

Extraction and Characterization of Ginger Oil and its Application

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Abstract

In Myanmar, ginger is called *gyin* and it is widely used in cooking and as a main ingredient in traditional medicines. In addition, ginger oil, an essential oil, is also used in medicine and used for cooking, as a flavoring for cookies, biscuits and cake, and it is the main flavor in ginger ale. The present research emphasized the extraction of ginger oil by using water distillation and water and steam distillation methods. The variation of extraction time to achieve the highest yield of ginger oil was conducted. The suitable extraction times were (2) hrs for water and steam distillation method and (4) hrs for water distillation method. The physico-chemical properties of ginger oil such as colour, refractive index, peroxide value and acid value were determined. Identification of extracted ginger oil was carried out by FT-IR analysis. Then, three types of balm using extracted ginger oil were also formulated by incorporating in beeswax, paraffin wax, camphor, menthol, methyl salicylate and eucalyptus oil respectively. The physico-chemical properties of balm were also determined and dermatological tests of prepared balm were also conducted for safe use.

Key words: Ginger Oil, water distillation, water and steam distillation

Introduction

Essential oils are concentrated volatile aromatic compounds produced from plants. Unlike fatty oils, these "essential" oils are volatile and highly concentrated substances extracted from flowers, leaves, stems, roots, seeds, bark, resin or fruit rinds. The amount of essential oils found in the plants can vary from 0.01 percent to 10 percent of the total. These oils have potent antimicrobial factors, having a wide range of therapeutic constituents. Essential oil plants and culinary herbs include a broad range of plant species that are used for their aromatic value as flavorings in foods and beverages and as fragrances in pharmaceutical and industrial products (Virendra and Diwaker, 2007). In Myanmar, ginger is called *gyin* and it is widely used as a cooking herb, condiment, spice and home remedy and as a main ingredient in traditional medicines for a long time ago. Today, many herbalists use ginger to help with treating health problems associated with inflammation, such as arthritis, bronchitis, and ulcerative colitis. In addition, ginger oil is used for the treatment of fractures, rheumatism, arthritis, bruising, carbuncles, nausea, hangovers, travel and sea sickness, colds and flu, catarrh, congestion, coughs, sinusitis, sores on the skin, sore throat, diarrhea, colic, cramps, chills and fever. Besides that, ginger oil is used for cooking, as a flavoring for cookies, biscuits and cake, and it is the main flavor in ginger ale, a sweet, carbonated, non-alcoholic beverage. Fresh ginger oil is a light green or yellow mobile liquid, possessing a characteristic of aromatic odour of the spice. It is produced by steam distillation from the dried rhizome of *Zingiberofficiale* Roscoe. The main constituents of the oil are sesquiterpenes and it lacks pungency (Khairu, 2006).

Thus, the objectives of this study are to compare the different extraction methods and, to give the information of usefulness of ginger oil.

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Materials and Methods

Materials

Fresh gingers, cultivated at Aung Pan Township, Shan State were purchased from Thiri Mingalar Market. Sodium sulphate (analar grade) was used for the extraction of ginger oil to absorb the water incorporated in the oil. Beeswax, Paraffin wax, Camphor, Menthol, Methyl salicylate, Eucalyptus oil and Peppermint oil were also used for the preparation of balm.

Methods

Pretreatment of Fresh Ginger

Fresh Aung Pan gingers were washed with water and peeled. Then, they were sliced into small pieces about (2 cm) and sun-dried. After being sun-dried, the dried gingers were ground and screened with (100 mesh) screen and then they were kept tightly in plastic bags at room temperature (27-30 °C). It was ready to extract the ginger oil by using water distillation and water and steam distillation methods.

