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Determination of content and chemical composition in Sri Lankan and Seychelles cinnamon volatile oil

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Abstract
Cinnamon is a small evergreen tropical tree that is originated in Sri Lanka that produces commercial important spice known as *Cinnamomum zeylanicum* scientifically. The cinnamon oil is a yellow color liquid when freshly distilled, gradually becoming reddish- brown with age and its odour is that of cinnamon. The grounded cinnamon bark samples were taken from different areas in Sri Lanka and a sample from Seychelles were subjected to investigate the volatile oil content and phytochemical composition competitively. The determination of volatile oil content in a spice is made by distilling the spice with water, collecting the distillate and measuring the volume of the oil using distillation unit. The volatile oil contents of the cinnamon samples were range between 1.3100+0.0036% and 1.4280+0.0165 (v/w) and about 85 chemical compounds were investigated through GCMS in the essential oil. Cinnamaldehyde which is the major compound ranges from 66.295% to 75.946% (w/w). According to the analysis the volatile oil content and chemical composition of the samples have been varied defending on the area and the country.

Keywords: cinnamon, volatile oil, cinnamaldehyde, GC-MS analysis

1. Introduction

Cinnamon was a useful spice to the human from thousands of years and it has been used to produce many commercially important products and ingredients such as flavouring agents, medicines, perfumes, soft drinks, etc. [1]. And also it has been used as an anointing oil as mentioned in Old Testament [2]. *Cinnamomum zeylanicum* is a tiny evergreen tropical tree which belongs to laurel family (Lauraceae). Its origin is in Sri Lanka and well known as “true cinnamon” or Ceylon cinnamon [3]. Cinnamon oil has shown most capable antibacterial properties. This bactericidal activity of cinnamon oil has been investigated and demonstrated. In combination with triclosan, gentamicin, or chlorhexidine or alone, cinnamon oil can effectively use to discourage the formation of biofilms, disconnect the subsisting biofilms, and kill microorganism in biofilms of clinical bacterial epidermidis strains. Mostly bacteria do not develop resistance to essential oils. That may be another benefit of the essential oil over antibiotics [4]. Cinnamon oil content can be extracted using distillation unit and its composition can be investigated using GCMS spectrograph. The average essential oil yields based on the dry weight of the cinnamon barks were determined as 1.0 % (v/w) [5]. GC peak in spectrograph are basis to calculate the relative amount of individual components in cinnamon oil composition. National Institute of Standards and Technology (NIST3.0) and WILEY 275 libraries together with GC-MS spectrograph obtained with the instrumental data bank can be used along with computer running the GC-MS system as a comparison to identify the different organic compounds, contained in the cinnamon bark essential oil based on the boiling point of the eluted component. GC-MS analyses produce about 95 % of the total components along with 14 and 15 major organic compounds in the cinnamon essential oils [5]. The Monoterpene hydrocarbons and phenolic compounds were the major compound groups of in essential oils according to GC-MS analyses [6]. Cinnamaldehyde (3-Phenyl-2-propenal) is the primary component which is found naturally in the essential oils (60–90%).It is a pale yellow liquid which causes to uniqueness of cinnamon and its spicy properties such as warmness, sweetness, spicy odor and pungent taste. Other than that Cinnamaldehyde also have good medicinal value such as destroying of cell membrane of both Gram-positive and Gram-negative bacteria, reducing of the intracellular ATP concentration and controlling the growth of fungi. Eugenol belongs to the class of phenylpropanoids chemical compounds [7].

2. Material and Methodology

2.1 Raw Materials

Cinnamon samples from different areas in Sri Lanka such as Matale, Rathnapura, Galle and Matara along with a Cinnamon sample From Seychelles islands were collected. Those laboratory samples were grounded as quickly as possible in a grinding mill to pass through the sieve with 1 mm diameter aperture. Precautions were used to avoid undue heating of apparatus during grinding. The ground stratifications (layering) were stored in a dry stoppered container (Ref:- I.S Specification No I.S 1797 – 1985 Methods of Test for Spices and Condiments / A.O.A.C 17th edn 2000, Official Method 920.164 Preparation of Test sample).

