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SOME PARAMETERS AFFECTING VOLATILE OIL EXTRACTION PROCESS FROM SOME SEEDS OF MEDICAL AND AROMATIC PLANTS USING WATER DISTILLATION UNIT

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ABSTRACT

Essential oils are derived from volatile aromatic compounds found in plants by either distillation or extraction process. Steam distillation uses heat from steam or water to break the oil glands in plants and vaporize the oil which is then condensed and separated from the water. The medical and aromatic plants were some Egyptian varieties of (coriander, anise, cumin and caraway). The extractions of oil from milled investigated seeds (sound, coarse and fine) were using water distillation.

The obtained results were as follows:1) The hardness was of 11.6, 18.3, 19.6, and 51.2 N. at the moisture content of 11.1, 12.1, 12.8 and 11.6 % for coriander, anise, cumin and caraway seeds, respectively.; 2) The extraction efficiency of oil was 60, 65.3, 76.8 and 92 % for coriander, anise, cumin and caraway seeds, respectively.; 3) The extraction efficiency was 60, 65.3, 76.8, and 92 % for coarse seeds and 45, 56, 69 and 88% for fine seed, and the value of sound seeds were 40, 45.3, 53.6 and 42 % for investigated seeds for coriander, anise, cumin and caraway seeds, respectively.; 4) The extraction efficiency of oils seeds for sound/coarse ratio was 66.66, 69.39, 69.79 and 45.65%. While, the extraction efficiency of oils seeds for fine/coarse ratio was 75, 85.7, 90.63 and 95.65% for coriander, anise, cumin and caraway seeds, respectively.; 5) Percentages of extraction oils in the case of coarse seeds were in two hours as followed: (66.7 and 33.3%); (71.4 and 28.6%); (72.4 and 27.6%) and (71.7 and 28.3%); in the case fine seeds the time extraction oils was three hours as followed: (52.2, 28.9 and 18.9%); (65.5, 20.2 and 14.3%); (60.3, 22.4 and 17.2%) and (56.3, 26.7 and 17%). While, in the case sound seed was the time was four hours as follows: (50, 25, 15 and 10%); (58.5, 18.4, 13.2 and 9.6 %); (58.6, 20.7, 12.4 and 8.3%) and (47.6, 23.8, 16.7 and 11.9%) for coriander, anise, cumin and caraway seeds, respectively.; and 6)The extraction oils percentages for sound, coarse and fine seeds by using distillation unit. They were as follows: (0.08, 0.12 and 0.09%); (1.36, 1.96, and 1.68%); (2.66, 3.84 and 3.48%) and (0.84, 1.84 and 1.76%) for coriander, anise, cumin and caraway seeds, respectively.

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INTRODUCTION

Essential oil are a kind of the subtle, aromatic and volatile liquids extracted from any part of plants through distillation. Essential oil can be distilled from the flower, bark, seed, leaves or roots of plants, or from the whole plant. According to ancient Egyptian hieroglyphics and Chinese manuscripts, priests and physicians were used. Essential oil was used to heal the sick from thousands of years. They are the oldest form of medicine and cosmetic known to man and were considered more valuables than gold. They are used in the food industry as flavoring, in the cosmetic industry for fragrances and in the pharmaceutical industry for its functional properties.

Guenther (1985) mentioned that the sweet basil (*Ocimum basilicum* L.) is a popular culinary herb and a source of essential oils extracted by steam distillation from the leaves and flowering tops. The European basil oils, considered to be the highest quality, contain methyl chavicol d-linalool and to a least extent 1.8-cineole, plus many other compounds. Egyptian basil oil is similar to the European, except that the concentration of d-linalool is lower and methyl chavicol is higher

ASTA (1986) indicated that the essential oil from aromatic plants are mostly volatile and thus, lend themselves to several methods of extraction such as hydrodistillation, water and steam distillation, direct steam distillation, and solvent extraction. The specific extraction method employed is dependent upon the plant material to be distilled and the desired end product.

Brophy and Jogia (1986) said that the essential oil is volatile secondary metabolites that plants produce for their own needs other than nutrition (i.e. protectant or attractant). In general they are complex mixtures of organic compounds that give characteristic odour and favour to the plants. The essential oil composition of O. basilicum varies depending on the environment and the chemotype.

