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Storage Behaviour onto Mint Oil: Physicochemical Properties

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In this study, the effect of storage conditions for the quality of mint oils was investigated. The changes in mint oil compositions were studied quarterly (each three months) during storage in different bottles for 12 months in the laboratory at room temperature (27 ± 3 °C) through stored upon the table, dark place (inside the shelf) and at low temperature (< 1 °C in a refrigerator). Optical rotation, refractive index and specific gravity have been investigated. The chemical properties of major constituents of *Mentha arvensis* oil were analyzed. The results demonstrate, for the storage of mint oils in the coloured glass bottles at cooling temperature.

Keywords: *Mentha arvensis*, Storage conditions, Optical rotation, Menthol, Menthone.

INTRODUCTION

India is world's largest producer and exporter of mint oil (*Mentha arvensis*)[1]. Oil of mint (*Mentha arvensis*) is the third most important flavoring material consumed world over. Mint oil, its major constituents and derivatives are used in food, pharmaceuticals, perfumes and flavour industry. Its major constituents[2,3] *i.e*. menthol, menthone, iso-menthone, menthyl acetate have various application in the fragrance and flavour industry as a source of raw material of various products. Mint oil and its derivatives are used as perfumes, food flavours, deodorants and pharmaceuticals[4]. During the middle ages, powdered mint leaves were used to whiten teeth[5]. Even today, about 80 % of the world's population relies predominantly on plants and plant extracts for health care[6]. The oil is a natural source of menthol, which is the main ingredient of cough drops and ointments like Vicks Vaporub, *etc*.[7]. Particularly, in recent years, essential oils and their components are gaining increasing interest due to being relatively safe for the environment as well as to the human health, their wide acceptance by consumers and their exploitation for potential multi-purpose functional use[8,9].

The common practice to store mint oil among the mint growers is to keep the oil in plastic canes of 10-50 kg capacity. Some growers were found to store the oil in small plastic canes which have already been used for storing petroleum or other products. The growers do not have apparatus like separating funnel to separate oil from water, oil produced contains sufficient moisture. As a result, quality of oil deteriorates considerably during storage[10]. None of the growers and distillers was found to use anti-oxidant material like sodium sulphate, required to maintain the quality of oil during storage[11]. The majority of the people and industries in developing countries use traditional methods for the storage of essential oils *e.g*. plastic drums and canes *etc*. These age old methods of storage affect the quality, stability and efficacy of the essential oils and aroma chemicals[12,13]. A study was conducted on the changes occurs on the quality parameters of the commercially exploited major essential oils (*Mentha arvensis*) due to prolonged storage under the different conditions[14,15].

The objective of this work is to determine the changes in the quality of standard mint oil (*Mentha arvensis*) due to their storage behaviour. The investigations were carried out by stored in different containers (glass bottles, plastic bottles and dark coloured glass bottles) with different conditions *i.e*. storage upon the table, dark place (inside the shelf) and at low temperature (< 1 °C in a refrigerator). Optical rotation, refractive index and specific gravity have been investigated. The chemical properties of major constituents of *Mentha arvensis* oil were analyzed.

EXPERIMENTAL

Mentha oil samples were obtained by hydro-distillation from Fragrance and Flavour Development Centre Kanpur (India) and analyzed by gas chromatography (GC) and gas chromatography/mass spectrometry (GC/MS) for the study of storage behaviour. The oil samples were stored in three different conditions *e.g*. (i) storage in dark place (inside the

shelf) at room temperature (27 ± 3 °C), (ii) storage upon the table at room temperature (27 ± 3 °C), (iii) storage in a refrigerator at cooling temperature (< 1 °C) and in different containers *e.g*. (i) dark coloured bottles, (ii) glass bottles, (iii) plastic bottles. The collected sample was further divided into nine equal parts for the study of storage as follows:

(A) Storage in dark place (inside the shelf) at room temperature (27 ± 3 °C). (i) Stored in dark coloured bottles, (ii) Stored in glass bottles, (iii) Stored in plastic bottles

(B) Storage upon the table at room temperature (27 ± 3 °C). (i) Stored in dark coloured bottles, (ii) Stored in glass bottles, (iii) Stored in plastic bottles.