2.2 Determination of volatile oil content

According to A.O.A.C 17th edition, 2000 Official Method 962.17, the grinded sample was weighed accurately 50 gm of the spice and placed in the flask with glass beads. About 300 ml water was added and a drop of antifoam if necessary. The trap with water was filled. An efficient water cooled condenser was placed on top of the trap and heated the flask with good stirring or agitation until boiling was started and continued boiling moderately briskly, but so that the lower part of the condenser remained cold. The apparatus was set so that the condensate would not drop directly on the surface of the liquid in the trap but run down the side walls. The flask was rotated randomly to wash down any material adhering to the upper part of the walls. Then it was distilled to take two consecutive readings with in 1 hour intervals without any change in oil content. The source of heat was removed and read the volume of oil ten minutes or so later. Calculated as v / w.

2.3 GC-MS analysis

HP 5890 series GC provided with mass selective detector (MSD), HP 5972 was used to identify the composition of components in cinnamon bark oil along with GC-MS analysis.1 µl volume of helium was injected produce constant flow of 1 ml/min and it is used as carrier gas. Injector temperature was held at 250 °C and Ion-source temperature was 280 °C. Then oven temperature was programmed from 50 °C, with an increase of 3 °C/min, to 280 °C. It was held for 10min till isothermal at 280 °C. Total GC running time was about 90min [6].

3. Results and discussion

3.1 Determination of volatile oil content of Sri Lanka and Seychelles cinnamon samples

The five types of cinnamon samples from different areas in Sri Lanka and Seychelles were taken and subjected to determine the volatile oil content. Results of average oil contents are given in the table 1.

Table 1: Average Volatile oil contents of Sri Lankan and Seychelles cinnamon samples

Area	Average oil content % v/w
Rathnapura	1.4280±0.0165[a]
Gammaduwa (Matale)	1.3200±0.0121[b]
Galle	1.3100±0.0036[e]
Matara	1.3130±0.0072[c]
Seychelles islands	1.3730±0.0105[d]

According to the table 1 the average oil contents of the cinnamon samples taken from different areas in Sri Lanka and Seychelles islands vary between 1.3100±0.0036 and 1.4280±0.0165 whereas resulted values have given as a percentage of oil weight to the sample weight (v/w).

According to comparative analysis of the samples, with reference to the linear model of one way ANOVA (Tukey test), at 0.05 significance level, mean value for triplicates of all the samples were significantly different (p=0.00, therefore p<0.05). According the comparison highest oil content was shown in the sample from Rathnapura and sample from galle has showed lowest oil content

According to the ESA requirement minimum volatile content should be 0.45 oil weight to sample weight (w/w) (the specific gravity of the cinnamon volatile oil is 1.010 to 1.030 at 25^0C.). In dry basis, the minimum volatile oil content of cinnamon 1s 1.00% as whole cinnamon and 0.7% in grounded form as recommended by ISO 6539: 1997 standards (The Spice Council, 2010). According the data in the table 1 the analysed results of the samples have got small deviations from the standards. Therefore essential oil contents are close to the standards as recommended by different institutes.

3.2 Determination of chemical composition in the Cinnamon volatile oil

The chemical composition in the cinnamon volatile oil samples have been analysed using GCMS method and discovered several chemical compounds in the oil.

3.2.1 Analysis of chemical composition in Cinnamon volatile oil of the sample-Rathnapura

Cinnamon volatile oil sample of Rathnapura was extracted and subjected to GCMS analysis to discoverer the chemical composition. The composition and the retention time of the major chemical compounds, which are in higher contents in the cinnamon volatile oil of Rathnapura sample are represented in the table 2.

