Original Article

Effect of Drying Method on Spearmint (*Mentha spicata* var. Viridis L.) Oil Content and Physicochemical Properties

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ABSTRACT

The experiment was investigated the effect of drying method of spearmint oil content and physicochemical properties. Spearmint samples were dried under different conditions till the weight of herb in each reached 20%. The treatments were: (i) shade drying under ambient conditions, (ii) sun drying (iii) forced-air oven drying at 60^{o}C, (iv) forced-air drying at 70^{o}C and (v) forced-air oven drying at 80^{o}C. Oil was extracted by water distillation according to the technique of the British Pharmacopoeia. Physicochemical properties were determined according to British Standards Institute. Spearmint oil content was significantly higher in shade drying than in sun drying and in forced-air oven drying. Oil content decreased with an increase in oven temperature. Refractive index and acid value were significantly higher in shade drying, compared with sun drying and decreased with an increase in oven temperature in forced air drying. Ester value of spearmint oil followed a trend, but opposite to that of acid value.

Keywords: Spearmint, Sun drying, Oven drying, Shade drying.

INTRODUCTION

Mint group (*Menta spp*) is considered as one of the most important and valuable essential oil source [1]. Spearmint is cultivated in different parts of the world, for example in North American, England, Germany, Holand and in the Mediterranean region[1]. Minor cultivation areas of spearmint exist in China and India, where high quality oils are produced[2]. The mint plants and their products are widely used as spice, flavoring agent and in folk medicine[3,4]. The oil is used in pharmaceutical, anti-septic, perfumery and food industries[3,5].

The major commercial form of spearmint is still the self-stable dried product, since it can be transported easily and stored well under proper conditions[6]. During the drying process, the condition or quality of spearmint oil can be adversely affected. It can result in loss of essential oils, changes in color and texture and decrease in nutritive value[7,8]. The drying method and duration have highly significant effects on oil content and composition. Essential oils are retained to a greater extent when plants are dried under ambient conditions, compared to sun drying or forced air[9]. Essential oil composition and quality are greatly influenced by oven drying temperature. About 75.7% of essential oils are lost during oven drying at 60°C than at 30°C[10]. As the temperature increases, the monoterpenes content gradually decreases and sesquiterpenes content increases[11].

The aim of this study was to evaluate the effect of drying method of spearmint herb on oil content, composition and physicochemical properties of the oil.

MATERIALS AND METHODS

Experimental site

A field experiment was conducted at 'Halfaya' area, Khartoum North (15^0 $40^/$N, 32^0 $22^/$E).

Experimental Material

Spearmint (*Mentha spicata* var. Viridis) plants were raised from underground runners (rhizome-like rootstock), obtained from fully mature plants grown in a spearmint growing area at 'Halfaya', Khartoum North. The underground and surface runners were transplanted into new well prepared flat beds at 30 x 30 cm Spacing. Pre-transplanting irrigation was applied, followed by the first irrigation immediately after transplanting. Irrigation was carried out every[7].

Samples of herb, about two kilograms each, were harvested from well established 70 days plants. The aerial parts of the plant, (main aerial stem, branches and leaves) were cut about 5 cm above the ground. Foreign materials and weeds were removed immediately from the harvested spearmint material.

Experimental design

The experiment was laid out in a completely randomized design, with four replications. The treatments were: (i) Shade drying, (ii) Sun drying, (iii) Forced-air oven drying at 60^0C, (iv) Forced-air oven drying at 70^0C and (v) Forced-air oven drying at 80^0C.

Drying

The different spearmint samples were dried under the following conditions till the weight of herb in each reached 20% of total weight: (a) Shade drying: samples were dried under shade at ambient temperature (37^0C) by spreading the spearmint herbs on polyethylene sheets. (b) Sun drying: samples were dried under direct sunshine for six days (144 hours) on polyethylene sheets. The herbs were turned twice a day to expose the inner layers to direct sun for regular drying. (c) Air-forced drying: samples were immediately dried in a forced-air oven (Memmert 854 Schwabach – Karl Kollo Scientific Technical supplies, West Germany) under controlled temperature either at 60^0C (for 14 hours), 70^0C (for 12 hours) or 80^0C (for 10 hours). After drying the herb samples were allowed to cool and placed in the black polyethylene bag for further investigations.