Croteau (1986) mentioned that the formation and accumulation of essential oil in plants are natural plant products which accumulate in specialized structures such as oil cells, glandular trichomes, and oil or resin ducts.

McHugh and Krukonis (1986) showed that the supercritical fluid extraction (SFE) has gained increasing attention over the traditional techniques, like steam distillation and solvent extraction, in the recovery of edible and essential oil, as the use of a non-toxic and volatile solvent, such as CO2, protects extracts from thermal degradation and solvent contamination.

Matthews and Braddock (1987) mentioned that itrus essential oils are recovered from thc peel which contain the oil sacs or glands located

irregularly in the outer mesocarp of the fruit. These glands are embedded at different depths in the flavedo, the colored, outer portion of the fruit and must be removed by first rupturing the glands by pressure or mechanical rasping. Citrus oil are recovered as cold-pressed oils or as a specific constituent such a d-limonene as by-products of the juice and beverage industry.

Simon (1990) showed that the essential oil plants and culinary herbs include a broad range of plant species that are used for their aromatic value as flavorings in foods and beverages and as fragrances in pharmaceutical and industrial products. Essential oil plants derive from aromatic plants of many genera distributed worldwide.

Gaudiel (1996) mentioned that the essential oil may be derived from plants with the following processes: 1)Hydro distillation, (water distillation), is a process in which water and plant material are boiled together in a common tube, 2) Steam distillation uses dry steam to vaporize and extract the oil. Steam distillation is used by commercial ventures seeking to process large quantities of essential oils economically. 3) Solvent extraction uses organic solvents to extract both essential oils and oleoresins which are then separated, and 4) Supercritical extraction is another form of solvent extraction in which carbon dioxide is used under extremely high pressure to extract both essential oils and oleoresins.

Cranshaw and Baxendale (1999) mentioned that the various oil have been used for centuries to control insect and mite pests. Oil remains an important tool to manage certain pest problems (e.g., scales, aphids, and mites) on fruit trees, shade trees and woody ornamental plants. Several recently, developed oil extends this usefulness to flowers, vegetables and other herbaceous plants. Oils also can control some plant diseases, such as powdery mildew. Oil used to protect plants have been called by many names, but perhaps horticultural oil describes them best.

Papamichail et al. (2000) indicated that a significant increase in extraction rate with increasing of pressure or decrease of the particle size of celery seed. A similar effect was observed with the increase of the solvent flow rate and decrease of temperature.

Se'kou et al., (2000) indicated that the essential oil were extracted from four West African plant species [Tagetes minuta (Family Compositae), Hyptis suaveolens (Family Labiatae), white basil Ocimum canum (Family Labiatae), and sweet basil O. basilicum (Family Labiatae)] by steam distillation. The oil of the pepper guineense (Family Piperaceae), was extracted from the fruits by hydro distillation and ethanol extraction.

Arafa (2001) mentioned that there is a negative relation between the essential oil quantity of aromatic plants and different temperatures. The

essential oil quantity was (0.34, 0.32, 0.3, 0.27 and 0.25 ml/100mg), (0.51, 0.48, 0.45, 0.41 and 0.32 ml/100mg), and (0.37, 0.34, 0.31, 0.29 and 0.27 ml/100mg) from plants leaves at 35, 40, 45, 50 and 60 °C, for M. Pulegium, Marjoram and peppermint, respectively. Also, he added that thei is a clear relation between the losses in the essential oil quantity of aromatic plants and different relative humidity. The losses were (0.3, 0.32, 0.33 and 0.34 ml/100mg), (0.46, 0.48, 0.49 and 0.50 ml/100mg), and (0.33, 0.35, 0.36 and 0.37 ml/100mg) from plants leaves at 25, 50, 65, and 75 °C, for M. Pulegium, Marjoram and peppermint, respectively.

The objective of the study was studying the following parameters: a) The effect of grain milled degree (sound, Coarse and fine) on essential oil extraction, and b) Some affecting parameters such as time oil extracting, percentage of extraction oil and particle size of seeds on the extraction rate.