(C) Storage in a refrigerator at cooling temperature (< 1 °C). (i) Stored in dark coloured bottles, (ii) Stored in glass bottles, (iii) Stored in plastic bottles.

The study of physico-chemical properties of mint oils have been carried out quarterly. The optical rotation was obtained by using Perkin Elemer digital polarimeter model 243-B, refractive index with Abbe type Refractrometer and chemical analysis was carried out by a gas chromatograph (model 5890 Hawlett Packered) equipped with flame ionization detector (FID) and HP carbowax-20 M (25 m × 0.32 m, film thickness 0.25 μm).

Physical analysis *viz*., optical rotation, refractive index, specific gravity and solubility in 70 % alcohol at 27 ± 3 °C have been observed quarterly. All experiments were performed in triplicate and mean values were considered in data analysis.

Chemical composition of mint oils: Injector and detector temperatures were set at 210 and 220 °C, respectively. Column oven temperature was programmed from 50 to 200 °C at a rate of 4 °C min^{-1}; initial and final temperatures was held for 1 and 10 min, respectively. Nitrogen was used as a carrier gas with a flow rate of 1.5 mL min^{-1}. A sample of 0.2 μL was injected using the split mode (split ratio 60:1). All quantification was done using a built-in data-handling program provided by the manufacturer of the gas chromatograph. All experiments were performed in triplicate and mean values were considered in data analysis.

In view of results calibration, before storage the mint oil samples were analysed for initial values of physicochemical properties are given in Table-1.

RESULTS AND DISCUSSION

Optical rotation: Storage in dark place (inside the shelf) at room temperature: It has been investigated during the stored in dark place (inside the shelf) at room temperature (27 ± 3 °C) the optical rotation increases in first three quarter and decreases in fourth quarter. Although, the obtained result showed very slight variation in the optical rotation values all the three oil sample bottles. Initial value (before storage *e.g*. fresh oil) of the optical rotation was -33.03 and final values are -33.000, -33.217 and -33.000 in plastic, glass and dark coloured glass bottle, respectively. These results are shown in Table-2.

Storage upon the table at room temperature effect on optical rotation: In this condition, the coloured glass bottles have very slight variation in the optical rotation value *i.e*. -33.03 to -33.135 while in plastic bottle and glass bottle the optical rotation value increases in first two quarter of the year and then it decreases in next two quarter of the year. The optical rotation values for the oil of plastic bottle and glass bottle are -33.03 to -33.700 and -33.03 to -32.801 respectively. The results are presented in the Table-2.

Storage in a refrigerator at cooling temperature effect on optical rotation: Table-1 is representing optical rotation values for the oil stored in the refrigerator at cooling temperature. Optical rotation value increases in first three quarter of the year of storage and then value decreases in last quarter of the year. The mint oil in plastic bottle have more variation (-33.03 to -33.590) than glass bottle (-33.03 to -33.381) and coloured glass bottle (-33.03 to -33.358).

Refractive index: Storage in dark place (inside the shelf) at room temperature: The refractive index values were slightly increases. Initial value (before storage *e.g*. fresh oil) was noted 1.4543; and after one year the values were 1.4555, 1.4555 and 1.4554 in plastic, glass and dark coloured glass bottle respectively. More variation was seemed in the oil of plastic bottle. The observed values were given in Table-3.