Table 2: Results of the GCMS analysis of the essential oil sample-Rathnapura

Chemical Compound	Retention time (mins)	Content %
Benzene,1,3,5-trimethyl	7.883	0.941
1,6-Octadlen-3-ol,3,7-dimethyl	11.593	2.496
Cinnamaldehyde	16.807	74.390
Tridecane	17.159	1.954
phenol,2-methoxy-3-(2-propenyl)	18.812	3.181
Caryophyllene	20.332	4.567
Caryophyllene oxide	24.287	1.431

With reference to the GCMS analysis, 42 chemical compounds were discovered with above major compounds. Most of the compounds, which are in minor amounts, are less than 1%. According to the table 2, the cinnamaldehyde is in the highest composition in the volatile oil sample and it is 74.390% and has a retention time of 16.807 minutes. According to Kamaliroosta and colleagues (2011), the cinnamaldehyde composition in volatile oil and retention time are respectively 62.09% and 17.55 minutes. Therefore resulted cinnamaldehyde content is most deviated from sited value.

3.2.2 Analysis of chemical composition in Cinnamon volatile oil of the sample-Gammaduwa (Matale)

The composition and the retention time of the major chemical compounds, which are in higher contents in the cinnamon volatile oil of Gammaduwa sample are represented in the table 3.

Table 3: Results of the GCMS analysis of the essential oil sample-Gammaduwa

Chemical Compound	Retention time (mins)	Content %
Benzene,1,2,3-trimethyl	8.547	1.017
beta-Phellandran	9.522	1.289
2-Propanal,3-phenyl	16.881	1.889
Cinnamaldehyde	18.593	68.933
Phenol,2-methoxy-3-(2-propenyl)	18.809	5.052
Copane	19.195	1.233
Caryophyllene	20.348	5.179
Caryophyllene oxide	24.290	1.232

The volatile oil sample of Gammaduwa is analyzed and 54 chemical compounds were identified using GCMS method. The eight compounds were in higher contents, which are higher than 1%. The content and the retention time of cinnamaldehyde of volatile oil of the sample-Gammaduwa respectively 68.933% and 18.593 minutes.

3.2.3 Analysis of chemical composition in Cinnamon volatile oil of the sample-Galle

Seven major compounds (composition is higher than 1%) which are discovered in the essential oil sample of Galle, after subjecting to the GCMS analysis are represented in the table4.

Table 4: Results of the GCMS analysis of the essential oil sample-Galle

Chemical Compound	Retention time (mins)	Content %
Benzene,1-ethyl-3-methyl	7.705	1.404
Bicloro[3.1.0]hex-2-ene,4-methyl-1-(1-methylethyl)	9.528	1.354
Cinnamaldehyde	16.352	66.295
Tridecane	17.165	2.160
Phenol,2-methoxy-3-(2-propenyl)	18.804	4.368
Caryophyllene	20.341	5.209
Caryophyllene oxide	24.287	1.455

Fifty nine organic compounds were identified. According to the table 4, the Cinnamaldehyde content of this sample and the retention time of the cinnamon volatile oil sample of Galle are respectively 66.295% and 16.352.

3.2.4 Analysis of chemical composition in Cinnamon volatile oil of the sample-Matara

The composition and the retention time of the major chemical compounds, which are in higher contents in the cinnamon volatile oil of Matara sample are represented in the table 5.

