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Effect of Drying Conditions and Days on Essential oil Yield and Quality of Lavender (Lavandula Angustifolia Mill.) Cultivars Grown in Wondo Genet, Ethiopia

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Abstract:

Lavender belongs to the genus Lavandula and the family Lamiaceae. Among the factor affecting the quality of lavender plant chemotype, are harvesting and storage conditions. No further study has been done on drying conditions and time in Ethiopia so far. The fresh leaf of the Lavender cultivar was subjected to sun and shade drying conditions and four drying days (0,5, 10, and 15). From each sample, the essential oil was extracted. The extracted essential oil was subjected to physical parameters analysis: - essential oil content (volume by weight and weight by weight), specific gravity, and refractive index. Local lavender shows a higher essential oil content and moisture content than the flowering lavender cultivar. All physical properties of essential oils except specific gravity, show significant differences in all cases between cultivar, drying conditions, drying days, and interaction effect of all cases. This shows drying conditions and drying days affect the quality of lavender essential oils. Therefore, this study provides evidence (information) that drying herbs on different drying days and drying conditions affect the essential oil content and physical properties of essential oil.

Key words: essential oil; hydrodistillation; open sun; shade

1.Introduction

Lavender belongs to the genus Lavandula and the family Lamiaceae which is a large group of tremendously useful plants like rosemary, basil, or sage. The most well-known representative of the Lavandula species is Lavandula angustifolia Mill [1]. True lavender plants, with their characteristic violet flowers and narrow leaves, are native to Europe, mainly the Mediterranean area, North America and Australia. Nowadays, the largest cultivations are located in France, Bulgaria, and Turkey. In Bulgaria, its cultivation area reaches more than 6000ha, and the Turkish production of lavender flowers oscillates around 50–75 tons per ha [2-5]. The history of true lavender usage goes back to Greek and Roman civilizations in ancient times, which used it due to its flavor. In the Middle Ages, lavender and its essential oil (EO) were recognized as a potential drug. It was applied in cases of migraines, panic attacks, or heart problems [4].

More contemporary applications are related to neuroprotective and anti-aging [1,2] preservative (due to antioxidant and antibacterial) [3,4], sedative [5], and anti-insomnia [6] properties of true lavender EO. However, the most important feature of lavender is its characteristic odor, which is exploited widely in the cosmetics and food industries. In the case of cosmetics, the recent research scopes are focused on applying lavender-free and encapsulated EO or hydrosols for aromatic, antioxidant, and antimicrobial purposes [3,7–9]

True lavender and its derivatives have found similar functions in the food industry. The most effects are expected in the case of food microbial control, for instance, Botritis cinereal, Escherichia coli, Staphylococcus aureus, Pseudomonasauerginosaor Candida albicans [10,12], preservation of fatty acids before oxidation [12], and flavoring nanocapsules [13]. These wide applications are mainly related to the unique lavender flower's EO composition. Numerous sources show that its main volatile constituents are linalool (20.0%–45.0%), linalyl acetate(25.0%–46.0%), and lavandulyl acetate (>0.2%) (14). Nevertheless, other components that occur in lavender EO such as camphor, 1,8-cineole, borneol, ocimene, and in higher amounts may be a disqualifying factor for expected plant usage [15].

The quality and effectiveness of true lavender flowers or their derivatives are remarkably related to various factors like plant chemotype, conditions of harvest and cultivation, and post-harvest treatment like storage and

preservation method (16). Water is one of the significant components of the biological materials of plants. Many postharvest operations start with the removal of water that is, drying. Aromatic plants and spices are often dried before extraction to reduce moisture content. Dehydration of plants can be performed using different methods. Natural drying (sun drying) and drying in the shade are still the most widely used methods because of their lower cost(17). Many research reports showed the effects of different methods of drying on essential oil content and the chemical composition of the essential oil plants(18). The drying process has increased the yield of essential oil from 94.0 to 98.4% along with an increase in the percentage of the major component, that is, piperitinone oxide from 79.9% to 88.5% which showed that the drying method had significantly affected the composition percentage of essential oils [18].

