Journal of Applied Research on Medicinal and Aromatic Plants xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Journal of Applied Research on Medicinal and Aromatic Plants

journal homepage: www.elsevier.com/locate/jarmap

Effect of drying methods on qualitative and quantitative properties of essential oil from the aerial parts of coriander

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ARTICLE INFO

Article history:
Received 29 May 2015
Received in revised form 2 July 2016
Accepted 20 July 2016
Available online xxx

Keywords:
Coriandrum sativum L.
Freeze–drying
Aliphatic aldehydes
Essential oil

ABSTRACT

Coriander (*Coriandrum sativum* L.) is mainly cultivated for its fruits and/or leaves, which are used for different purposes such as food, drugs, and spice as both a fresh and dried herb. To determine the effect of drying methods on essential oil of coriander, the stem and leaves of an Iranian landrace of coriander were dried in sunlight, shade, mechanical ovens (40 and 60 °C), microwave oven (500 and 700 W), and by freeze–drying. The essential oils were analyzed using GC-FID and GC/MS. The highest essential oil yield was obtained from freeze–dried tissue followed by the shade–dried sample. In total, 39 components were determined in the essential oils from fresh and dried coriander. The main components were decanal (0–37.5%), *cis*-phytol (1.0–34.1%), 1-tetradecanol (trace – 31.7%), 2*E*-dodecenal (8.3–17.2%), dodecanal (0.5–14.8%), *n*-decanol (0.5–14.8%), *trans*-2-undecen-1-ol (trace – 12.9%), 2*E*-decenal (0–11.3%), 1-eicosanol (0–6.4%), and methyl chavicol (0–6.0%). The percentages of decanal and *n*-decanol in the oil, however, decreased significantly when the plant material was dried in the oven at 60 °C or microwaved. The percentages of 1-tetradecanol, 1-eicosanol, and *cis*-phytol increased significantly when the plant tissue was dried in the oven at 60 °C or microwaved. Generally, the drying of coriander in freeze–drying is most suitable and can be recommended for high–oil yield.

1. Introduction

Coriander (*Coriandrum sativum* L.) belongs to the family Apiaceae (sym. Umbelliferae), is an annual, herbaceous with white flowers and 30–60 cm tall. Coriander is indigenous to the Mediterranean basin areas and the Near East (Purseglove et al., 1981). Coriander is a culinary and medicinal plant that is cultivated throughout the world for its nutritional value (Mani et al., 2011). This plant is widely distributed and mainly cultivated for its fruits and/or leaves, which are used for different purposes such as food, drugs, cosmetics and perfumery. As a medicinal plant, especially fruit parsley has been credited with a long list of medicinal uses (Msaada et al., 2007). Fresh leaves of coriander are routinely added for their delicious taste and flavor which they impart to various dishes in Asian countries (Purseglove et al., 1981). The leaves contain volatile oil, proteins, flavonoid glycosides (quercetin, isoquercitrin, and rutin), caffenic acid, minerals (calcium, phosphorus, and iron), carotene, fiber, and carbohydrates (Purseglove et al., 1981). Both the fresh and dried leaves are widely used to enhance the flavor of foods or to mask unpleasant odors of certain foods in the cuisines of China, Mexico, Brazil, South America, India, and Southeast Asia (Potter, 1996; Gil et al., 2002). The fresh and dried aerial parts (stem and leaves) of coriander, known as “Geshniz” in Persian, are widely used to enhance the flavor of foods, such as vegetables, soups or Iranian cuisine (especially, lentil soup and legumes soup), meatball, and polo or Persian rice (Ghasemi Pirbalouti, 2010).

Traditionally in Iran, the stem and leaves of coriander have been used as a medicinal plant in the treatment of smallpox, reflex stomach and abdominal pains, infections, and gums problem (Mir Heidar, 1992 Zargari, 1992). The leaves of coriander stimulate appetite and the fresh juice is often recommended for patients suffering from vitamin A, B, and C deficiencies and for the relief of anxiety and insomnia (Bhattachacharjee, 2001; Emamghoreishi et al., 2005). Results a study by Chung et al. (2012) indicated the essential oils from the leaves and stem of coriander had significant toxic effects against the larvae of *Aedes aegypti*. Mani et al. (2011) suggested the fresh leaves of coriander (5, 10, and 15% w/w in nor-

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http://dx.doi.org/10.1016/j.jarmap.2016.07.006
2214-7861/

mal animal diet) may be a useful remedy in the management of Alzheimer's disease on account of its multifarious effects such as, memory-improving property, cholesterol-lowering property and anticholinesterase activity. As a source of aroma the compounds, the aerial parts (stem and leaves) of coriander possesses a range of biological properties, including antioxidant properties (Shahwar et al., 2012), antibacterial activity (Matasyoh et al., 2009), and antifungal activity (Matasyoh et al., 2009; Begnami et al., 2012).