Table 5: Results of the GCMS analysis of the essential oil sample-Matara

Chemical Compound	Retention time (mins)	Content %
Heptane,2,5-dimethyl	4.633	2.549
Heptane,2,3-dimethyl	5.057	1.128
Heptane,2,3-dimethyl	5.057	1.128
Octane, 4-methyl	5.263	3.493
Octane, 3-methyl	5.419	4.919
o-Xylene	5.933	2.142
Nonane	6.121	6.720
4-Octane-3-one	6.257	1.261
Cyclohexane,(1-methylethyl)	6.559	1.801
Benzene,(1-methylethyl)	6.705	1.814
Cyclohexane propyl	6.818	1.634
Octane,2,6-dimethyl	6.927	1.270
Benzene, propyl	7.479	1.009
Benzene,1-ethyl-2-methyl	7.678	2.784
Benzene,1,2,3-trimethyl	7.864	1.213
Benzene,1,2,3-trimethyl	8.544	1.527
Cinnamaldehyde	15.549	73.299
Tridecane	17.149	1.044
Phenol,2-methoxy-3-(2-propenyl)	18.799	2.318
Cyclo[7.2.0]undec-4-ene,4,11,11-trimethyl-8-methylene	19.189	1.041
Cyclo[3,1,1]hept-2-ene,2,6-dimethyl-6-(4-methyl-3-pentenyl)	20.350	4.915

According to the GCMS analysis, 80 chemical compounds were discovered with above major compounds. Most of the compounds, which are in minor amounts, are less than 1%. According to the table 5, the cinnamaldehyde composition of the volatile oil sample is 73.299% which is in the highest composition and has retention time of 15.549 minutes.

3.2.5 Analysis of chemical composition in Cinnamon volatile oil of the sample- Seychelles Islands

Twenty five major compounds (composition is higher than 1%) which are discovered in the essential oil sample of Seychelles Islands, after subjecting to the GCMS analysis are represented in the table 6.

Table 6: Results of the GCMS analysis of the essential oil sample- Seychelles Islands

Chemical Compound	Retention time (mins)	Content %
Octane	3.981	1.780
Heptane2,6-dimethyl	4.506	1.084
Heptane2,5-dimethyl	4.637	4.320
Heptane,2,3-dimethyl	5.079	1.802
Octane,4-methyl	5.275	5.029
Octane,3-methyl	5.431	5.704
1-Ethyl,4-methylcyclohexane	5.789	1.312
0-Xylene	5.935	2.381

Nonane	6.140	7.341
Cyclohexane,1-ethyl,4-methil,trans	6.269	1.451
Cyclohexane,1-ethyl,4-methil,cis	6.339	1.275
Cyclohexane,(1-methylethyl)	6.567	2.515
Benzene,(1-methylethyl)	6.710	2.438
Cyclohexane, propyl	6.825	2.196
Octane,2,6-dimethyl	6.933	1.720
Heptane,3-ethyl-2-methyl	7.115	1.310
Benzene,1,3,5-trimethyl	7.866	1.782
Benzene,1-ethyl-2-methyl	8.177	1.013
Benzene,1,2,3-trimethyl	8.545	1.862
Bicyno [3,1,0-hex,2-ene,4-methyl-1-(1-methylethyl)	9.530	1.233
1,5-Octadien-3-ol,3,7-dimethyl	11.592	1.384
Cyclohexane-1-mthanol,alpha,alpha,-4-trimethyl	14.195	1.123
Cinnamaldehyde	16.684	75.946
Tridecane	17.143	1.321
Euganol	18.804	5.587

Eighty five organic compounds were identified in the Seychelles essential oil sample, whereas resulted values from GCMS method. 25 major volatile compounds were higher than 1% in content, as shown in the table 6. The cinnamaldehyde content and the retention time of this essential oil sample are respectively 75.946%. and 16.684 minutes.

According to the analysis the volatile oil content of the samples has been varied defending on the area and the country. These differences in oil contents are caused due to the differences in the soil, climate condition, temperature, geography, seasonal changes, growing conditions and post-harvest patterns and techniques. Essential oil quality of the cinnamon is influenced mainly by the soil and climatic factors and best quality is produced in the white sandy soil.

Conclusion

The volatile oil which is useful component in cinnamon has shown higher contents in all cinnamon samples when consider with international requirements. The cinnamaldehyde is the major compound in the cinnamon volatile oil which contain about 85 chemical compounds. Different geographical factors and climatic conditions influences volatile oil content and chemical composition.

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