This study aimed to analyze the essential oil yield and quality of lavender cultivars stored and dried at different drying conditions and days.

2. Materials and methods

2.1 Sample Collection and Preparation

The Experiment was carried out in the Wondo Genet Agricultural Research Center. The two lavender cultivars (Local and Flowering) were collected from the Wondo genet Agricultural Research Center experimental field at optimum harvesting age at the sampling site of altitude of 1800 m a.s.l., latitude and longitude of N 39° 1' 44" E 8° 25' 59". The collected samples were weighed and taken to the Wondo Genet Food Science and Nutrition Research Laboratory for extraction. The samples were stored under two different drying conditions, open sun, and shade. There were also four different drying days for both shade and sun-dried samples. 0 days, 5 days, 10 days, and 15 days after harvesting.

2.2 Essential Oil Extraction

The essential oil was extracted from fresh leaves using the Clevenger-type apparatus for 3 hours by hydro-distillation methods and dried with anhydrous Na_2SO_4 according to (19).

2.3 Moisture Content

The moisture content of lavender samples was determined from the fresh leaf by using a drying oven according to the method described by (20). The moisture content was calculated as follows

$$\text{Moisture content (\%)} = \frac{\text{mass of fresh sample} - \text{mass of dry sample}}{\text{mass of fresh sample}} \text{ x } 100$$

2.4 Physical Quality parameter of essential oil

2.5 Essential Oil Content

The Essential oil content of lavender samples was calculated by the following formula.

$$\text{Oil content (w/w (\%)} = \frac{\text{mass of extracted oil (g)}}{\text{mass of extracted sample (g)}} \times 100$$

2.6 The Specific Gravity of the Essential Oil

The specific gravity was determined according to the method described by (21). The 5ml of distilled water was added to the cleaned pycnometer. The distilled water was weighed (M_{water}) (make sure that there is no bubble or air inside the pycnometer while weighing).

The distilled water was removed and the pycnometer was dried. Then the same volume of oil was added to the pycnometer and weighed (M_{oil}). Finally, specific gravity or relative density was calculated using the following formula

$$\text{Specific gravity/relative density} = \frac{\text{mass of oil}}{\text{mass of water}} \text{ x } 100$$

1.7 Refractive Index Determination

The refractive indexes of the essential oils were measured by a Refractometer (Reichert, AR200) according to the method described by (21)(22). The prism of the Digital spectrophotometer was cleaned and the read button was pressed first to make sure that it is cleaned well. The sample was applied to the prism of a Digital spectrophotometer using a micropipette. Finally, the result of the refractive index was read and recorded. The triplicate analysis was taken place and the result was the average triplicate value in all cases.

2.8 Data Analysis

Significant differences in the physical properties of the essential oil extracted from the Lavender cultivar were subjected to JMP software.

3. Result and discussion

In this study, the physical quality parameters of Lavender cultivar like Essential oil content, Moisture content, Specific gravity, and Refractive index were analyzed and their significant difference was analyzed using JMP software. Table 1 shows the mean value of the effect of storage times and drying conditions on the physical properties of the Lavender cultivar. The result of the mean variety effect on lavender cultivar shows that Local lavender has a high moisture contentof26.70%, high essential oil content volume by weight of 2.18%, and high essential oil content weight by weight of 1.90%but low specific gravity of 0.9113 and low refractive index1.4671 than Flowering lavender. There is a significant difference between the two cultivars in all properties except specific gravity. The result of the mean drying condition effect on lavender varieties shows that shade drying has a high moisture content of 26.09%, a high essential oil content volume by weight of 1.75%**, a** high essential oil content weight by weight of 1.65%, and a high refractive index of 1.468 but low specific gravity value0.9121 than open sun drying. There is a significant difference between the two drying conditions in moisture content, and essential oil content weight by weight. But there is no significant difference between the two drying conditions in the case of essential oil content volume by weight, specific gravity, and refractive index. The result of the mean drying days effect on the lavender cultivar shows that day 0 shows maximum moisture content, essential oil content volume by weight, essential oil content weight by weight, and specific gravity followed by day 5, day 10, and day 15 respectively. In the case of the refractive index day,15 shows the maximum value followed by day 0. Day 5 and day 10 have equal values of the refractive index. All properties except specific gravity show a significant difference between four drying days.