Storage upon the table at room temperature effect on refractive index: There was high variation observed in the oil of plastic bottle. Initial value was recorded 1.4543. Yet, later on three months kept upon the table at room temperature condition

TABLE-1

Parameters	Optical rotation	Refractive index	Specific gravity	Solubility in 70 % alcohol	
Physical properties	- 33.03	1.4543	0.8920	2.0 vol.	
Chemical properties	Limonene 2.0 %	Menthone 8.0 %	Iso-menthone 3.5 %	Menthyl acetate 2.26 %	l-menthol 76.04 %

TABLE-2
EFFECTS ON OPTICAL ROTATION DURING STORAGE CONDITION

Storage condition	Bottles	February 2012	May 2012	September 2012	January 2013
Storage in dark place (Inside the shelf) at room temperature (27 ± 3 °C)	Plastic	-33.130	-33.710	-33.690	-33.000
	Glass	-33.133	-33.515	-33.414	-33.217
	Coloured Glass	-33.133	-33.313	-33.242	-33.000
Storage upon the table at room temperature (27 ± 3 °C)	Plastic	-33.130	-32.875	-33.000	-33.700
	Glass	-33.133	-33.495	-33.221	-32.801
	Coloured Glass	-33.133	-33.150	-33.193	-33.135
Storage in a refrigerator at cooling temperature (< 1 °C)	Plastic	-33.133	-33.311	-33.408	-33.590
	Glass	-33.133	-33.857	-33.665	-33.381
	Coloured Glass	-33.133	-33.525	-33.698	-33.358

TABLE-3
EFFECTS ON REFRCTIVE INDEX DURING STORAGE CONDITION

Storage condition	Bottle	February 2012	May 2012	September 2012	January 2013
Storage in dark place (Inside the shelf) at room temperature (27 ± 3 °C)	Plastic	1.4544	1.4547	1.4551	1.4555
	Glass	1.4543	1.4547	1.4551	1.4555
	Coloured Glass	1.4543	1.4546	1.4550	1.4554
Storage upon the table at room temperature (27 ± 3 °C)	Plastic	1.4544	1.4548	1.4552	1.4559
	Glass	1.4543	1.4547	1.4551	1.4556
	Coloured Glass	1.4543	1.4547	1.4551	1.4556
Storage in a refrigerator at cooling temperature (< 1 °C)	Plastic	1.4544	1.4548	1.4552	1.4556
	Glass	1.4543	1.4547	1.4551	1.4550
	Coloured Glass	1.4543	1.4547	1.4551	1.4550

the coloured glass bottle has the variation from 1.4543 to 1.4559 and in plastic bottle 1.4543 to 1.4556. One thing more, in this case similar values were obtained in coloured glass and glass bottles. These variations are shown in the Table-3.

Storage in a refrigerator at cooling temperature effect on refractive index: At cooling temperature condition the refractive index values (initial and final) are seems almost similar (Table-3). The changes in refractive index values of oil kept in the coloured glass bottles were from 1.4543 to 1.4550 and in plastic bottle 1.4543 to 1.4556.

Specific gravity: There are not significant variations in the specific gravity of the mint oil during the storage. While in dark place (inside the shelf) at room temperature (27 ± 3 °C) condition showed more variation. The values of specific gravity of mint oil in plastic bottle have the variation from 0.8920 to 0.8988, in the coloured glass bottle 0.8920 to 0.8978 and in glass bottle 0.8920 to 0.8980. The specific gravity values for the oil stored in refrigerator at cooling temperature (< 1 °C) condition was recorded 0.8920 to 0.8978, 0.8920 to -0.8977 and 0.8920 to 0.8978 in plastic bottle mint oil, glass bottle and coloured glass bottles, respectively. The results were shown in the Table-4.

Chemical properties: Effects onto the chemical properties were studied through the major constituents of the *Mentha arvensis* oil stored in the different conditions *viz.*, l-menthol, menthone, iso-menthone, neo-menthol and menthyl acetate.

