EFFECT OF DIFFERENT DRYING AND STORAGE METHODS ON THE QUALITY OF SOME MEDICINAL PLANTS:

I- EFFECT OF DIFFERENT DRYING AND STORAGE METHODS ON THE QUALITY OF LEMONGRASS OIL (*Cymbopogon citratus*).

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ABSTRACT

This study was carried out on lemongrass in Agriculture Research Station, Department of Vegetable and Floriculture, Faculty of Agriculture, Mansoura University in two successive seasons (June 1993 and 1994), for evaluation of the effect of different drying, storage methods and periods on properties of lemongrass plant. The essential oil percentage was determined in addition to its physical and chemical properties. The highest percentage of essential oil was obtained from drying plant in shade and storing in cotton bags for three months (1.85%), while the lowest one was obtained from drying in sun and storing in plastic bags for 12 months (0.42%). The lowest values of acid number (5.87) was observed in the drug, dried in shade and stored in cotton bags, while the highest value (11.8) was obtained from the plant which dried in oven and stored in plastic bags for 12 months. The lowest value of refractive index (1.37) detected was when the plant dried in shade and stored in cotton bags for three months, While the highest value (1.48) was noticed in the drug dried in oven and stored in plastic bags for 12 months. The highest percentage of citral (the main component of essential oil) was obtained (67.7%) by shade drying and storing in cotton bags for three months, while the lowest (52.9%) was obtained by oven drying and storing in plastic bags for 12 months.

INTRODUCTION

The medicinal and aromatic plants are the groups of plants that could be used in many purposes. In this investigation the lemongrass was chosen.

Cymbopogon citratus, (D.C. Stapf) Fam. Paaceae (Gramineae), is cultivated worldwide in the tropics yielding the economically important lemongrass oil. In addition, it is used as a medicinal plant in different respects, (Villavicencio and Biskup, 1990). Lemongrass is widely cultivated to obtain citral, a main component of the essential oil which is used in the chemical industries. The essential oil contents of the leaf blade and sheath is 0.42 and 0.13 %, respectively, citral content, (analysed by GLC) were 87.28 and 82.39 %, respectively, (Ming *et al.,* 1996). The main components of *Cymbopogon citratus,* were citral, nerol, geraniol, linalool, terpineol and citronellol (Kasumov and Babaev, 1983).

The oil was used for preservation of foodstuffs and wide use in perfumery and pharmaceutical purposes. Lemongrass leaves are combined with other herbs to treat fevers and stomachache (Syed *et al*., 1995).

Essential oil enclosed in the plant tissue is usually in one way or another affected by the drying of plant material after the harvest. This effect was studied and described in many investigations.

Jude (1940) found that the drugs which contained volatile oils were liable to lose their aroma if not dried or distilled immediately. For these reasons drying apparatus should be situated as near as possible to the growing plants areas.

Guenther (1952) stated that plant material must be stored in dry and low temperature atmosphere and in a room free from air circulation to avoid evaporation. He added that the major sources of losses represented were by oxidation and resinification of the essential oils, this agreement with Wallis (1964) who reported that leaves must be dried carefully so as to retain their fresh green colour and prevent the decomposition of the active constituents. The important factors are to use low temperature as possible and to carry out the operation as rapidly as possible. Drying under sheds at the air temperature is frequently adopted especially with leaves containing essential oil. Kocurtks and Dovjak (1979) studied natural and artificial drying medicinal plants and found that, the drying temperature for essential oil, plants should not exceed 35 °C and 60 °C.

The methods of storing are important as well as the methods of drying. The herbs should be allowed to cool when they come from drying and then be stored in air-tight dark containers.

Paakkonen *et al*. (1992) packed dried and chopped herb samples in polyethylene and paper bags. These were stored at 23 °C and 35 °C in light or in the dark. Herbs dried with different methods exhibited different sorption capacities. Odour and taste of air dried was sensitive to storage conditions.