The value of essential oil content in this study was found within the range of research findings [23]. The value of the refractive index and specific gravity of this study was slightly less than the research finding [28]. The small variation between the two research findings may arise because of environmental and cultivar differences [27].

Variables	MC (%)	VW EOC (%)	WW EOC (%)	SPG	RI
Cultivar					
Lo	26.70^{a}	2.18^{a}	1.98^{a}	0.9113^{a}	1.4671^{a}
Fl	23.87^{b}	1.25^{b}	1.26^{b}	0.9133^{a}	1.4690^{b}
SE	0.1152	0.0424	0.0389	0.0023	0.00004
Drying Conditions					
Shade	26.09^{a}	1.75^{a}	1.65^{a}	0.9121^{a}	1.4682^{a}
Open Sun	24.48^{b}	1.68^{a}	1.59^{b}	0.9125^{a}	1.4678^{a}
SE	0.1152	0.0424	0.0389	0.0023	0.00004
Drying Days					
Day 0	64.93^{a}	3.35^{a}	3.29^{a}	0.9083^{a}	1.4680^{b}
Day 5	14.75^{b}	1.34^{b}	1.23^{b}	0.9125^{a}	1.4678^{c}
Day 10	11.32^{c}	1.16^{bc}	1.06^{bc}	0.9133^{a}	1.4678^{bc}
Day 15	10.13^{d}	1.00^{c}	0.91^{c}	0.9150^{a}	1.4684^{a}
SE	0.1629	0.0599	0.0550	0.0032	0.00006

Means with a different letter in the column of superscripts are significantly different at $p<0.05$. Where; - Lo = Local lavender, Fl = Flowering lavender %MC = Percent of moisture content, EOC = Essential Oil Content %VW = Percent of Volume by weight = weight by weight, Spg= Specific gravity, and RI=Refractive Index.

Table 1: Mean value of the effect of storage times and drying conditions on the physical properties of the Lavender cultivar

3.1 Interaction effects

Table 2 shows the mean value of the interaction effect of drying methods and drying days on the physical properties of the Lavender cultivar. From the table of the interaction effect of variety by drying conditions the highest value of moisture content was observed in local lavender, shade dry with a value of 28.44%, and the lowest value was observed in flowering lavender, shade dry with a value of 23.75%. The highest value of essential oil content in volume by weight was found in local lavender, shade dry (2.30%), and the lowest value was found in flowering lavender, shade dry (1.20%). The highest value of essential oil content in weight by weight was found in local lavender, shade dry (2.09%) and the lowest value was found in flowering lavender, shade dry (1.21%). The highest specific gravity value was observed in flowering lavender, shade dry (0.9142), and the lowest value was observed in local lavender, shade dry (0.9100). The highest value of the refractive index was found in flowering lavender, shade dry (1.4693), and the smallest value was found in local lavender, shade dry (1.4670). All physical properties of essential oils except specific gravity were significantly different between cultivar and drying conditions.

The table of the interaction effect of a cultivar by drying days shows that local lavender, on day 0 has high moisture content with a value of 66.47%, and flowering lavender, on day 10 has low moisture content with a value of 9.60%. The highest value of essential oil content in volume by weight was found in local lavender, day 0 (4.14%), and the lowest value was found in flowering lavender, day 15 (0.59%). The highest value of essential oil content in weight by weight was found in local lavender, day 0(3.76%), and the lowest value was found in flowering lavender, day 15 (0.54%). The highest specific gravity value was observed in flowering lavender, day 15 (0.9183), and the lowest value was observed in flowering lavender, day 0 (0.9067). The highest Refractive index value was found in flowering lavender, day 15 (1.4698), and the smallest value was found in local lavender, day 5 (1.4667). All properties of essential oils except specific gravity have a significant difference between cultivar and drying days.