MATERIAL AND METHODS

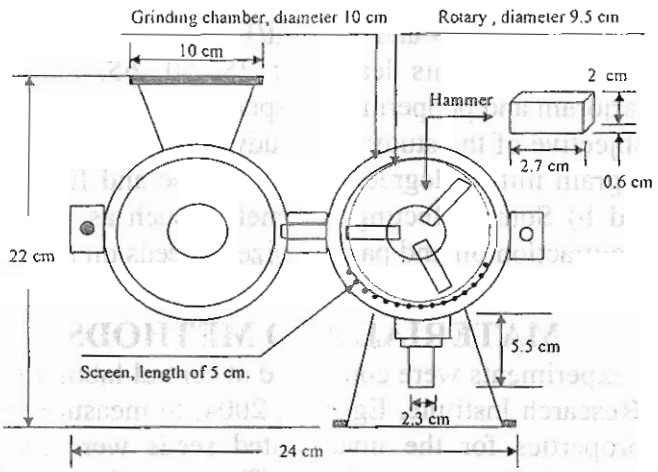
The main experiments were conducted at central laboratory, Agricultural Engineering Research Institute, Egypt in 2004, to measure the physical and mechanical properties for the investigated seeds were (coriander, anise, cumin and caraway) Egyptian varieties. The extraction of oil from milled investigated seeds (sound, coarse and fine), using water distillation unit which local fabricated by **(Arafa, 2001).**, as shown in Fig (1).

Some physical and mechanical properties of investigated seeds:

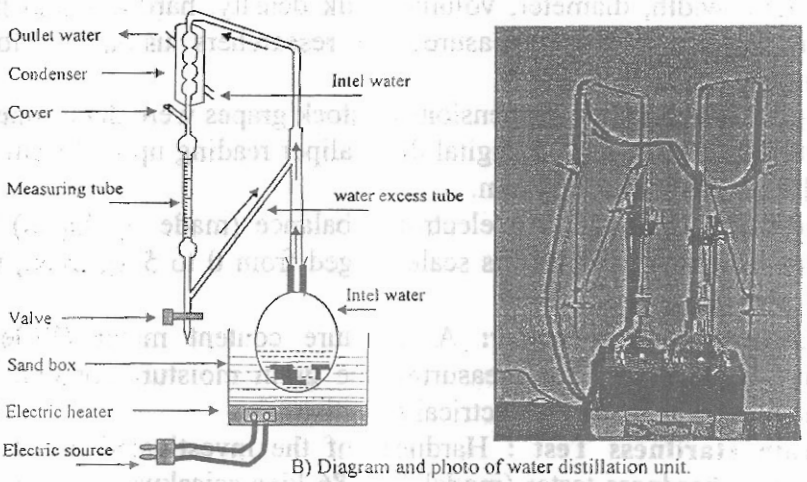
Length, width, diameter, volume, bulk density, hardness and moisture content for seeds, were measured by researchers using the following instruments:

- **Digital dial caliper:** Dimensions of stock grapes were determined to have thickness of stocks. A digital dial caliper reading up to 15 cm was used. Its accuracy was 0.05 mm.
- **Electronic balance:** An electronic balance (made by Japan) was used for weighing samples. Its scale ranged from 0 to 5 kg max., with accuracy of 0.2 g,
- **Moisture content meter:** A moisture content meter (Wile 35 Moisture Meter) used for measuring the grain moisture-content. The measurement was made by electrical sensitive.
- **Grain Hardness Test :** Hardness of the investigated seeds was tested using hardness tester (model 174886 kiya seisakusho LTD). The hardness value of each sample was recorded in kilogram and calculated as Newten.

Some physical and mechanical properties of the investigated seeds were illustrated in Table (1). The plant material was purchased at Giza local



A) Diagram of hammer mill.



B) Diagram and photo of water distillation unit.

Fig. (1) : Laboratory hammer mill and water distillation unit.

markets in Egypt. The investigated seeds are some of the most important plants, they belong to family umbilliferae.

Table (1): Some physical and mechanical properties of investigated seeds.

Investigated seeds	Dimension, mm	Shape	Colour	Hardness, N	M.C., %	Weight of 1000 grains, g	Bulk density, g/cm^3
Coriander	2–3 diam.	Spherically	Green brown	11.6	11.1	20	0.216
Anise	2-3 diam. 3-4 length	Oval	Greenlly gray	18.3	12.1	4	0.332
Cumin	2-3 diam. 4-6 length	Oval	Light brown	19.60	12.8	9	0.332
Caraway seed	1-3 width 4-7 length	Hard pen	Smooth brown	51.2	11.6	12	0.412

Plants material: Annually total cultivated area of medical and aromatic plants about 500,000 fed./year **(Agricultural Statistics Economic Affairs Sector, 2001).** Investigation seeds of medical and aromatic plants were Egyptian, P.anisum, Egyptian, and C.carvi varities for coriander, anise, cumin and caraway, respectively.