Extraction of Ginger Oil

By Water and Steam Distillation Method

(100) g of dried ginger powder was placed in two way round-bottomed flask. This flask was connected to another 1000 mL round-bottomed flask in which steam was generated. Extraction was carried out for 2 hrs. During distillation, steam was passed through the dried ginger powder and extracted the volatile oil. Then, the volatile ginger oil was carried along with the steam passing through the condenser and collected in the receiver. Then, ginger oil in the distillate was dried over anhydrous sodium sulphate for one night. Finally, ginger oil was obtained and its yield was calculated.

By Water distillation Method

(100) g of dried ginger powder and (750) mL of water were mixed in a round-bottomed flask and extraction was conducted for 4 hrs. The volatile oil which passed through the condenser was collected in the receiver. Then, the collected mixture of water and ginger oil was separated by drying sodium sulphate for one night. Finally, ginger oil was obtained and its yield was calculated.

Effect of extraction time on the yield of extracted ginger oil was also studied for both methods. The results are shown in Table (3).

Methods of Identification and Analysis

Physico-chemical properties of fresh ginger and dried ginger powder were firstly investigated. Then, the phytochemical characteristics of fresh ginger were also detected. The functional groups present in the extracted ginger oil was identified by Fourier Transform Infrared (FT-IR) spectrum. To evaluate the quality of ginger oil, the characteristics such as refractive index, colour, acid value, and peroxide value were also determined.

Results and Discussion

The physico-chemical properties such as moisture content, ash content, protein content, crude fiber, crude fat and carbohydrate content of fresh ginger and dried ginger powder were determined. The results were tabulated in Table (1). From this Table, it can be seen that moisture content is the largest percentage in fresh ginger (79.87%). It has crude fat content of 0.39% and carbohydrate content of 16.68%. Dried ginger powder has the carbohydrate content of 73.11%, protein content of 7.37% and crude fat content of 2.17%. It was noted that the characteristics of fresh ginger and dried ginger powder were in accordance with the literature values.

The phytochemical investigation of fresh ginger such as alkaloid, carbohydrate, glycoside, phenol, α -amino acid, saponin, tannin, flavonoid, terpenoid and steroid were determined and the results were shown in Table (2). From Table (2), all types of compound detected are present except tannin and steroid.

The effect of extraction time on the yield of ginger oil by using different methods such as water and steam distillation and water distillation, was investigated and the results were shown in Tables (3) and Figures (1), (2). According to the results as shown in Figures (1) and (2), it can be seen that the most suitable extraction time to achieve the highest yield of ginger oil is (2) hours for water and steam distillation and (4) hours for water distillation.

FT-IR spectra of Table (4) and Figure (3) shows the functional groups present in the organic samples which could be assigned. Stretching bands of alkene groups were found at 889.21, 827.49, 671.25 and 545.87 cm^{-1} respectively. Phenol groups gave the absorption band at 1095.60 and 1446.66 cm^{-1} . The characteristics of extracted ginger oil such as colour, refractive index, acid value and peroxide value were determined and the results are shown in Table (5). It can be clearly seen that the characteristics were in accordance with the literature.

Three types of formulation of balm were made by using different ingredients of beeswax, paraffin wax, camphor, menthol, methyl salicylate, eucalyptus oil, peppermint oil and ginger oil. The effect of beeswax on the viscosity of prepared balm (B_1) in which lacks of ginger oil is shown in Table (6). Based on these results, it can be seen that (4) g of beeswax gave slightly soft viscosity of prepared sample. The effect of the amount of camphor on the properties of prepared balm (B_1) is shown in Table (7). According to the results in Table (7), it was found that (7) g of camphor gave the skin absorption and cooling sensation of prepared sample. The effect of the amount of peppermint oil on the properties of prepared balm (B_1) is described in Table (8). The results in Table (8) can be pointed out that (2) g of peppermint oil gave the pungent character of prepared sample. Similarly, in the preparation of balm samples (B_2) and (B_3), the effect of beeswax, camphor and ginger oil on the properties of balm were also studied and the results were shown in Tables (6), (7) and (8). According to these results, the most suitable amounts used are (4) g of beeswax, (7) g of camphor and (2) g of ginger oil for (B_2) and (4) g of beeswax, (7)g of camphor and (2) g of ginger oil for (B_3).