Underriner and Hume (1994) stated that spices should be stored in airtight packaging to reduce oxidation, whole spices have indefinite shelf-life but when ground the pungency and colour can be lost. In general, ground spices stored beyond 6 months could show a noticeable loss of pungency.

The lemongrass leaves oil had kept for 2 years, exhibited maximum activity, due to its high citral content (Syed *et al*., 1995).

MATERIALS AND METHODS

The leaves of lemongrass (*Cympobogon citratus* D.C Stapf) was obtained from Experimental Station Faculty of Agricultural, Mansoura University in June 1993 and 1994. The samples were randomized collected and divided in three replicates (18 plants each).

The experiment was carried out in Experiment Laboratory Vegetable and Floricultural Department.

The treatments were investigated in this study were as followed:

1- Drying methods:

Shade, oven at 60 °C and sun samples of the fresh lemon grass leaves (cut into small pieces each about 3 cm long) were put in groups (100 gm each) for the following different drying procedures.

1-1 Shade drying :

The samples were put on shelves for ten days in paper bags until the dry weight still constant (three successive times weighing). These dried samples were kept for further methods of storage.

1-2 Oven drying:

The fresh samples were put in oven at 60 °C, in paper bags for three days until the dry weight was constant (three successive times of weighing). These dried samples were kept for further storage methods.

1-3 Sun drying:

The fresh samples were put in the sun in paper bags for 6 days until the dry weight was constant (three successive times of weighing).

2-Storage methods:

The samples were stored in different bags 10 x 10 cm (cotton or plastic)

3- Storage periods:

After each drying method (shade, oven or sun), the samples were stored in cotton or plastic bags for one year at room temperature. The dried samples (9 bags each of shade, oven or sun) were separately, put in either cotton or plastic bags for 4 storage periods (3, 6, 9, 12 months). Sample of each drying method is kept unstored and used as control. The storage samples after 3, 6, 9, 12 months were used for determination of essential oil.

Oil determination:

The essential oil percentages were determined in the dried samples in both seasons by distillation in clevenger apparatus according to methods described by British Pharmacopoeia (1963).

Physical and chemical properties of plants :

- Acid number :

The acid number was determined according to the directions given by Guenther (1972).

- Refractive index:

The refractive index of essential oil was determined according to the method mentioned by Guenther (1952) the refractometer of carlzeiss (Germany) was used at 25 °C.

- Gas liquid chromatography (GLC):

The essential oil samples obtained from different treatments were subjected to GLC analysis. The use of GLC in the quantitative determination could be achieved by following El-Deeb (1981) methods. The percentage of main components (cetral-b (neral) and citral-a (geranial) were calculated.

Statistical analysis

The obtained data were subjected to statistical analysis using technique of Factorial experimental in randomized complete design according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1. Oil percentage:

Data in Table (1) showed that, the oil percentage was markedly influenced by drying methods. Shade drying gave the highest oil percentage

(1.99%) followed by oven and sun drying methods (1.86 and 1.80%, respectively). For the storage process, the oil of samples stored in cotton and plastic bags were slightly decreased in all samples after 3 months of storage. However, the samples stored in cotton bags showed higher oil content in comparison with the samples stored in plastic bags for all drying methods. At the end of storage periods the shade drying method recorded the highest oil content in comparison with the oven and sun drying methods. Since the oil percentage at the end of storage periods were (1.32, 0.58, 0.52%) for the shade, oven and sun dried samples stored in cotton bags, respectively. The corresponded values for the samples stored in plastic bags were (0.94, 0.48, 0.42%), respectively. The above mentioned results revealed also that, shade drying method was considered the most appropriate method for drying lemongrass leaves stored in cotton bags for 3 months. This result was in agreement with Mettivier and De Groot (1960).

Table 1: Average of oil percentage as affected by the interaction between drying, storage methods and storage periods of lemongrass leaves.