Herbs and vegetables, such as coriander, can be marketed as fresh or dried products, according to their intended use and the supply chain all worldwide locations. They must be preserved to make them available to consumers and process industry all year round easily (Ghasemi Pirbalouti et al., 2013a). In addition, consumer demand for processed products that keep more of their original fresh plant characteristics has increased. Fresh vegetables and herbs usually contain 75–85% water, and these water levels need to be lowered to less than 15% for preservation (Diaz-Maroto et al., 2002a,b). Drying process increases the shelf life of plants by slowing microorganism growth and by preventing biochemical reactions that can alter organoleptic characteristics (Diaz-Maroto et al., 2003; Hamrouni-Sellami et al., 2012). Herbs and almost all vegetable and fruits are dried under sunlight because of the lower cost (Soysal, 2004). Investigators (Hamrouni-Sellami et al., 2011; Rahimmalek and Goli, 2013) reported that the herb samples dried by the different methods resulted in both increased and reduced essential oil yields, depending on the drying method, duration, and temperature. Air drying and its effects on the characteristics of coriander have been studied by researchers (Ahmed et al., 2001; Shaw et al., 2007). Shaw et al. (2007) reported that the microwave drying of the coriander foliage was faster than for convective drying. They also stated the microwave drying is able to reduce the coriander moisture content to the 12%. Results of an investigation (Sarimeseli, 2011) showed that the microwave drying can be performed in very short times compare to other methods and the dried leaves of coriander have somewhat the same colors and odors as the fresh ones, which are very desirable properties by consumers and food industry.

Yet, no studies have documented a suitable drying method to maintain volatile oil constituents in coriander. This study assessed the effects of different drying methods on quality and quantity essential oil from the stem and leaves of coriander to determine the best drying method.

2. Material and methods

2.1. Chemicals

Homologous series of C_5–C_{24} *n*–alkanes (Sigma–Aldrich, Steineheim, Germany) were used for identification of all constituents by calculation of the retention indexes. Anhydrous sodium sulphate (Na_2SO_4) for drying extracted oil was purchased from Merck Co. (Darmstadt, Germany).

2.2. Plant material

The aerial parts, including mixed stem and leaves of Iranian landrace (Isfahan) of coriander (*Coriandrum sativum* L.) were collected from Nazhvan farm lands at Isfahan, southwestern Iran (latitude 32°38′N, longitude 51°32′E, and altitude 1601 m above sea level). Shrimardi confirmed plant identities and voucher specimen (No. 161) has been placed in the Herbarium of Research Center for Medicinal Plants, Shahrekord Branch, I.A.U., Iran. To preserve their original fresh quality, the collected aerial parts were stored in a refrigerator at 4 °C until used in the drying tests. The collected samples were randomly divided into eight batches containing three

Table 1
Effect of different drying methods on the main constituents of essential oil of coriander.

Components	RI†	Essential oil constituents (%)							ANOVA
		Fresh-sample	Freeze-dried	Shade-dried	Sun-dried	Oven-dried (40 °C)	Oven-dried (60 °C)	Microwaved (500 W)-dried	Microwaved (700 W)-dried	
Methyl chavicol	1194	0.00 ± 0.00a*	1.50 ± 0.57a	1.14 ± 0.73 a	6.02 ± 2.74a	5.40 ± 1.17a	0.00 ± 0.00a	3.74 ± 2.53a	0.21 ± 0.36a	$p > 0.05$
Decanal	1206	20.18 ± 6.08b	25.62 ± 7.42b	37.50 ± 4.46a	26.38 ± 6.28b	9.55 ± 5.86c	0.00 ± 0.00c	28.87 ± 1.16ab	10.06 ± 2.49c	$p \leq 0.01$
2*E*-decenal	1258	6.51 ± 1.11ab	5.32 ± 0.92ab	5.59 ± 1.35ab	7.52 ± 2.79a	0.00 ± 0.00b	0.00 ± 0.00b	5.91 ± 1.13ab	11.32 ± 3.19a	$p \leq 0.05$
n-Decanol	1271	14.76 ± 4.61a	10.53 ± 0.78abc	8.46 ± 2.17bc	10.08 ± 1.74abc	13.15 ± 0.87ab	4.56 ± 2.45bc	0.48 ± 0.60d	1.36 ± 1.85d	$p \leq 0.01$
Dodecanal	1405	7.14 ± 1.24a	7.29 ± 1.80a	5.85 ± 0.98a	5.30 ± 1.41a	7.15 ± 5.30a	0.00 ± 0.00b	5.85 ± 1.67a	7.65 ± 0.84a	$p \leq 0.05$
2*E*-dodecenal	1463	10.85 ± 2.25a	10.17 ± 1.11a	12.44 ± 3.25a	10.00 ± 3.14a	8.31 ± 5.10a	11.56 ± 3.56a	14.85 ± 0.90a	17.20 ± 1.97a	$p > 0.05$
trans-2-Undecen-1-ol	1467	5.64 ± 0.66b	3.39 ± 3.32b	7.32 ± 0.39b	1.11 ± 0.38b	12.88 ± 7.21a	0.00 ± 0.00b	0.00 ± 0.00b	0.30 ± 0.51b	$p \leq 0.01$
1-Tetradecanol	1673	11.23 ± 3.39bc	8.81 ± 2.40bcd	0.00 ± 0.00e	2.80 ± 1.84de	6.65 ± 3.40cde	31.74 ± 0.29a	9.08 ± 0.83bcd	15.80 ± 0.59b	$p \leq 0.01$
cis-Phytol	1891	2.39 ± 2.52b	1.00 ± 0.98b	1.07 ± 0.95b	1.15 ± 0.98b	6.38 ± 2.19b	34.05 ± 5.22a	2.20 ± 0.45b	2.15 ± 0.72b	$p \leq 0.01$
1-Eicosanol	2276	0.00 ± 0.00b	0.00 ± 0.00b	0.00 ± 0.00b	0.00 ± 0.00b	0.00 ± 0.00b	1.17 ± 0.86b	1.34 ± 1.26b	13.09 ± 8.68a	$p \leq 0.01$

* Means with different letter in a row are statistically significant at 5% level probability. Values of major compounds are given as means ±SD.
† Retention indices (RI) determined on HP-5MS capillary column.