The physico-chemical properties of prepared balm samples such as viscosity and pH were determined and the results were shown in Table (9). According to those results, the most suitable amount of viscosity is (1300) cP and pH is 6.9 for (B_2). Dermatological test of prepared balm (B_2) was shown in Table (10). The result shows that the prepared sample (B_2) provides effective pain relief for sore muscles, neck and shoulder stiffness. In addition to their natural ingredients, camphor, menthol and the main constituent of ginger oil, zingiberene, the prepared samples gave distinct flavor.



Fresh Ginger



Dried Ginger Powder



Ginger Oil extracted by water & Steam Distillation

Ginger Oil Balm (B₂)**Table(1) Physico-Chemical Properties of Fresh Ginger**

Sr. No	Characteristics	Fresh ginger	*Literature value	Dried ginger Powder	*Literature Value
1.	Moisture content (w/w%)	79.87	75.14	9.66	3.5
2.	Ash content (w/w%)	0.66	0.61	3.23	3.4
3.	Protein (w/w%)	1.38	1.82	7.37	5.5
4.	Crude fiber (%)	1.02	2.0	4.46	4.9
5.	Crude fat (%)	0.39	0.17	2.17	0.76
6.	Carbohydrate (%)	16.68	17.77	73.11	21.92

*(<http://en.wikipedia.org/wiki/medicalnewtoday.net>)

Table (2) Phytochemical Characteristics of Fresh Ginger

Sr. No.	Tests	Extract	Reagents	Observation	Inference
1	Alkaloids	1%HCl	Mayer's reagent	White ppt	+
2	Flavonoids	70%EtOH	H ₂ SO ₄ (conc:) +Mg turning	Pink colour	+
3	Glycosides	H ₂ O	10%Lead acetate sol ⁿ	White ppt	+
4	Phenol	H ₂ O	5%FeCl ₃ solution	Brown ppt	+
5	Tannins	H ₂ O	1% Gelatin+ 10%NaCl solution	No ppt	-
6	Saponin	H ₂ O	H ₂ O	Persistent foam	+
7	Carbohydrate	H ₂ O	10%α naphthol &H ₂ SO ₄ (conc:)	Red ring	+
8	α-amino acid	H ₂ O	Ninhydrin reagent	Purple colour	+
9.	Terpenoid	Petroleum ether	Acetic anhydrite & Conc.H ₂ SO ₄	Pink	+
10.	Steroid	Petroleum ether	Acetic anhydrite & Conc.H ₂ SO ₄	-	-

Table (3) Effect of Extraction Time on Yield of Ginger Oil Extracted by Water and Steam Distillation and Water Distillation Methods

Weight of dried ginger powder = 100 g
 Particle size of dried ginger powder = 100 mesh

Sr. No	Extraction time (hr)	Water& steam distillation		Water distillation	
		Weight of oil (g)	Oil yield (%)	Weight of oil (g)	Oil yield (%)
1.	1	0.9	0.9	0.3	0.3
2.	2 *	1.77	1.77	0.28	0.28
3.	3	1.71	1.71	0.33	0.33
4.	4**	0.73	0.73	0.52	0.52
5.	5	1.0	1.0	0.43	0.43