Oil extraction and determination

The spearmint oil was extracted by water distillation and determined according to the technique of British Pharmacopoeia[12]. After distillation to be completed, the whole system was left for about half an hour, so that a good separation can be obtained. The volume of the oil was recorded and expressed in ml per 100 g.

Physicochemical properties

The oil was prepared for examination according to British Standards 2073: 1976 (BSI, 1976)[13]. Refractive index was determined by Abbe refractometer (No. 918095-Bellingham and Stanley Ltd., London, England) according to British standards Institute[13] and expected to four decimal places. Acid value and ester values were determined according to British Standards[13]. The acid value was expressed in mg of KOH per g spearmint oil and ester value was expressed in mg of KOH required to neutralize the acid per g spearmint oil.

Statistical analysis

Analysis of variance and Duncan multiple range test with a significance level of $P \leq 0.05$ was performed on the data[14].

RESULTS AND DISCUSSION

Effect on spearmint oil content

Oil content was highest in both shades dried herbs (at ambient temperature) and oven-dried herbs at 60°C (1.1 ml/100g), followed by sun-dried samples (1.0 ml/100g), then in oven-dried samples at 70oC (0.8 ml) and least in oven-dried samples at 80oC (0.6 ml/100g) (Fig. 1).

Charles *et al*.[9] reported that the drying method and duration have highly significant effects on oil content and composition. Artemisinin content in *Artemisia annua* L. (Asteraceae) was retained to a greater extent when plants were dried under ambient temperature, compared to sun-drying or forced-air at 30[0] to 80°C[9]. Diaz-Maroto *et al*.[15] evaluated the effect of drying method on volatile compounds content, structural integrity and sensory characteristics of parsley. Conventional oven-drying resulted in losses of volatile compounds that fluctuated with the drying temperature and drying time employed. Oven-drying at 45°C and air-drying at ambient temperature where the method produced the best results is that about 76% of essential oil was lost during oven-drying of Lavandin (*Lavandula intermedia*) at 60°C, compared with drying at 30°C[10]. Deans and Svoboda[16] mentioned that loss of essential oil is unavoidable during drying processes, but selection of the best drying parameters helps to minimize any loss of the oil during drying.

Effect on physicochemical properties of spearmint oil

In the natural herb drying, refractive index of spearmint oil was higher in oil distilled from herbs dried under shade at ambient temperature (1.486) than that from sun-dried herbs (1.484) (Fig. 2). In the forced-air oven drying, refractive index was highest in oil extracted from herbs, dried at 60°C (1.488), followed by the herb, dried at 70°C (1.487) and least in the herbs dried at 80°C (1.481) (Fig. 2).

Acid value was higher in spearmint oil from herbs, dried under shade at ambient temperature (1.403), compared to that from herbs dried under direct sunshine (1.122) (Fig. 3).

In a forced - air oven drying, acid value was higher in oil from forced-air dried herb at 60°C (3.366), followed by that dried at 70°C (3.039), and least in that dried at 80°C (1.683) (Fig. 3). Ester values of spearmint oil followed a trend just reverse to that of acid values. In natural herb drying, ester value was higher in oil from the sun-dried samples (111.21) than from those dried under shade (84.15) (Fig. 4). In a forced - air oven drying, ester value was low in oil from herbs, dried at 60°C (50.49), followed by those dried at 70°C (36.00) and highest in herbs dried at 80°C (28.05) (Fig. 4). During the drying process, the condition, properties and quality of spearmint oil can be adversely affected[7,8]. Essential oil composition and quality are significantly influenced by oven drying temperature[10]. Hot air drying, in some case, can cause changes in oil properties and degradation in terms of color reaction and decomposition of active ingredients[17]. Due to the drying conditions, the rate of loss of different oil components may be different. Lighter oil components may be evaporate at higher rates than the heavier components[18]. Some constituents may be lost or oxidized to other constituents[9]. This can affect the physicochemical properties of the oil. Moreover, essential oil constituents have their own specific functional groups that determine the degree of light incidence and refraction in the oil and consequently the refractive index be changed. Since spearmint oil is composed of different components with different functional groups (aldehydes, ketones, alcohols, esters)[19], which undergo different chemical, changes due to environmental and herbal condition during drying, the acidity of the oil may change and consequently acid values and ester values may vary.