Storage methods / Storage period (months)	Drying methods					
	Shade		Oven		Sun	
	Cotton bags	Plastic bags	Cotton bags	Plastic bags	Cotton bags	Plastic bags
0	1.99		1.86		1.80	
3	1.85	1.82	1.68	1.44	1.66	0.98
6	1.82	1.48	1.59	0.57	1.64	0.55
9	1.56	0.98	0.91	0.57	0.60	0.50
12	1.32	0.94	0.58	0.48	0.52	0.42
LSD at 5 %	0.26					

Plastic bags were not recommended for storage, because their material may chemically react with the compound of the essential oil. Chemical reaction causing the decomposition of certain compounds may take place during storage and might also occur during distillation. The rate of these reactions is slower at low temperature, but they could still be of significant extent during a prolonged storage time (Harnoh, 1992).

Moreover, the results were in agreement with Balbaa *et al*. (1974) who studied the effect of drying *Digitalis lanata* leaves artificially in circulating hot air oven at 55 - 60 °C, 90 - 95 °C and 120 - 125 °C and in shade or in sun. They found that shade drying was the favorable and satisfactory method for quality and glycosidal content.

Karawya and Hifinawy (1977) found that drying of *Mentha piperita* herb in the sun had decreased the essential oil content by 75 %.

Sanakat and Maharaj (1994) dried the herb *Eryngium foetidum*, results showed that, higher temperatures had a deleterious effect on the

odour and flavour of the oil extracted from the herb and the volatile oil content decreased from 0.84 to 0.12%.

2. Acid number (value):

The determination of acid value is very important as an indicator to the changes occurred in the oil, such as oxidation of aldehydes and hydrolysis of esters which increase acid value (Guenther, 1961).

Table (2) presents the average acid number as affected by drying and storage methods. The results showed that shade drying methods recorded the lowest acid number followed by sun and oven drying methods. These results could be attributed to the effect of high temperature of oven method on acid number of dried samples. For storage process, the table also indicated that, cotton bags storage method showed lower acid number in comparison with plastic bags. The observed lower acid number of cotton bags in comparison with plastic bags could be attributed to the lower temperature of samples stored in cotton bags. In contrast, the higher temperature of the samples stored in plastic bags oxidize the esters content of oil into acid and thereby, the acid number increases with the storage periods. At the end of storage period, the acid number of the samples stored in cotton bags after drying by shade, oven and sun were 8.08, 10.80, 9.80 respectively. In general, the above mentioned results revealed that, shade drying and cotton bags stored method may be considered the most suitable procedure for keeping the oil of lemongrass leaves without increase in acidity number. Aldehydes decreased during storage periods and it was said that the citral percentage decreased and converted into acid. These results were in agreement with Soliman (1963) and El-Ramal (1976).

Table 2: Average of acid number as affected by the interaction between drying, storage methods and storage periods of lemongrass leaves.

Storage methods / Storage period (months)	Drying methods					
	Shade		Oven		Sun	
	Cotton bags	Plastic bags	Cotton bags	Plastic bags	Cotton bags	Plastic bags
0	5.85		5.72		5.60	
3	5.87	5.90	6.70	6.75	6.83	6.82
6	6.03	7.73	8.78	8.70	7.32	8.75
9	7.07	8.63	8.90	8.75	8.50	9.50
12	8.08	8.78	10.8	11.8	9.80	10.5
LSD at 5 %	0.29					

3. Refractive index:

Refractive index is the ratio of velocity of light in a vacuum to its velocity in a substance. It varies with the wave length of light used. The

results in Table (3) showed, the refractive index at 20 °C of dried lemongrass leaves oil and stored in cotton and plastic bags for 3, 6, 9, 12 months.