In this study the l-menthol (free alcohol) contents were increases except the oil kept in a refrigerator at cooling temperature (< 1°C). Initially (before storage *e.g.* fresh oil) the l-menthol content was 76.04 % in the mint oil. It increased up to 82.7 and 82.74 % in the oil of plastic bottle at room temperature upon the table and in the dark place, respectively. While oil in coloured glass bottle, increased to 77.25 % in dark place and 77.0 % upon the table at room temperature and 76.5 % was stored in refrigerator (Figs. 1-3).

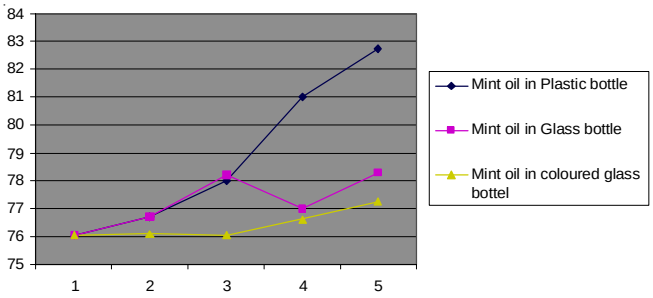

Fig. 1. Effect on 1-menthol in mint oil: storage in dark place (inside the shelf) at room temperature (27 ± 3 °C)

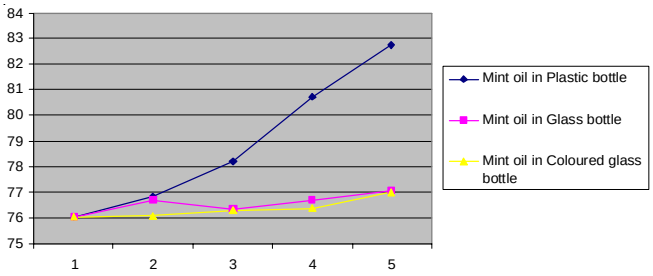

Fig. 2. Effect on 1-menthol in mint oil: storage upon the table at room temperature (27 ± 3 °C)

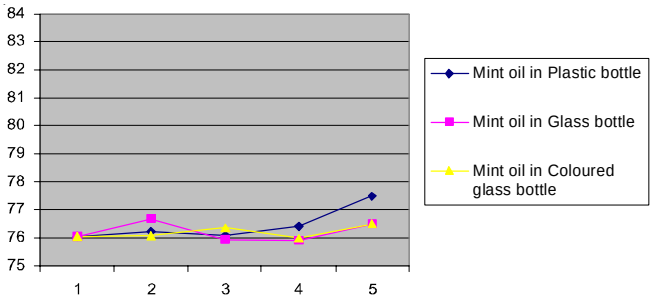

Fig. 3. Effect on 1-menthol in mint oil: storage in a refrigerator at cooling temperature (< 1 °C); 1 = October, 2011; 2 = February, 2012; 3 = May, 2012; 4 = September, 2012; 5 = January, 2013

TABLE-4
EFFECTS ON SPECIFIC GRAVITY DURING STORAGE CONDITION

Storage condition	Bottle	February 2012	May 2012	September 2012	January 2013
Storage in dark place (Inside the shelf) at room temperature (27 ± 3 °C)	Plastic	0.8940	0.8971	0.8983	0.8986
	Glass	0.8950	0.8982	0.8987	0.8983
	Colored Glass	0.8960	0.8975	0.8977	0.8979
Storage upon the table at room temperature (27 ± 3 °C)	Plastic	0.8945	0.8972	0.8975	0.8988
	Glass	0.8960	0.8970	0.8972	0.8980
	Colored Glass	0.8965	0.8968	0.8970	0.8978
Storage in a refrigerator at cooling temperature (< 1 °C)	Plastic	0.8940	0.8960	0.8967	0.8980
	Glass	0.8930	0.8950	0.8957	0.8977
	Colored Glass	0.8930	0.8940	0.8942	0.8978

Menthone content was remains no change with storage in a refrigerator at cooling temperature (< 1 °C). While it decreases in the oil of plastic bottles upon the table and in the dark place at room temperature (27 ± 3 °C). The created changes are plotted in the Figs. 4-6.