Laboratory hammer mill: Specifications of hammer mill were as follows: type of swinging beaters hammer mill, overall length is 450 mm, width is 150 mm, height 220 mm, grinding chamber diameter is 95 mm, rotor diameter is 88 mm, rotor speed is 5000 rpm, hammer tip speed is 23.04 m/see, hammer length is 30 mm, power source is electrie motor with power 0.2 kW. As shown in Fig (2).

Preparation of milled grain: The grain was milled by hammer mill to get two types of milled grain, one of them coarse and the second fine. The hammer mill was crushed in boiling distilled water and then homogenized. It was altered through a 53 mm mesh sieve, a piece of 45 mm nee steel gauze.

Distillation procedure: The essential oil for four species of plants were extracted by water distillation unit, which called hydro distillation, where water and plant material are boiled together in a common flask. Distillation separates chemicals by the difference in how easily they vaporize. During water distillation, samples were weighed and extracted gradually to reach the maximum yield of essential oil for each species.

Distillation unit: Water distillation unit was experimented in this study, which is locally fabricated by researchers. It consists of as the followed:

1) **Heater**, it has 3 kW power, local manufacturing rectangular shape 15X25 cm, thermal stone and nickel chrome with diameter 1 mm. It has aluminum stand.
2) **Sandbox**, it was heated by using electric heater. Which was fabricated with 2 mm thickness wool of layer galvanize 15X35X10 cm dimensions full of fine sand with two glass flask each of one litter for each flask as capacity.

3) **The glass apparatus**, it consists of the flask put in about 100 ml of water. The steam of water and oil raising up and pass through steams' tube till in arrives to the condenser and changes into liquid case, descend to measure tube which was filed with water before the beginning of work, then the oil float on the surface of the water, the excess water return through to the flask passing through steam's tube, an hour later after the flame was put out, the valve was opened to send out the excess water till the floating oil descend in the measuring tube.

Efficiency of distillation, the efficiency of distillation was calculated by using equation (1). While, Bume degree of oil, which was calculated as the density by using equation (2). By **(El- Shiekh, 1993).**

Efficiency of distillation = Actual quantity of oil, g/Laboratory quantity of oil, g... (1)
Bume' degree = (140/density of oil, g/cm^3) – 130 ---------- (2)

RESULTS AND DISCUSSIONS

The results for essential oil of the four investigated species extracted by water distillation unit were reported as follow:

Table 1 shows that some physical and mechanical properties of the investigated seeds of aromatic and medical plants were measured to describe milled operation. It was noticed that the hardness was of 11.6, 18.3, 19.6, and 51.2 N at the moisture content of 11.1, 12.1, 12.8 and 11.6 % for coriander, anise, cumin and caraway seeds, respectively. Also, the data in the table indicated that the weight of 1000 grains was 20, 4, 9 and 12 g while the density of investigated seeds was 0.216, 0.332, 0.332 and 0.412 g/cm^3 for coriander, anise, cumin and caraway seeds, respectively.

Fig. 2 shows the efficiency and losses of extraction oils for the different investigated seeds. It was noticed that the increases the extraction efficiency of oils, the extraction losses of oils was decreased. Where, the extraction efficiency of oil were 60, 65.3, 76.8 and 92 % for coriander, anise, cumin and caraway seeds, respectively.

Table (2) and Fig. (3) show oil the extraction efficiency for sound, coarse and fine investigated seeds. It was noticed that the extraction efficiency of oils for coarse seeds was more than in fine or sound seed, the extraction efficiency was 60, 65.3, 76.8, and 92 % for coarse seeds and 45, 56, 69 and 88% for fine seed. While, it was lowest values of sound seeds of 40, 45.3, 53.6 and 42 % for investigated seeds for coriander, anise, cumin

and caraway seeds, respectively. That means that increase in surface of seeds was followed by increase in extraction oil percentage.

