.44	0.44	0.33	1.02
5	2-Propen-1-ol, 3-phenyl-, acetate (CAS) Cinnamyl acetate	16.51	10.95	9.22	22.44

The chromatogram for the lower stem aged 7 years with a retention time of 18.772 minutes at peak number 12 identified a compound with the molecular formula C_9H_8O, namely cinnamaldehyde with a 61.58% concentration, which can be seen in Figure 4. The data were obtained by comparing the GC spectra -MS with the spectrum data library. The upper stem aged 7 years indicated 59.68% cinnamaldehyde content with a retention time of 18.331 minutes at peak number 10 as shown in Figure 5. According to Figure 6, a 73.50% level was derived from cassiavera aged 18 years with a retention time of 18.388 minutes at peak number 10. In the broken plant with a retention time of 17.240 minutes at peak number 5, the lowest value, i.e. 54.03%, was obtained as presented in Figure 7. Wasi et al. (2017) carried out the isolation process successfully with column chromatography. The analysis conducted using the GC-MS spectrometer showed that the identified cinnamaldehyde compound 71.36% with a molecular weight of 132 g/mol.

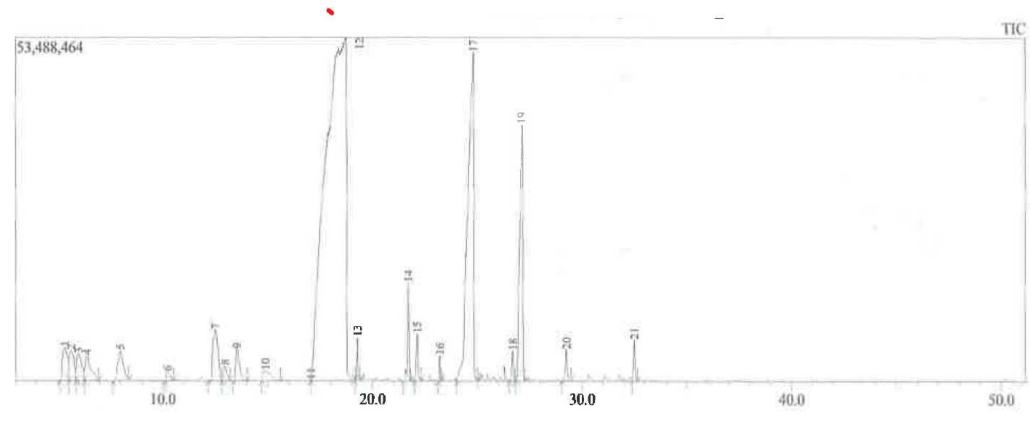

Figure 4. GC-MS analysis of cassiavera oil in lower stem aged 7 years

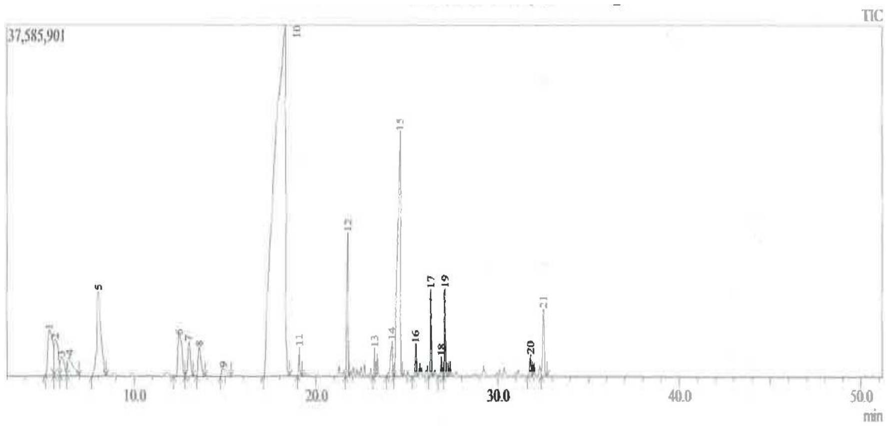

Figure 5. GC-MS analysis of cassiavera oil aged 7 years upper stem

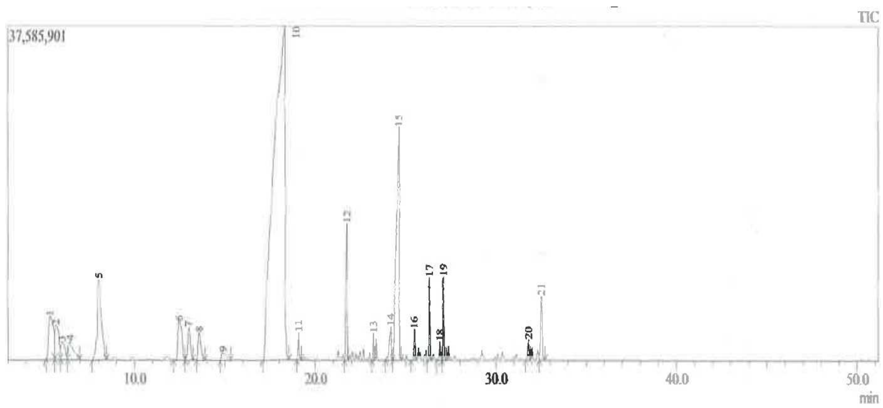

Figure 6. GC-MS analysis of 18-year-old cassiavera oil

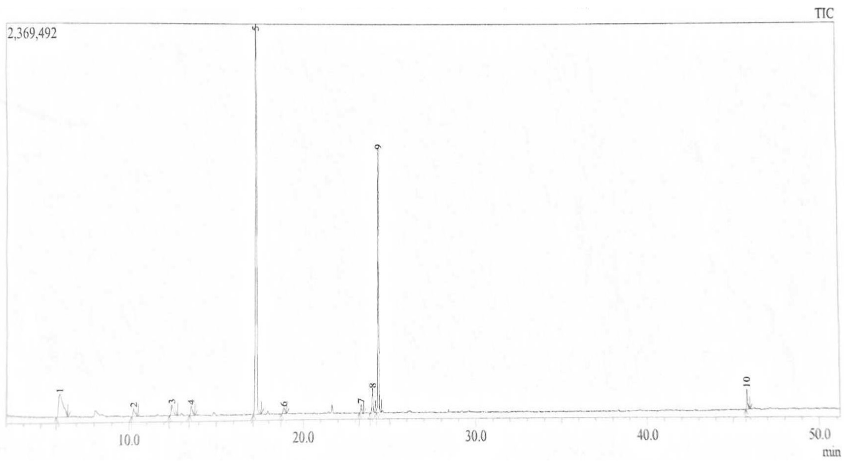

Figure 7. GC-MS analysis of broken cassiavera oil

Other compounds measured were Benzaldehyde (CAS) Phenylmethana, 3-Cyclohexen-1-methanol, alpha,alpha,4-trimethyl, 2-Propenal, 3-phenyl-(CAS) Cinnamyl alcohol, and 2- Propen-1-ol, 3-phenyl-, acetate (CAS) Cinnamyl acetate. Benzaldehyde (CAS) Phenylmethane is the simplest aromatic aldehyde compound, which is colorless at room temperature and has an almond odor. The largest content discovered in this research was 11.05% in broken cassiavera, followed by 1.28% in the 18-year-old plant, 1.21% in the 7 years old lower stem, and 1.21% in the the upper stem. This content was obtained at peak chromatogram number 3 in both stem parts and the 18 years old plant, while that of broken cassiavera was at number 1.