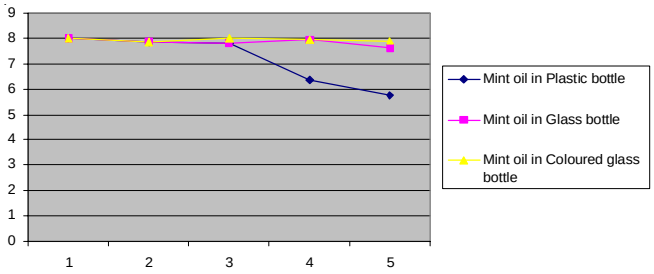

Fig. 4. Effect on menthone in mint oil: storage in dark place (inside the shelf) at room temperature (27 ± 3 °C)

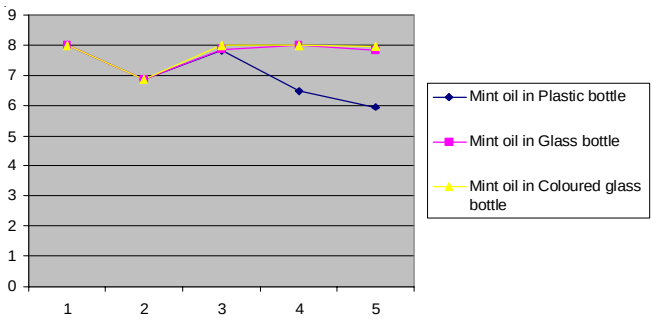

Fig. 5. Effect on menthone in mint oil: storage upon the table at room temperature (27 ± 3 °C)

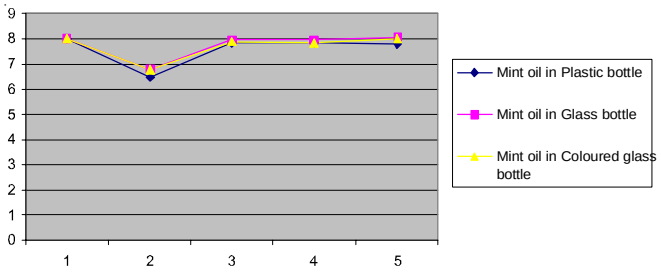

Fig. 6. Effect on menthone in mint oil: storage in a refrigerator at cooling temperature (< 1 °C); 1 = October, 2011; 2 = February, 2012; 3 = May, 2012; 4 = September, 2012; 5 = January, 2013

Iso-menthone constituent shows a slight variation in the bottles kept in refrigerator at cooling temperature (< 1 °C). It was decreased (Figs. 7-9) in plastic bottles under dark place and also for kept upon table at room temperature (27 ± 3 °C).

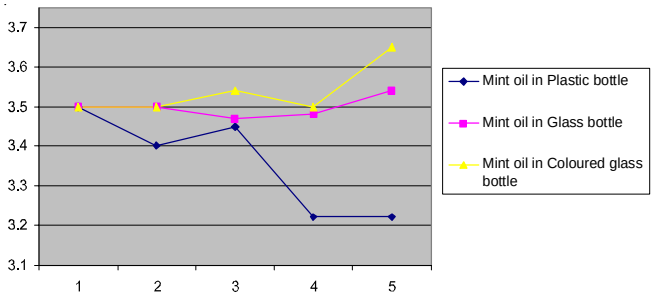

Fig. 7. Effect on Iso-menthone in mint oil: storage in dark place (inside the shelf) at room temperature (27 ± 3 °C)

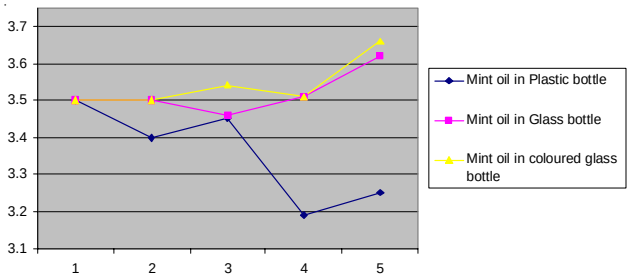

Fig. 8. Effect on Iso-menthone in mint oil: storage upon the table at room temperature (27 ± 3 °C)