CONCLUSION

We can conclude that spearmint oil content was higher in shade drying than in sun drying and for forced-air oven drying, and oil content decreased with an increase in oven temperature. Refractive index and acid value were higher in shade drying, compared with sun drying and decreased with an increase in oven temperature in forced-air drying. In contrast ester value increase with an increase in temperature even from shade to direct sunshine or increasing of the oven temperature. It is recommended that the temperature of the forced - air oven to be studied from 30^0C to 50^0C under Sudan conditions; also 5^0C must be focused, to have more detailed information's about the effect of drying temperature of spearmint oil.

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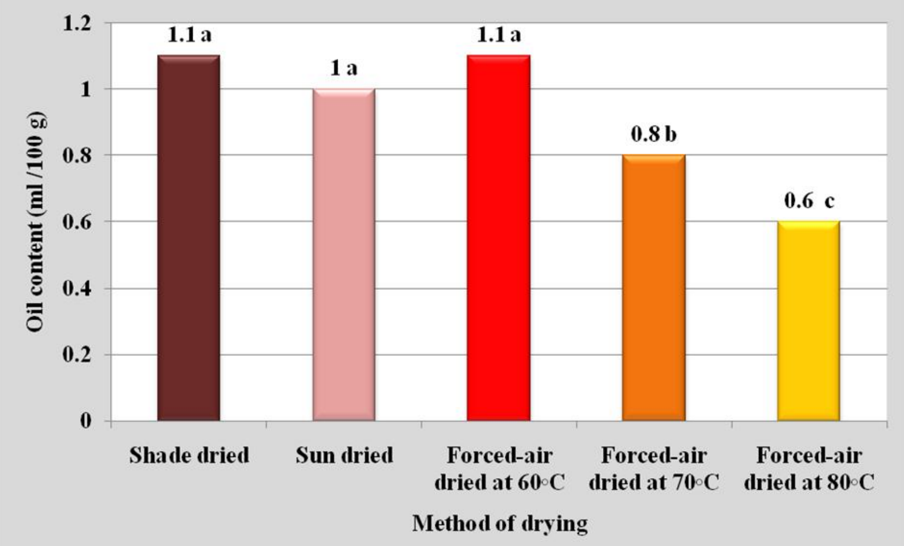
Fig. 1. Oil content of spearmint distilled from shade dried herb, sun dried herb, forced-air dried herb at 60◦C, forced-air dried herb at 70◦C and forced-air dried herb at 80◦C.



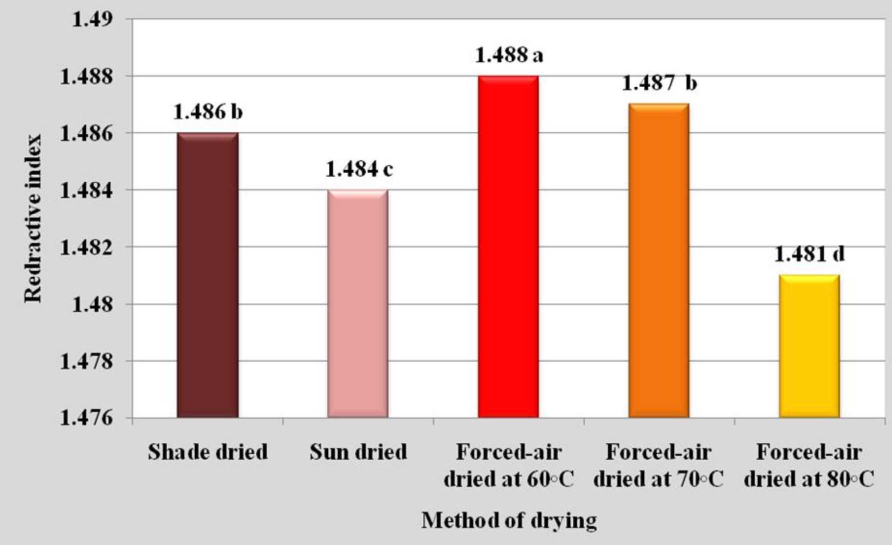


Fig. 2. Refractive index of spearmint distilled from shade dried herb, sun dried herb, forced-air dried herb at 60◦C, forced-air dried herb at 70◦C and forced-air dried herb at 80◦C.

