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Comparison of Lipophilic Substances of the Bark of Chinese (*Cinnamomum cassia* (L.) C. Presl.) and Ceylon Cinnamon (*Cinnamomum zeylanicum* Blume)

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Abstract: The components of the essential oil and fatty acids extracted from the bark of Chinese (*Cinnamomum cassia* (L.) C. Presl.) and Ceylon cinnamons (*Cinnamomum zeylanicum* Blume) were analyzed and compared by gas-liquid chromatography (GLC). Totally ten components in the essential oil of the bark of Ceylon cinnamon and three components in Chinese cinnamon have been identified obtained by steam distillation. Hexane extracts from the bark of Ceylon cinnamon contained eight components of the essential oil and extract from the bark of Chinese cinnamon - two components. It is shown that the main component of the essential oil of bark of Ceylon and Chinese cinnamons is a *trans*-cinnamaldehyde. Fatty acids in the bark of Ceylon cinnamon consist of 6 polyunsaturated fatty acids with domination of palmitic and stearic acids. Five fatty acids have been identified in the bark of Chinese cinnamon with domination of palmitic acid. The composition of essential oils and fatty acids extracted from the bark of Ceylon and Chinese cinnamons determined by GLC is the specific features, which allow the distinguishing of these barks.

Key words: Bark · Chinese cinnamon · Ceylon cinnamon · Essential oil · Fatty acid

INTRODUCTION

Currently, the search for additional sources of medical plant raw material is important. Food plants as possible sources of medical plant raw material for the pharmaceutical industry are considered as the most prospective [1]. For example, Chinese (*Cinnamomum cassia* (l.) C. Presl.) and Ceylon cinnamon (*Cinnamomum zeylanicum* Blume), which are widely used as food plants (spicy herbs) in different countries are interesting as the study objects. In addition, there are monographs representing the studies of the bark of Ceylon cinnamon in the European [2], British [3], Spanish [4] and Ukrainian [5] pharmacopoeias and the bark of Chinese cinnamon in Japanese [6] and China [7] pharmacopoeias. The monographs on the essential oil from the bark of Ceylon cinnamon are included into the European [2], British [3], Spanish [4] and Ukrainian [5] pharmacopoeias and the essential oil of the bark of Chinese cinnamon in Ukrainian [5], Chinese [7] and Spanish [4] pharmacopoeias. Japanese pharmacopoeia [6] contains a monograph on the cinnamon essential oil that can be obtained or from the bark of Chinese or Ceylon cinnamons. In addition, the Russian pharmacopoeia (of 1910) [8] contained the study on the bark of Chinese cinnamon.

This study was aimed at the comparison and analysis of the chemical composition of lipophilic substances from the bark of Chinese (*C. cassia* (L.) C. Presl.) and Ceylon cinnamon (*C. zeylanicum* Blume) as perspective national official medical plant raw material.

MATERIALS AND METHODS

Industrial series of the cinnamon bark corresponding to the requirements of GOST (State Standard) 29049-91 “Spices. Cinnamon. Technical conditions” served as the study objects. According to this standard, the cinnamon bark can be obtained from 4 cinnamon wood species, including *C. zeylanicum* and *C. cassia*, which differ in appearance. The bark of Chinese cinnamon is the sticks

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with 5 mm outer layer and length more than 10 cm and the bark of the Ceylon cinnamon consisted of the sticks in form of the folded tubes, smooth and cleared from the 3 mm outer layer and length more then 10 cm.

To study the composition of the essential oil by GLC according to the General article of pharmacopoeia "Gas chromatography" of the State Pharmacopeia [9], the samples have been prepared by two methods:

- Essential oil was obtained by the method described in the XI edition of first State Pharmacopeia [10]. Analytical sample of raw material was pounded to the 2 mm particles. Approximately 15,0 g (the exact hinge) of the pounded material were placed in the 1 L Erlenmeyer flask and added with 300 ml of water. The flask was closed by a rubber stopper with reverse ball-fridge and bottom-attached graduated collector for essential oil with the 0,025 ml graduating mark. The flask with solution was boiled on water bath for 3 hours. Essential oil obtained by the distillation was transferred to volumetric flask, dissolved in 20 ml of 96 % ethanol and adjusted until 25 ml.
- Analytical sample of raw materials was pounded until 2 mm particles. Approximately 5,0 g (exact hinge) of the pounded material were transferred in the cartridge of filter paper, placed in Soxhlet extractor and extracted by 200 ml of hexane for 3 hours. The hexane extract was filtered through Millipore filter with a diameter of pores 0,45 μm.