The data collected showed the effects of drying, storage methods and storage periods on refractive index which was significantly influenced by drying methods. The highest value after 12 months was (1.48) in plastic bags dried in oven compared with (1.45) dried in sun and (1.42) dried in shade. This may be due to the effect of heat under the oven drying and unsuitable storing. Refractive index values seemed to be more or less in the oil samples during the storage periods. The changes in refractive index after 12 months of storage may be caused by the deterioration of essential oil. Similar results were obtained by Guenther (1961) and Abd El-Aal (1990).

Table 3: Average of refractive index as affected by the interaction between drying, storage methods and storage periods of lemongrass leaves.

Storage methods / Storage period (months)	Drying methods					
	Shade		Oven		Sun	
	Cotton bags	Plastic bags	Cotton bags	Plastic bags	Cotton bags	Plastic bags
0	1.36		1.39		1.38	
3	1.37	1.39	1.40	1.40	1.38	1.39
6	1.38	1.40	1.42	1.42	1.38	1.40
9	1.38	1.41	1.43	1.45	1.44	1.43
12	1.39	1.42	1.45	1.48	1.44	1.45
LSD at 5 %	0.02					

4. GLC study:

The GLC separation of the constituents of the oil from lemongrass leaves at different drying and keeping methods during 12 months storage period showed that the major and the most biologically active component of oil was citral-b (neral) and citral –a (geranial).

Geranial percentage was produced in better yield with drying in shade than that in oven and sun (67.7, 66.4 and 64.1%), respectively (Tables 4, 5 and 6) after 3 months of storage in cotton bags. On the other hand the same consequent was observed by keeping in plastic bags, geranial % was (57.8, 58.9 and 57.8%), respectively. The degradation effect of light and heat is more drastic in sun than in oven (heat factor) and than in shade (absence of light and heat factor), on the geranial content which is liable for oxidation, polymerization or resinification.

At the end of storage period after one year the geranial content was decreased at the three dry methods (shade, oven and sun) in cotton bags (59.0, 62.2 and 61.8%), respectively and in plastic bags (54.7, 52.9 and 55.8%), respectively.

Merory (1968) mentioned that comminuted spices did not retain their characteristic aroma for a long period of time. The grinding procedure

enlarges the surface of the spice manifold by the size and number of the ground particles. Simultaneously, oil sacks are reptured and exposed to air and oxidation. Whole and ground spices should be stored at temperature and humidity not exceeding 63 °F in dark and clean places. Direct sunlight causes loss in spices; dampness and caking are provoked by content of stored spices with outside walls and with the cold ground of the storage place.

This evidenced was due to the aeration of the drug in cotton bag, but the plastic one affords unsuitable atmosphore (no aeration, stimulate fungal and microbial growth) to keep the drug.

Table 4: GLC of lemongrass leaves oil dried in shade and stored in cotton and plastic bags for (3, 6, 9 and 12 months).

Storage methods / Periods / Component	Oil components percentage								
	Cont.	Cotton bags				Plastic bags			
		3	6	9	12	3	6	9	12
α- and β-pinene	0.94	1.20	1.05	0.67	1.02	1.01	1.14	1.00	1.03
Myrcene	0.76	0.20	0.36	0.03	0.17	0.04	0.15	0.08	0.15
Limonene	0.13	0.10	0.36	0.13	0.25	0.29	0.18	0.04	0.04
Trans-β-Ocimene	0.25	0.10	0.48	0.90	0.08	0.04	0.08	0.93	0.08
Terpinolene	0.50	0.60	0.40	0.13	1.90	0.43	0.65	0.40	0.60
5-methyl-hepta-3-one	0.18	0.40	0.24	0.13	0.13	0.22	0.30	0.31	0.34
Citronellal	0.06	0.20	0.18	0.19	0.25	0.29	0.48	0.39	0.30
Linalool	1.26	0.80	0.80	0.65	0.57	1.15	0.68	0.62	0.45
β-Caryophyllene	1.76	1.40	1.92	1.26	1.29	2.01	2.28	2.30	1.85
Citral-b (neral)	25.5	27.1	32.2	34.7	34.7	36.5	36.9	38.2	40.2
Citral-a (geranial)	67.9	67.7	61.5	60.7	59.0	57.8	56.6	55.5	54.7
Geraniol	0.76	0.20	0.36	0.51	1.14	0.22	0.46	0.23	0.26

Table 5: GLC of lemongrass leaves oil dried in oven and stored in cotton and plastic bags for (3, 6, 9 and 12 months).