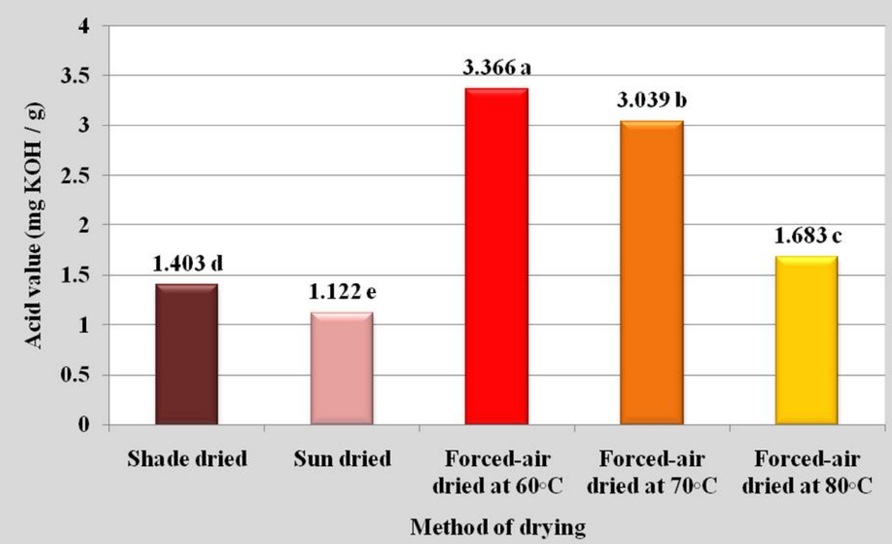


Fig. 3. Acid value of spearmint distilled from shade dried herb, sun dried herb, forced-air dried herb at 60◦C, forced-air dried herb at 70◦C and forced-air dried herb at 80◦C.

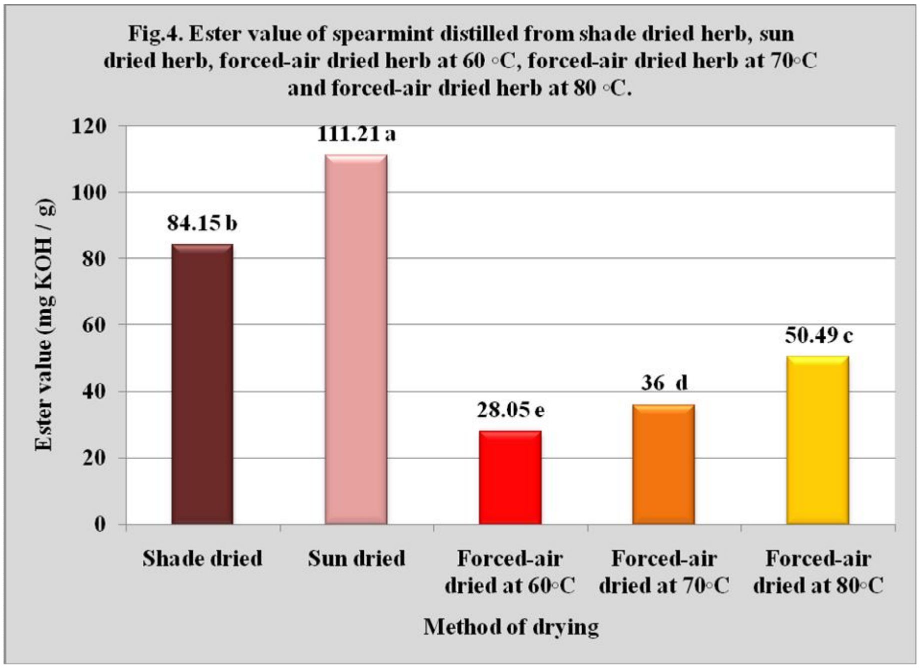


Fig.4. Ester value of spearmint distilled from shade dried herb, sun dried herb, forced-air dried herb at 60 ◦C, forced-air dried herb at 70◦C and forced-air dried herb at 80 ◦C.
Ester value (mg KOH / g)
120
100
80
60
40
20
0
84.15 b
111.21 a
28.05 e
36 d
50.49 c
Shade dried
Sun dried
Forced-air dried at 60◦C
Forced-air dried at 70◦C
Forced-air dried at 80◦C
Method of drying