The table of the interaction effect of drying conditions by drying days shows that shade dry, day 0, and open sundry, day 0 have high moisture content with a value of 64.93%, and open sundry, day 10 has low moisture content with a value 8.63%. The highest value of essential oil content in volume by weight was found in shade dry, day 0, and open sundry day 0 (3.35%), and the lowest value was found in open sundry, day 15 (0.95%). The highest value of essential oil content in weight by weight was found in shade dry, day 0, and open sundry day 0 (3.29%) and the lowest value was found in open sundry, day 15 (87%). The highest specific gravity value was observed in open sundry, day 15 (0.9167), and the lowest value was observed in shade dry, day 0, and open sundry, day 0 (0.9083). The highest Refractive index value was found in shade dry, day 10 (1.4690), and the smallest value was found in open sundry, day 0, and open sundry, day 5 (1.4677). All properties of essential oils except specific gravity and refractive index have a significant difference between drying conditions and drying days.

The table of the interaction effect of varieties by drying conditions drying days shows that the highest value of moisture content was found in local lavender, shade dry, day 0, and local lavender, open sundry, day 0 (66.47%) and the lowest value of moisture content was found in flowering lavender, open sundry, day 10 (8.33%). The highest value of essential oil content in volume by weight was found in local lavender, shade dry, day 0, and local lavender, open sundry, day 0(4.14%), and the lowest value was found in flowering lavender, shade dry, day 15(0.44%). The highest value of essential oil content in weight by weight was found in local lavender, shade dry, day 0, and local lavender, open sundry, day 0 (3.76%), and the lowest value was found in flowering lavender, shade dry, day 15 (0.40%). The highest specific gravity value was 0.9233 and the lowest value was 0.9067. The highest Refractive index value was found in flowering lavender, shade dry, day 15 (1.4706), and the smallest value was found in local lavender shade dry, day 5 and local lavender, open sundry, day5, and local lavender, open sundry, day 15 (1.4667). All properties of essential oils except specific gravity have a significant difference between varieties, drying conditions, and drying days.