3-Cyclohexen-1-methanol, alpha,alpha,4-trimethyl is a viscous, colorless liquid with the aroma of clove flowers. Besides cassiavera, this compound can be found in plants such as lotus, catnip, daisy, and mangosteen. Its highest composition of 1.59% was found in the broken sample, followed by 1.50% in 18 years old cassiavera, 1.04% in the 7-year-old lower stem, and 1.22% in the upper stem. This content was obtained at the peak (peak) chromatogram number 9 on cassiavera aged 7 years on rootstock, number 8 on cassiavera aged 7 years on scion, number 8 on cassiavera aged 18 years, and number 4 on broken cassiavera. .

2-Propenal, 3-phenyl-(CAS) Cinnamyl alcohol is a white to yellowish crystalline solid with an odor similar to water hyacinth. The highest composition of 1.02% was found in broken cassiavera, followed by 0.33% in the 18-year-old plant, 0.44% in the 7-year-old lower stem, and 0.44% in the upper stem at peak chromatogram numbers 6, 11, 13, and 11, respectively.

2-Propen-1-ol, 3-phenyl-, acetate (CAS) Cinnamyl acetate is a colorless slightly yellow liquid with a floral odor. The compositions of 22.44%. 9.22%, 16.51%, and 10.95% were obtained from broken cassiavera, 1the 8 year-old plant, lower stem, and upper stem at peak numbers 9, 17, 17, and 15, respectively.

4. Conclusion

Based on the results, the highest oil yield was obtained in 18-year-old cassiavera, namely 1%. At the age of 7 years, the oil content is high enough, i.e. 0.9%, hence harvesting can be performed because the waiting period is shorter. The test results for the physicochemical properties of several samples showed that all solubility in 70% ethanol complied with INS 06-3734-2006 and the RI was best in the 7-year-old upper stem, 18-year-old plant, and broken cassiavera. The chemical tests indicated that the cinnamaldehyde content of 7.350%, 59.68%, 61.58%, and 54.03% was found in the 18 year-old plant, 7 year-old upper and lower stem, as well as the broken cassiavera, respectively. Overall, the quality of the oil produced meets the minimum requirement of INS 06-3734-2006, namely 50% cinnamaldehyde.

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