* Most suitable extraction time for water& steam distillation

** Most suitable extraction time for water distillation

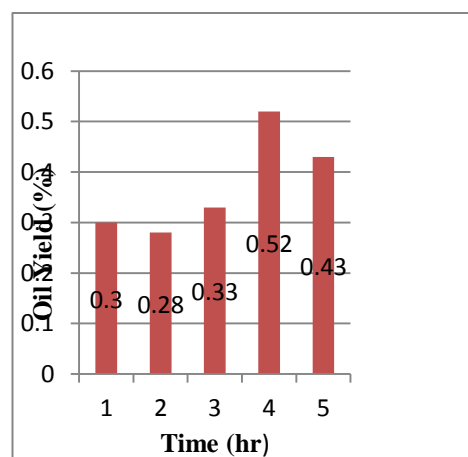
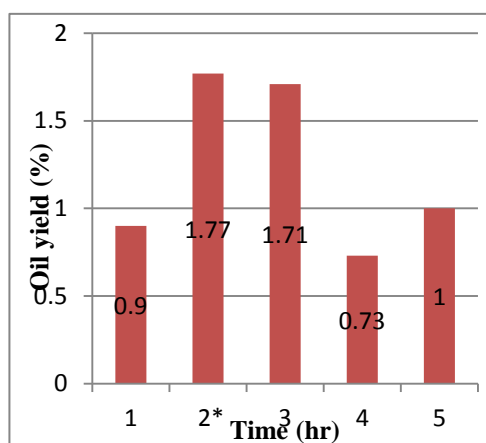


Figure (1) Effect of Extraction Time on Yield of Ginger Oil Extracted by Water and Steam Distillation

Figure (2) Effect of Extraction Time on Yield of Ginger Oil Extracted by Water Distillation



Figure (3) FT-IR Spectrum Data of Extracted Ginger Oil

Table (4) FT-IR Spectrum Data of Extracted Ginger Oil

Wave number, cm ⁻¹		Functional group	
Observed	Literature *		
3732.38	3500-3300	<i>v</i> - NH	Stretching vibration of amines groups
3446.91	3560-3500	<i>v</i> - OH	Stretching vibration of carboxylic acid
2933.83	3000-2840	<i>v</i> - CH	Stretching vibration of alkane group
1666.55	1800-1600	<i>v</i> - C=C	Stretching vibration of carboxylic acid
1446.66	1650-1390	<i>v</i> - OH	Stretching vibration of alcohol and phenol group
1377.22	1390-1230	<i>vs</i> - CH	CH symmetric bending vibration
1095.60	1260-1000	<i>v</i> - C - O	Stretching vibration of alcohol and phenol groups
889.21	~ 890	<i>v</i> - CH	Stretching vibration of alkene groups (1-1-distributed)

Table (5) Physico-Chemical Properties of Extracted Ginger Oil

Sr. No	Properties	Experimental value	Literature value *
1.	Refractive index	1.489	1.489-1.494
2.	Colour	1.8R,20.0Y, Neutral 0.1	-
3.	Peroxide value (milliequi peroxide oxygen per kg)	1.8	0.3-2.3
4.	Acid value (mg KOH per g)	2.791	0.5-4.1

*<http://www.indiaessentialoils.com/ginger-oil.html>

Table (6) Effect of the Amount of Beeswax on the Characteristics of Balm

Paraffin Wax - (4)g Camphor - (7)g

Methyl Salicylate - (7)g Methanol - (4)g

Sr. No	Beeswax (g)			E.O (B ₁) (g)	P.O (B ₁) (g)	Viscosity (cP)	E.O (B ₂) (g)	G.O (B ₂) (g)	Viscosity (cP)	G.O (B ₃) (g)	Viscosity (cP)	Organoleptic Properties
	B ₁	B ₂	B ₃									
1	1			2	2	350	2	2	360	2	380	very soft, very oily, slightly viscous
2	2			2	2	660	2	2	600	2	660	soft, oily, slightly viscous
3	3			2	2	950	2	2	960	2	980	moderate soft, moderate oily, moderate viscous
4	4*			2	2	1200	2	2	1300	2	1500	slightly soft, slightly oily, slightly viscous
5	5			2	2	1550	2	2	1560	2	1580	hard, not oily, more viscous

