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Effect of Drying Methods on Essential Oil Content of *Acorus calamus* Collections from Himachal Pradesh

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Abstract

The present study was carried out at Dr. YS Parmar university of Horticulture and Forestry, Nauni, Solan Himachal Pradesh during September 2022 to September 2023 to evaluate the effect of different drying methods (sun drying, shade drying, oven drying at 40°C) on essential oil content of vacha (*Acorus calamus*) rhizomes collected from different sites in Himachal Pradesh. Volatile oil content of dried rhizomes was determined by Clevenger type apparatus. The rhizomes were collected at senescence stage and dried under shade, sun and oven before extraction of essential oil in powdered form. The statistical analysis revealed significant effect on essential oil content of *Acorus calamus* rhizomes collected from different sites across various districts of Himachal Pradesh as well as drying methods and their interaction between different sites. It was found that highest essential oil content (3.43%) was obtained from D_1 (shade drying method) and minimum essential oil content (2.69%) was obtained from D_3 (sun drying). However, among different sites, highest essential oil content (3.95%) was recorded from rhizomes collected from Site S_1 (Bandrol, Kullu) and minimum essential oil content (1.93) was obtained from site S_6 (Bashoo, Mandi). With regard to interaction effect between different sites and drying methods, treatment combination S_1D_1 (Bandrol, Kullu site with shade drying method) and S_4D_1 (Khajjiar, Chamba with shade drying method) exhibited maximum essential oil content i.e. 4.41% and 4.30%, respectively.

Keywords: *Acorus calamus*, essential oil, shade drying

1. Introduction

Acorus calamus L. commonly known as Sweet Flag is an important aromatic herb belonging to the family Acoraceae. It is a semi-aquatic, perennial, monocot, aromatic herb that can reach a height of 2 meters and has creeping rhizomes. Its essential oil also contains other chemical constituents like eugenol, methyl eugenol, camphor, linanool and linolenic acid etc besides asarone (Chandra and Prasad, 2017). *Acorus calamus* L. grows on marshy soil, in shallow water and on the edges of ponds in northern temperate, subtropical, and warm parts of the Indian subcontinent, Sri Lanka and the Philippines., etc (Verma and Singh, 2012). In India, it occurs naturally in the Indian Himalayan region. It includes the Indian states of Jammu, Kashmir, Himachal Pradesh, Uttarakhand and Manipur (Mittal et al., 2015). It is extensively grown across various states in India, including Himachal Pradesh, Manipur, Uttarakhand, Jammu and Kashmir, Nagaland, Uttar Pradesh, Tamil Nadu, Andhra Pradesh, Maharashtra, and Karnataka (Kasture et al., 2016). Its distribution has been documented across multiple districts of Himachal Pradesh encompassing Chamba, Solan, Kinnaur, Kullu, Mandi, Shimla, Kangra, and Sirmaur (Mittal et al., 2009).

Acorus calamus L. holds significant value in Ayurvedic medicine as an essential herb. It is regarded as a "rejuvenator" for the nervous system and brain and is often utilized to treat digestive disorders (Rajput et al., 2014). It is extensively applied in many ethnomedicines for its medicinal and therapeutic properties (Bisht and Bhatt, 2014). Due to its high demand in pharmaceutical companies for its diverse medicinal and other applications, the plant is being rapidly extracted from the wild. The rhizomes of *A. calamus* and their essential oil are widely used in the flavoring industry and for various activities (Rajput et al., 2014; Sharma et al., 2014). In ancient India, Ayurvedic medicinal practices claimed that the rhizome of *A. calamus* helps to rejuvenate the central nervous systemand improve brain power (Gilani et al., 2006).

Acorus has been used as a traditional medicinal plant for the

treatment of various diseases for over 2000 years (Jadid et al., 2020). It is used to treat epilepsy, palpitations, abdominal pain, bruising, forgetfulness, etc. (Anonymous, 2020, Balakrishnan et al., 2022). The Mulam people in China collect *Acorus* flowers to treat wounds (Gu et al., 2021). The rhizome of *A. calamus* has the effect of inducing resuscitation, relieving phlegm, improving intelligence, resolving dampness and appetite, as well as prolonging life (Anonymous, 2020).

Hydro-distillation is the most commonly used method for extraction of essential oil. Methods of extraction, distillation time, drying methods and harvesting season significantly affects the essential oil content (%) of *Acorus calamus* (Verma et al., 2017).