The alcoholic solutions, hexane extracts of essential oil from the bark and 0,01% alcohol solutions of standard samples of the essential oil components were chromatographed in five replicates.

The study was conducted using "Kristallyuks-4000M" chromatograph. Separation was carried out on a quartz capillary column HP-5ms (copolymer 5% diphenyl – 95% dimethylpolysiloxane) (Agilent, United States) with a size 30 m x 0,25 mm x 0.25 μm, column temperature gradient from 100 to 150°C, heating rate 5°C per minute (pressure on column 1 ATM). Mobile phase (carrier gas) – nitrogen, evaporator temperature 220°C with the consumption of the carrier gas – 30 ml/min (nitrogen), air – 300 ml/min, hydrogen – 30 ml/min, the inflow rate – 1.1 ml/min and the flow division – 1:27. The system was equipped by flame ionization detector with the temperature 250°C. The volume of injected sample was 1 μml and time of analysis – 15 minutes.

Fatty oil was extracted from raw material by hexane. To achieve this, the analytical sample of raw materials was pounded to the crushed to 2 mm particles. Approximately 5,0 g of the pounded material were transferred to the cartridge of filter paper, placed in Soxhlet extractor and extracted by 200 ml of hexane for 3 hours on an electric range with isolated coil. Hexane extract was removed to evaporation bowl and evaporated on a water bath to dry.

The study of the composition of the fatty oils was conducted by GLC. The fatty acids were preliminary transformed to methyl esters by dissolvent of the remainder in evaporation bowl in 25 ml of hexane. This solution was added by 10 ml of 2% sodium hydroxide in methanol, placed on a water bath, heated for 10 min with backflow condenser and added by 10 ml of 14% boron trifluoride and kept in the same conditions for 10 min. The mixture was cooled until room temperature and removed to 50 ml flask, added by 20 ml of saturated solution of sodium chloride, mixed and upper hexane layer was removed. 25 ml of hexane extract containing methyl esters of fatty acids was placed in 50 ml flask, added by 5,0 g of anhydrous sodium sulfate and mixed. Hydrolysis of standard samples of fatty acids was conducted simultaneously using the same method.

Chromatographic separation was carried out on capillary column with a polar stationary phase Supelcowax-10 and size 30 m x 0,25 mm x 0,25 μm (Supelco, United States) at the column temperature 220°C and pressure 0,9 atm. Mobile phase (carrier gas) – nitrogen, evaporator temperature – 250°C with the flow of the carrier gas (nitrogen) 30 ml/min, air – 300 ml/min, hydrogen – 30 ml/min, inflow rate – 0,6 ml/min and flow division – 1:115. The system was equipped by flame ionization detector with the temperature 250°C. The volume of injected sample was 1 ml and time of analysis – 10 min.

Components of essential and fatty oils were identified by comparison of retention time of studied substances with standards.

General: As the result of chromatography, the essential oil of the bark of *C. zeylanicum* obtained by steam distillation, contained α-pinene, β-pinene, cymene, limonene, linalool, camphor, citronellol, *trans*-cinnamaldehyde, estragol and eugenol and the essential oil of the bark of *C. cassia*, obtained by the same method, contained linalool, citronellol and *trans*-cinnamaldehyde (Table 1). It is established that hexane extract from the bark of *C. zeylanicum* contains the following components

Table 1: A comparative analysis of the chemical composition of essential oil of the bark of Ceylon and Chinese cinnamon using the steam distillation method

		Bark of *C. zeylanicum* Blume		Bark of *C. cassia* (L.) C. Presl	
Retention time, min	Component of essential oil	Relative content, %	Concentration in essential oil, %	Relative content, %	Concentration in essential oil, %
2,44	α-pinene	0,12	0,02	–	–
2,73	β- pinene	0,10	0,02	–	–
3,07	cymene	0,58	0,11	–	–
3,39	limonene	0,13	0,03	–	–
3,79	linalool	6,03	1,45	1,94	0,25
4,72	camphor	0,50	0,13	–	–
4,98	–	1,38	–	–	–
5,19	–	1,76	–	–	–
5,67	citronellol	3,53	3,53	9,36	9,36
6,61	*trans*-cinnamaldehyde	34,81	35,40	73,55	73,54
6,84	estragol	0,10	0,14	–	–
8,31	eugenol	3,82	0,99	–	–
9,75	–	10,07	–	8,03	–
10,20	–	32,56	–	7,13	–
10,56	–	2,39	–	–	–
12,21	–	2,12	–	–	–