Variables	MC (%)	VWEOC (%)	WW EOC (%)	SPG	RI
Cultivar by drying conditions					
Lo, Shade	28.44^{a}	2.30^{a}	2.09^{a}	0.9100^{a}	1.4671^{c}
Lo,Open Sun	24.97^{b}	2.07^{a}	1.88^{a}	0.9125^{a}	1.4670^{c}
Fl, Shade	23.75^{c}	1.20^{b}	1.21^{b}	0.9142^{a}	1.4693^{a}
Fl,Open Sun	23.98^{c}	1.29^{b}	1.30^{b}	0.9125^{a}	1.4686^{b}
SE	0.1629	0.0599	0.0550	0.0032	0.00006
Cultivar by drying days					
Lo, D0	66.477^{a}	4.14^{a}	3.76^{a}	0.9100^{a}	1.4674^{c}
Lo, D5	17.77^{c}	1.72^{b}	1.57^{c}	0.9100^{a}	1.4667^{d}
Lo, D10	10.67^{f}	1.46^{c}	1.33^{c}	0.9133^{a}	1.4670^{d}
Lo, D15	11.91^{d}	1.40^{c}	1.27^{c}	0.9117^{a}	1.4670^{d}
Fl, D0	63.40^{b}	2.56^{c}	2.81^{b}	0.9067^{a}	1.4686^{b}
Fl, D5	11.73^{de}	0.97^{d}	0.88^{d}	0.9150^{a}	1.4689^{b}
Fl, D10	9.60^{g}	0.86^{d}	0.79^{d}	0.9133^{a}	1.4687^{b}
Fl, D15	10.73^{ef}	0.59^{d}	0.54^{d}	0.9183^{a}	1.4698^{a}
SE	0.2304	0.0848	0.0778	0.0046	0.00008
Drying conditions by days					
Shade, D0	64.93^{a}	3.35^{a}	3.29^{a}	0.9083^{a}	1.4679^{a}
Shade, D5	15.90^{b}	1.36^{bc}	1.24^{b}	0.9150^{a}	1.4680^{a}
Shade, D10	11.63^{de}	1.24^{bc}	1.13^{bc}	0.9117^{a}	1.4690^{a}
Shade, D15	11.91^{d}	1.05^{b}	0.95^{bc}	0.9133^{a}	1.4680^{a}
Open Sun, D0	64.93^{a}	3.35^{a}	3.29^{a}	0.9083^{a}	1.4677^{a}
Open Sun, D5	13.60^{c}	1.33^{bc}	1.21^{bc}	0.9100^{a}	1.4677^{a}
Open Sun, D10	8.63^{f}	1.09^{bc}	0.99^{bc}	0.9150^{a}	1.4679^{a}
Open Sun, D15	10.73^{e}	0.95^{c}	0.87^{c}	0.9167^{a}	1.4679^{a}
SE	0.2304	0.0848	0.0778	0.0046	0.00009
Cultivar by drying conditions and days					
Lo, Shade, D0	66.47^{a}	4.14^{a}	3.76^{a}	0.9100^{a}	1.4674^{d}
Lo,Open Sun,D0	66.47^{a}	4.14^{a}	3.76^{a}	0.9100^{a}	1.4674^{d}
Fl,Open Sun,D0	63.40^{b}	2.81^{b}	2.56^{b}	0.9067^{a}	1.4685^{bc}
Fl, Shade, D0	63.40^{b}	2.81^{b}	2.56^{b}	0.9067^{a}	1.4685^{bc}
Lo, Shade, D5	22.13^{c}	1.79^{c}	1.63^{c}	0.9067^{a}	1.4667^{e}
Fl, Open Sun, D5	13.80^{d}	1.00^{efg}	0.92^{efg}	0.9067^{a}	1.4686^{bc}
Lo, Open Sun, D5	13.40^{d}	1.67^{cd}	1.51^{cd}	0.9133^{a}	1.4667^{e}
Lo, Shade, D15	12.74^{de}	1.67^{cd}	1.51^{cd}	0.9133^{a}	1.4673^{de}
Lo, Shade, D10	12.40^{def}	1.60^{cde}	1.46^{cde}	0.9100^{a}	1.4668^{de}
Lo, Open Sun, D15	11.07^{efg}	1.15d^{ef}	1.04^{def}	0.9100^{a}	1.4667^{e}
Fl, Shade, D15	11.07^{efg}	0.44^{g}	0.40^{g}	0.9133^{a}	1.4706^{a}
Fl, Shade, D10	10.87^{fg}	0.87^{fg}	0.79^{fg}	0.9133^{a}	1.4690^{b}
Fl, Open Sun, D15	10.40^{gh}	0.75^{fg}	0.69^{f}	0.9233^{a}	1.4690^{b}
Fl, Shade, D5	9.67^{ghi}	0.93^{fg}	0.85^{fg}	0.9233^{a}	1.4691^{b}
Lo, Open Sun, D10	8.93^{hi}	1.33c^{def}	1.21^{cdef}	0.9166^{a}	1.4672^{de}
Fl, Open Sun, D10	8.33^{i}	0.84^{fg}	0.78^{fg}	0.9133^{a}	1.4682^{c}
SE					

Means with a different letter in the column of superscripts are significantly different at $p<0.05$. Where; - Lo = Local lavender, Fl = Flowering lavender %MC = Percent of moisture content, EOC = Essential Oil Content %VW = Percent of Volume by weight = weight by weight, Spg= Specific gravity, and RI=Refractive Index

Table 2: Mean value of the interaction effect of drying methods and drying days on the physical properties of the Lavender cultivar.

2. Conclusions and Recommendations

The effects of drying conditions and drying days on the essential oil content, moisture content, and some physical properties of essential oil of lavender cultivar were analyzed. The results the finding of this study showed that drying conditions and drying days affect the quality of lavender essential oils. All physical properties of essential oils except specific gravity, show significant differences in all cases between variety, drying conditions, drying days, and interaction effects of all. This shows that drying conditions and drying days can affect all oil's physical properties except oil-specific gravity (density). Local lavender has higher essential oil content and moisture content than flowering lavender. The oil content decreases with increasing drying days for both lavender

cultivars. As a recommendation further study has to be done for essential oil chemical composition.

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