E.O - Eucalyptus oil

P.O - Peppermint oil

G.O - Ginger oil

*Most suitable amount

Table (7) Effect of the Amount of Camphor on the Characteristics of Balms

Paraffin Wax - (4)g Beeswax - (4)g
 Methyl Salicylate - (7)g Methanol - (4)g

Sr. No	Camphor (g)			E.O (B ₁)(g)	P.O (B ₁)(g)	pH	E.O (B ₂)(g)	G.O (B ₂)(g)	pH	G.O (B ₃)(g)	pH	Organoleptic Properties
	B ₁	B ₂	B ₃									
1	4			2	2	7.1	2	2	7.1	2	7.1	slightly skin absorption, slightly cooling sensation
2	5			2	2	7.1	2	2	7.1	2	7.1	slightly skin absorption, slightly cooling sensation
3	6			2	2	7.1	2	2	7.1	2	7.1	moderate skin absorption, moderate cooling sensation
4	7*			2	2	6.8	2	2	6.9	2	6.9	skin absorption, cooling sensation
5	8			2	2	6.9	2	2	6.9	2	6.9	skin absorption, cooling sensation

E.O - Eucalyptus oil

G.O - Ginger oil

P.O - Peppermint oil

*Most suitable amount

Table (8) Effect of the Amount of Oils on the Characteristics of Balms

		Paraffin Wax	- (4)g		Beeswax	-(4)g			
		Methyl Salicylate	- (7)g		Methanol	-(4)g			
		Camphor	-(7)g						
Sr. No	E.O (B ₁)(g)	P.O (B ₁)(g)	pH	E.O (B ₂)(g)	G.O (B ₂)(g)	pH	G.O (B ₃)(g)	pH	Organoleptic Properties
1	2	0.5	7.1	2	0.5	7.1	0.5	7.1	not pungent
2	2	1	7.1	2	1	7.1	1	7.1	slightly pungent
3	2	1.5	7.1	2	1.5	7.1	1.5	7.1	moderate pungent
4	2	2*	6.8	2	2*	6.9	2*	6.9	Pungent
5	2	2.5	6.9	2	2.5	6.9	2.5	6.9	more pungent

E.O - Eucalyptus oil G.O - Ginger oil P.O - Peppermint oil

*Most suitable amount

Table (9) Physico-chemical Properties of Prepared Balms

Sr. No.	Sample	Characteristics		Organoleptic Properties	Literature Value**	
		Viscosity(cP)	pH		Viscosity(cP)	pH
1	B ₁	1200	6.8	no burning, slightly pain relief, slightly reduce inflammation	-	-
2	B ₂ *	1300	6.9	no burning, pain relief, reduce inflammation	-	5.5-7.5
3	B ₃	1600	6.9	very hot and very pungent	-	-

*Most suitable amount

**<http://www.Pain Balm English>.

Table (10) Dermatological Test of Balm (B₂)

Size of patch = 1 square inch

Testing Time = 6 hr

Paraffin Wax - 4g

Beeswax - 4g

Menthol - 7g

Camphor - 7g

Methyl Salicylate - 4g

Eucalyptus Oil - 2g

Ginger Oil - 2g

Sr. No	Male / Females	Age(years)	Organoleptic Properties
1	Male	54	no burning, pain relief, reduce inflammation
2	Female	55	no burning, pain relief, reduce inflammation
3	Female	45	no burning, pain relief, reduce inflammation
4	Female	40	no burning, pain relief, reduce inflammation
5	Female	35	no burning, pain relief, reduce inflammation
6	Female	28	no burning, pain relief, reduce inflammation
7	Female	23	no burning, pain relief, reduce inflammation

Dermatological tests were performed with seven volunteers (staffs and students) of Industrial Chemistry Department, University of Yangon.

Conclusion

Essentials oils are used as flavorings in foods and beverages and as fragrances in pharmaceutical and industrial products. In this research, dried ginger powder was used to extract ginger oil by water and steam and water distillation methods. Water and steam distillation method can give the highest yield of ginger oil. The most suitable extraction time was (2) hrs. The extracted ginger oil was used for the preparation of balm. Effects of pain relieving of shoulder stiffness and no burning to skin are more prominent than the balm made without using ginger oil.

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