Table 2: A comparative analysis of the chemical composition of essential oil of the bark of Ceylon and Chinese cinnamon by method of hexane extraction in the Soxhlet extractor

		Bark of *C. zeylanicum* Blume		Bark of *C. cassia* (L.) C. Presl.	
Retention time, min	Component of essential oil	Relative content, %	Concentration in essential oil, %	Relative content, %	Concentration in essential oil, %
2,41	α-pinene	0,13	0,75	–	–
2,71	β- pinene	0,04	0,02	–	–
3,04	cymene	0,08	0,53	–	–
3,75	linalool	0,91	0,07	–	–
4,67	camphor	0,35	0,003	–	–
5,61	citronellol	12,27	12,28	9,97	9,97
6,54	*trans*-cinnamaldehyde	69,59	69,58	74,77	74,76
8,24	eugenol	2,12	0,02	–	–
9,69	–	3,24	–	–	–
10,11	–	11,27	–	15,26	–

Table 3: Comparative analysis of fatty acid composition of the bark of Ceylon and Chinese cinnamon

		Bark of *C. zeylanicum* Blume		Bark of *C. cassia* (L.) C. Presl.	
Retention time, min	Component of essential oil (acids)	Relative content, %	Concentration in essential oil, %	Relative content, %	Concentration in essential oil, %
3,57	palmitic	47,79	0,85	86,96	2,68
4,72	–	22,50	–	7,44	–
5,07	stearic	22,18	0,40	3,65	0,08
5,18	oleic	0,35	0,01	0,69	0,02
5,65	linoleic	3,42	0,09	0,30	0,01
5,98	β-linolenic	1,18	0,03	–	–
6,31	α-linolenic	2,58	0,04	0,96	0,03

of the essential oil: α-pinene, β-pinene, cymene, linalool, camphor, citronellol, *trans*-cinnamaldehyde and eugenol and the extract from the bark of *C. cassia* contained only citronellol and *trans*-cinnamaldehyde (Table 2). It is shown that the main component of the essential oils of studied barks is a *trans*-cinnamaldehyde. However, its relative content in the essential oil obtained by steam distillation from the bark of *C. cassia* was more than 70%, however, the content of the essential oil extracted from the bark of *C. zeylanicum* using the same method, was

only 35% (Table 1). The relative content of *trans*-cinnamaldehyde in hexane extracts from the both barks was approximately similar (Table 2).

Identification of fatty acids and behavior of methyl esters of fatty acids according to retention time revealed the presence of six polyunsaturated fatty acids – palmitic, stearic, oleic, linoleic, α- and β-linolenic acids in the bark of Ceylon cinnamon, while the bark of Chinese cinnamon contained five 5 polyunsaturated fatty acids – palmitic, stearic, oleic, linoleic and α-linolenic acid (Table 3).

Thus, palmitic and stearic acids dominate in the fatty acid composition of the bark of Ceylon cinnamon prevails and palmitic acid in the bark of Chinese cinnamon.

CONCLUSIONS

As the result of the study, ten components have been identified in the essential oil from the bark of Ceylon cinnamon obtained by steam distillation and three components in the essential oil from the bark of Chinese cinnamon. Hexane extract from the bark of the Ceylon cinnamon contains eight components of the essential oil and the extract from the bark of the Chinese cinnamon only two components. It was shown that the main component of the essential oil from the bark of Ceylon and Chinese cinnamon is a *trans*-cinnamaldehyde.

Fatty acids in the bark of the Ceylon cinnamon are represented by six polyunsaturated fatty acids with maximum content of palmitic and stearic acids, while the bark of Chinese cinnamon contains five acids with maximum content of palmitic acid.

Thus, essential and fatty oil from the bark of *C. zeylanicum* and *C. cassia* are interesting for prospective study and use in the national medicine as the sources of valuable biologically active substances. The studied barks are different in both external features and chromatographic profiles of essential and fatty oils that can be used for the identification of raw materials.

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