Table (2) and Fig (4) show the efficiency of extracted oil for investigated seeds of aromatic and medical plant in cases of the sound/coarse and fine/coarse ratios. The extraction efficiency of oil seeds for sound/coarse ratio was 66.66, 69.39, 69.79 and 45.65% while, for fine/coarse ratio was 75, 85.7, 90.63 and 95.65% for coriander, anise, cumin and caraway seeds, respectively. Because of steam power was decreased inside cells of seed, that's lead to difficult extract of oils from materials.

Table (2): Extraction oil efficiency for different milled grains.

Type of Seed	Extraction oil efficiency for different milled grains, %					
	Sound grains		Coarse milled grains		Fine milled grains	
	Extracted, %	Efficiency, %	Extracted, %	Efficiency , %	Extracted, %	Efficiency, %
Coriander	0.08	40.00	0.12	60.00	0.09	45.0
Anise	1.36	45.33	1.96	65.33	1.68	56.0
Cumin	2.68	53.60	3.84	76.80	3.48	69.6
Caraway	0.84	42.00	1.84	92.00	1.76	88.0

	Extraction oil efficiency and ratio for different milled grains with coarse milled oil percentage.				
Type of	Extraction oil percentage, %			Extraction oil ratio, %	Extraction oil ratio, %
Seed	Coarse	Sound	Fine	Sound/ coarse	Fine/ coarse
Coriander	0.12	0.08	0.09	66.66	75
Anise	1.96	1.36	1.68	69.39	85.71
Cumin	3.84	2.68	3.48	69.79	90.63
Caraway	1.84	0.84	1.76	45.65	95.65

Table (2) and Fig. (5) show that the time losses of extraction was less in the case of sound/coarse which was about 50% than in the case of the fine/coarse which was about 33.3 %. That means that the time of extraction oil from coarse seed decreased with 50% of sound /coarse in all investigated seeds. Also, the time extraction of oil was decreased in the case of coarse seed with 33.3 % on fine seed for all investigated seeds.

Table (3) and Fig. (6) indicated that the densities of oil as a Bume' degree for extracted oil from investigated seeds of aromatic and medical plants were calculated. It was noticed that the Bume degree was of 30, 12.1, 18.8 and 23.3 Be' for coriander, anise, cumin and caraway seeds, respectively.

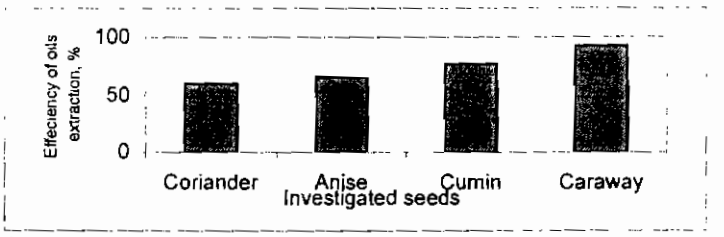


Fig. (2) : Efficency of extration oil for different investigated seed.

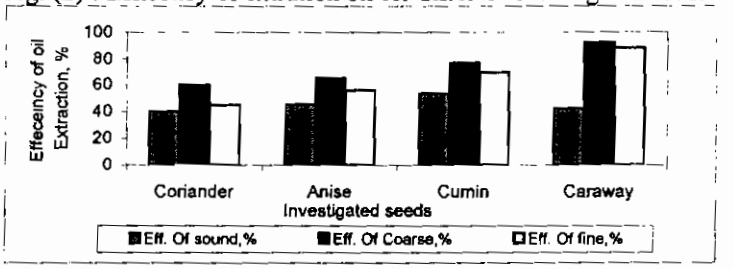


Fig. (3) : Extraction of oil effeciency for investegated aromatic and medical seeds.

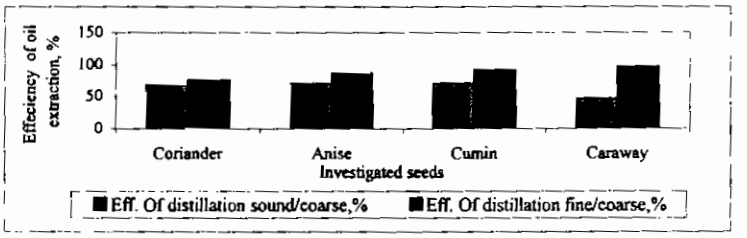


Fig.(4) : Extraction of oil effeciency for investegated aromatic and medical seeds at sound/coarse and fine/coarse.