Storage methods / Periods / Component	Oil components percentage								
	Cont.	Cotton bags				Plastic bags			
		3	6	9	12	3	6	9	12
α- and β-pinene	0.77	1.23	1.66	0.91	0.80	1.29	1.01	0.20	1.15
Myrcene	0.19	0.15	0.37	0.23	0.13	0.24	0.51	0.05	0.54
Limonene	0.15	0.06	1.16	0.04	0.20	0.08	0.38	0.20	0.08
Trans-β-Ocimene	0.15	0.03	0.99	0.30	1.00	0.15	0.19	0.20	0.36
Terpinolene	0.38	0.37	1.24	0.61	0.24	1.26	1.26	1.53	1.87
5-methyl-hepta-3-one	0.10	0.25	0.83	0.15	0.29	0.44	0.19	0.46	0.58
Citronellal	0.10	0.25	0.62	0.15	0.53	0.29	0.32	0.46	0.65
Linalool	0.34	1.23	1.24	0.80	1.40	0.98	1.14	0.61	0.72
β-Caryophyllene	0.58	1.72	2.65	1.80	0.60	1.89	1.39	1.23	1.62
Citral-b (neral)	30.2	28.0	25.6	31.2	32.2	32.3	36.6	38.8	39.2
Citral-a (geranial)	66.7	66.4	63.7	63.7	62.2	58.9	56.6	56.2	52.9
Geraniol	0.29	0.31	0.21	0.11	0.53	2.18	0.38	0.05	0.29

The other main component (neral) was increased by storage period through one year in cotton bags (27.1, 32.4, 34.2 and 34.7%), respectively

after 3, 6, 9 and 12 months, keeping in cotton bags by shade drying and (36.5, 36.9, 38.2 and 40.2%), respectively in plastic bags. These results obtained by oven and sun drying. Bhattacharya *et al*. (1998) observed that the compositions of freshly distilled and 1 year stored cymbopogon flexuosus essential oils were compared. Essential oil quality deteriorated with storage. The freshly distilled essential oil contained higher concentrations of neral (33.2%) and geranial 53.1%). Brandares *et al*. (1987) determined the effect of temperature, light and length of storage on the quality of the lemongrass oil extracted from fresh and air dried leaves. Evaporation by exposure to sunlight was about 3 times faster at room temperature. The citral content of the oils decreased after a year of exposure under the same temperatures. The oil samples, taken monthly for 9 months, indicated a deterioration in quality with time, it was more marked following exposure to light. The rates of evaporation of oils extracted from fresh and air dried samples upon exposure to different temperatures were also determined. The most stable of the oil samples was that extracted from fresh leaves. It contained more higher-boiling constituents and had the highest aldehyde content (70.40% citral, compared with 67.32 for oils from air-dried leaves.

Torres and Ragadio (1996) studied the essential oil, hydrodisitilled from leaves of *C. citratus*. The main essential oil constituent was citral (69.39 %), geraniol, myrcene, linalool and citronellol. Also keeping the drug for longer periods help in greater oil loss and further degradation for its citral content. Therefore, it is better to prepare the oil directly after collection and gentle drying (especially in shade)

Table 6: GLC of lemongrass leaves oil dried in sun and stored in cotton and plastic bags for (3, 6, 9 and 12 months).