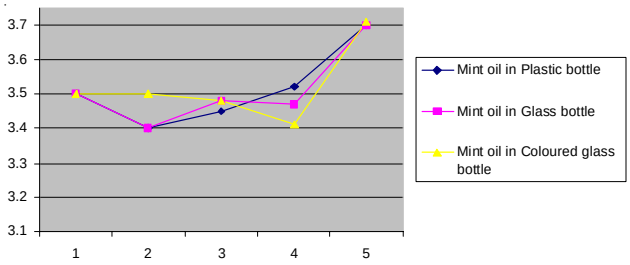

Fig. 9. Effect on Iso-menthone in mint oil: storage in a refrigerator at cooling temperature (< 1 °C); 1 = October, 2011; 2 = February, 2012; 3 = May, 2012; 4 = September, 2012; 5 = January, 2013

It is observed that the menthyl acetate in the mint oil decreases while prolong storage under different conditions, as presented in the Figs. 10-12.

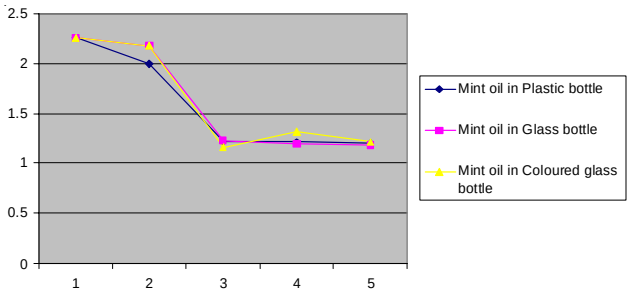

Fig. 10. Effect on menthyl acetate in mint oil: storage in dark place (inside the shelf) at room temperature (27 ± 3 °C)

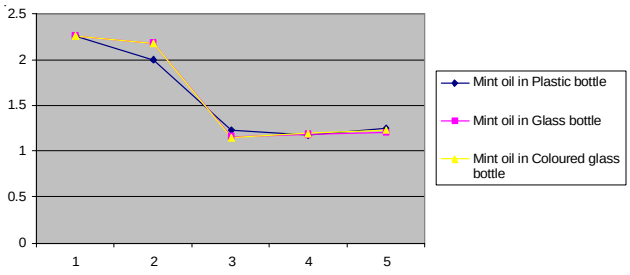

Fig. 11. Effect on menthyl acetate in mint oil: storage upon the table at room temperature (27 ± 3 °C)

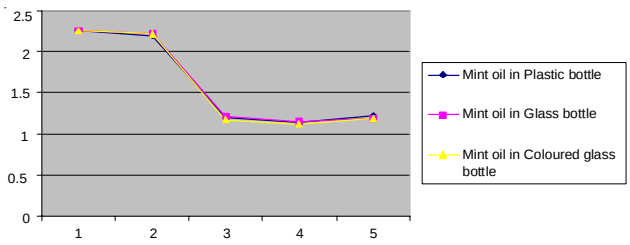

Fig. 12. Effect on menthyl acetate in mint oil: storage in a refrigerator at cooling temperature (< 1 °C); 1 = October, 2011; 2 = February, 2012; 3 = May, 2012; 4 = September, 2012; 5 = January, 2013

Conclusion

The results of the present work showed, the free alcohol content increases and ester content decreases during the storage of mint oil (*Mentha arvensis*). The study revealed that the oil kept for the long time, free alcohol content increases and ester content decreases. The results of this study demonstrating for the essential oils to storage in coloured glass bottle in cooling temperature, to avoiding the unwanted significant changes in the physicochemical properties.

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