Literature survey revealed that divergent drying methods have been used previously for drying different medicinal and aromatic plants. To maintain their quality, sun and shade drying have been used successfully for drying of plant material but they have disadvantage of slowness of the process, exposure to environmental contamination, uncertainty of weather and high labour requirements (Omidbaigi, 2005) Room temperature or shade drying is the traditional technique being used to preserve medicinal plants, as the low temperatures are thought to protect the active components from degradation. (Fennell et al., 2004). In contrast with conventional methods, oven drying with different temperatures have been experienced cost and time effective in recent three decades for drying most of the plant materials. There is little or no information on postharvest factors *viz.*, drying methods on essential oil content of *A. calamus* so an attempt has been made to study the effect of these factors in the western Himalayas.

2. Materials and Methods

The present study was carried out at Dr. YS Parmar university of Horticulture and Forestry, Nauni, Solan Himachal Pradesh (173 230) India, during September, 2022 to September, 2023 to evaluate the effect of different drying methods (sun drying, shade drying, oven drying at 40°C) on essential oil content of vacha (*Acorus calamus*) rhizomes collected from different sites in Himachal Pradesh (Table 1). The rhizomes of *Acoruscalamus*collected from different sites were grouped into three parts each and were subjected to three types of drying treatments.

2.1. Shade drying

In this method of drying, rhizomes collected from 10 different sites were dried under the constant shade for particular duration until the moisture content becomes constant. Constant weight was achieved after 15 days of drying. The rhizomes samples were then grinded using grinder or pestle and mortar. 150 g of powdered rhizomes from each site were then subjected to hydro distillation using Clevenger-type apparatus for the extraction of essential oil from the dried powdered rhizomes of *Acorus calamus*.

2.2. Sun drying

In this method of drying, rhizomes collected from 10 different sites were dried under the sunlight from 10 am to 4 pm until moisture content becomes constant. Constant weight was achieved after 70 hours of drying.

2.3. Oven drying at 40°C

In this method of drying, the samples were dried in a hot-air oven at 40˚C until the moisture content becomes constant. Constant weight was achieved after 42 hours of drying. Rhizome samples collected from different sites were chopped into smaller pieces and then subjected to oven drying at 40°C until the moisture content become constant. The dried rhizomes samples were then grinded using grinder or pestle and mortar. 150 g of powdered rhizomes from each site are then subjected to hydro distillation using Clevenger- type apparatus for the extraction of essential oil from the dried powdered rhizomes of *Acorus calamus.*

2.4. Statistical analysis

Data was analysed using Factorial Randomised Block Design.

Table 1: Description of sites of collection of *Acorus calamus* rhizomes from different districts of Himachal Pradesh

Sl. No.	Name of the sites	Latitude	Longitude	Altitude
S_1	Bandrol (Kullu)	32°1'55.59234"N	77° 7' 49.0548"E	1340 m
S_2	S_2 14 mile (Kullu)	32° 7' 41.826"N	77° 9' 14.4396"E	1447 m
S_3	Mangla (Chamba)	32°32'58.12"N	76°7'6.91"E	1030 m
S_4	Khajjiar (Chamba)	32°33'20.86"N	76°3'56.1"E	1970 m
S_5	Bhanota (Chamba)	32° 36' 54.936"N	76° 4' 38.0928"E	880 m
S_6	Basahu (Mandi)	31°23'53.0628"N	76°58'40.0836"E	1020 m
S_7	Harabag (Mandi)	31° 29' 1.3596"N	76°52'11.9928"E	650 m
S_8	Khaltoo (Solan)	30° 51' 1.0188"N	77° 11' 8.4336"E	990 m
S_9	Kunihar (Solan)	31° 5' 17.6136"N	76°57'11.6856"E	773 m
S_{10}	Basal (Solan)	30° 56' 0.0456"N	77° 5' 32.8812"E	1600 m

Analysis of variance was worked out and critical difference at 5% level of significance was calculated.

3. Results and Discussion

3.1. Effect of different drying conditions on essential oil content of Acorus calamus L. collections

Data presented in table 2 revealed that different sites, drying methods (i.e. sun drying, shade drying and oven drying at 40°C) and their interaction exhibited significant effect on essential oil content of *Acorus calamus*. With respect to different sites the mean value for essential oil content ranged from 1.93% to 3.95%. The maximum value (3.95%) for essential oil content was recorded in S_1 (Bandrol, Kullu) which was followed by S_4 (3.93%) (Khajjiar, Chamba) and both the treatments were statistically at par with each other. However, the minimum value for essential oil content (1.93%) was recorded in S_6 (Basahoo, Mandi) which was significantly different from all other treatments.

With regard to different drying methods maximum mean value for essential oil content (3.43%) was recorded in D_1 (shade drying) followed by D_2 (3.22%) (sun drying) and minimum value (2.93%) was recorded in D_3 (oven drying). However, D_1 was statistically superior to D_2 and D_3.