Storage methods / Periods / Component	Oil components percentage								
	Cont.	Cotton bags				Plastic bags			
		3	6	9	12	3	6	9	12
α- and β-pinene	0.87	1.55	0.81	0.80	1.92	1.17	0.63	0.19	1.32
Myrcene	0.24	0.23	0.14	0.20	0.14	0.16	0.07	0.03	0.50
Limonene	0.54	0.93	0.03	0.10	0.11	0.16	0.14	0.21	0.19
Trans-β-Ocimene	0.24	0.04	0.34	0.04	0.21	0.04	0.07	0.07	1.99
Terpinolene	0.54	1.86	1.42	1.99	0.57	0.78	0.84	2.48	0.99
5-methyl-hepta-3-one	0.33	0.23	0.14	0.13	0.21	0.35	0.56	0.14	0.33
Citronellal	0.33	0.47	0.07	0.13	0.25	0.43	0.42	0.14	0.25
Linalool	1.36	1.55	0.47	0.70	1.28	1.24	1.11	1.65	1.65
β-Caryophyllene	2.44	2.48	1.61	1.55	1.96	1.71	1.95	2.48	3.31
Citral-b (neral)	26.9	26.4	31.1	30.5	31.3	36.0	37.6	36.3	33.5
Citral-a (geranial)	65.9	64.1	63.8	63.2	61.8	57.8	56.4	56.1	55.8
Geraniol	0.31	0.16	0.07	0.66	0.29	0.16	0.22	0.21	0.17

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تأثير طرق تجفيف وتخزين مختلفة على خواص بعض النباتات الطبية :

١- تأثير طرق تجفيف وتخزين أوراق نبات حشيشة الليمون على صفات الزيت الطيار

محمد يونس على عبد الله – حكمت يحى مسعود – هناء أحمد أبو الفتوح على

قسم الخضر والزينة ـ كلية الزراعة جامعة المنصورة.

تم إجراء البحث على أوراق نبات حشيشة الليمون فى معمل قسم البساتين بكلية الزراعة جامعة المنصورة بغرض تقييم تأثير طرق التجفيف المختلفة (الظل ـ الفرن ـ الشمس) وطرق التخزين (فى أكياس من القماش القطن والبلاستيك ١٠ x ١٠ سم) على نسبة الزيت وصفاته الطبيعية والكيميائية وتأثير مدة التخزين حيث أخذت عينات كل ثلاثة شهور لتحليلها كيميائياً وطبيعياً وقد أعطت الدراسة النتائج التالية:

- أعطت معاملة المقارنة (بداية التخزين) أعلى نسبة للزيت وأقل رقم حموضة ومعامل الانكسار حيث كانت (١,٩٩%، ٥,٨٥، ١,٣٦) على الترتيب يليها معاملة التجفيف فى الظل والتخزين فى أكياس من القطن لمدة ثلاثة شهور فكانت (١,٨٥% ، ٥,٨٧ ، ١,٣٧) على الترتيب. ارتفع رقم موضة ومعامل الإنكسار بإطالة فترة التخزين لمدة عام كامل من تخزين العقار فى أكياس من البلاستيك بطريقة التجفيف فى الفرن حيث كانت (١١,٨ ، ١,٤٨) على الترتيب.
- أعطت طريقة التجفيف فى الشمس أقل نسبة زيت طيار (٠,٤٢%) بعد تخزين العقار لمدة عام كامل فى أكياس من البلاستيك.
- كانت أعلى نسبة للمركب الرئيسى للزيت الطيار (سترال) (٦٧,٩%) فى بداية التخزين (معاملة المقارنة) فى طريقة التجفيف فى الظل يليها بعد ثلاثة شهور من التخزين فى أكياس من القماش القطن (٦٧,٧%).
- كانت أقل نسبة للمركب الرئيسى للزيت الطيار (سترال) ٥٢,٩% بعد تخزين العقار لمدة عام كامل فى أكياس من البلاستيك بطريقة التجفيف فى الفرن.

توصى الدراسة بتجفيف أوراق حشيشة الليمون فى الظل وتخزينها فى أكياس من القماش القطن لمدة لا تتجاوز ثلاثة شهور للحصول على أفضل ا