From the interaction effect between different sites and drying methods, it was observed that the value for essential oil content ranged from 1.46% to 4.41% in treatment combination S_6D_3 and S_1D_1, respectively. The maximum value for essential oil content (4.41%) was recorded in treatment combination S_1D_1 followed by S_4D_1 (4.30%) and both the treatment combinations were statistically at par with each other. However, the minimum value for essential oil content (1.46%) was registered in treatment combination S_6D_3 which was significantly different from all other treatment combinations. Drying is a prevalent technique employed for the preservation of medicinal and aromatic plants, as it helps safeguard their bioactive compounds. In the postharvest phase, medicinal plants are particularly susceptible to fungal deterioration primarily because of their elevated moisture levels. Therefore, when selecting the most suitable approach, it's crucial to reduce the moisture content through drying by approximately 10% to 12% (Hazrati et al., 2021). Drying methods have significant effect on the essential oil content of the plants. In the present study maximum essential oil content (3.43%) was obtained when rhizomes of *Acorus calamus* were dried under shade followed by oven drying at 40°C (3.06%) and minimum essential oil content (2.69%) was recorded in sun dried rhizomes. In case of shade drying higher essential oil content (%) might be due to the fact that essential oils are composed of volatile compounds that can easily evaporate when exposed to high temperatures and direct sunlight. However, shade drying allows for a gentler drying process with lower temperatures, which helps to preserve these volatile compounds. Sunlight contains ultraviolet (UV) radiation, which can trigger photochemical degradation of essential oil compounds. Oven drying involves exposure to elevated temperatures, which can cause the breakdown of essential oil compounds which results in reduction of volatile compounds of essential oil. Further lower essential oil content (%) might be due to broken oil glands at higher temperature in oven drying method.

Table 2: Effect of different drying conditions on essential oil content (%) of *Acorus calamus* L. collections

Drying methods/ Sites	D_1 (Shade drying)	D_2 (Oven drying at 40°C)	D_3 (Sun drying)	Mean
S_1 (Bandrol, Kullu)	4.41	3.95	3.48	3.95
S_2 (14 mile, Kullu)	2.97	2.59	2.22	2.59
S_3 (Mangla, Chamba)	3.59	3.26	2.88	3.24
S_4 (Khajjiar, Chamba)	4.30	3.95	3.54	3.93
S_5 (Bhanota, Chamba)	3.57	3.24	2.95	3.25
S_6 (Basahoo, Mandi)	2.33	2.01	1.46	1.93
S_7 (Harabag, Mandi)	3.99	3.53	3.19	3.57
S_8 (Khaltoo, Solan)	3.02	2.70	2.35	2.69
S_9 (Kunihar, Solan)	3.57	3.22	2.93	3.24
S_{10} (Basal, Solan)	2.53	2.15	1.88	2.18
Mean	3.43	3.06	2.69	
		Site	Drying methods	Site×Drying methods
CD (p=0.05)		0.06	0.03	0.02
SEm±		0.03	0.01	0.01
SEd±		0.11	0.05	0.04

Similar findings have been reported by Pirbalouti et al. (2013) where drying methods significantly affects essential oil content of basil. They observed that maximum essential oil content was found in shade drying followed by freeze drying. It was observed that increase in drying temperature results in reduction of monoterpene hydrocarbons which affects essential oil content (%).

Similar trend of reduction of volatile oil content of plants by the impact of higher temperature has been reported for peppermint by Blanco et al. (2002) and in bay leaf by Sekeroglu et al. (2007). Similar findings of reduction of essential oil content with exposure to heat and sunlight was reported by Hassanpouraghdam et al. (2009) in case of *Ocimum basilicum* where highest essential oil content was reported in shade drying and reduction in essential oil content was revealed with exposure to elevated temperature and sunlight in case of sun drying and oven drying.

Similar findings of reduction of essential oil content (%) in case of *Polygonum minus* roots was observed by Azhari et al. (2020). It was reported that increase in drying temperature results in reduction of essential oil content (%). Similar trend of decrease of essential oil content (%) with increase in drying temperature was observed by Khangholi et al. (2008). They reported gradual loss of monoterpene content with increase in drying temperature.

4. Conclusion

The shade drying method proved to be the best method for getting higher essential oil content (3.43%) as compared to sun and shade drying from *Acorus calamus* rhizomes. However among different sites, highest essential oil content (3.95%) was recorded from site S_1 (Bandrol, Kullu). With regard to interaction effect, treatment combination S_1D_1 (Bandrol, Kullu site with shade drying) and S_4D_1 (Khajjiar, Chamba with shade drying) exhibited maximum essential oil content i.e., 4.41% and 4.30% respectively.

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