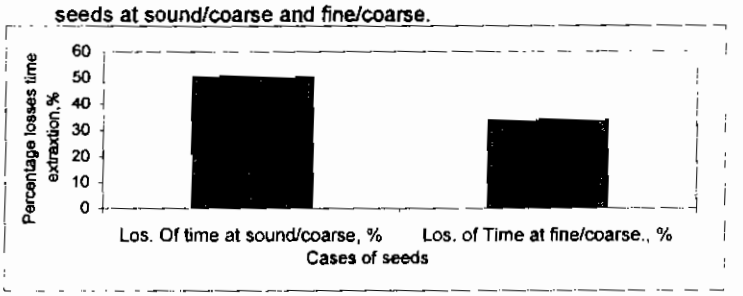


Fig. (5): Losses time extraction related to case of seeds for investegated seeds.

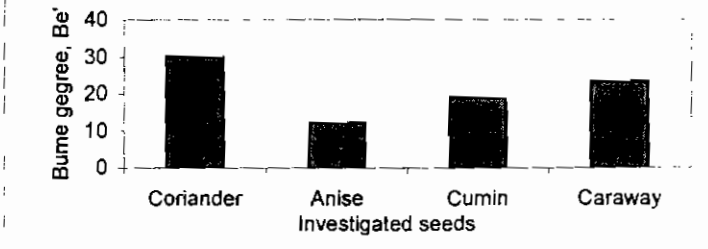


Fig.(6): Bume degree as dendsity of oils

Table (3): Extracted oil percentage every hour and its percentage of extracted total oil.

Type of seeds		Percentage of oil extracted every hour, %				Total extracted oil	Oil extraction in h1,% for total extraction			
Name	Milled type	h1	h2	h3	h4	%	h1,%	h2,%	h3,%	h4,%
Coriander	Sound	0.04	0.02	0.012	0.008	**0.08**	50.0	25.0	15.0	10
	Coarse	0.08	0.04	0	0	**0.12**	66.7	33.3	0.0	0
	Fine	0.047	0.026	0.017	0	**0.09**	52.2	28.9	18.9	0
Anise	Sound	0.8	0.25	0.18	0.13	**1.36**	58.8	18.4	13.2	9.6
	Coarse	1.4	0.56	0	0	**1.96**	71.4	28.6	0.0	0
	Fine	1.1	0.34	0.24	0	**1.68**	65.5	20.2	14.3	0
Cumin	Sound	1.56	0.55	0.33	0.22	**2.66**	58.6	20.7	12.4	8.3
	Coarse	2.78	1.06	0	0	**3.84**	72.4	27.6	0.0	0
	Fine	2.1	0.78	0.6	0	**3.48**	60.3	22.4	17.2	0
Caraway	Sound	0.4	0.2	0.14	0.1	**0.84**	47.6	23.8	16.7	11.9
	Coarse	1.32	0.52	0	0	**1.84**	71.7	28.3	0.0	0
	Fine	0.99	0.47	0.3	0	**1.76**	56.3	26.7	17.0	0

Table (3) and Fig. (7) indicated that the extraction oil percentages through extraction period for investigated seeds at different cases of seeds (sound, coarse and fine of milled seeds). Generally, percentages of extracted oil in the case of coarse seeds were the lowest time of about two hours it was followed with (66.7 and 33.3%); (71.4 and 28.6%); (72.4 and 27.6%) and 71.7 and 28.3%) for first and second hours for coriander, anise, cumin and caraway seeds, respectively. While, in the case of the fine seeds the time extracting oil was three hours. The first and second and third hours were as follow: (52.2, 28.9 and 18.9%); (65.5, 20.2 and 14.3%); (60.3, 22.4 and 17.2%) and (56.3, 26.7 and 17%) for coriander, anise, cumin and caraway seeds, respectively. But, the percentage of extracted oil in the case of the sound seed, it was largest time (about four hours). First, second, third, and fourth hour were as follows: (50, 25, 15 and 10%): (58.5, 18.4, 13.2 and 9.6 %); (58.6, 20.7, 12.4 and 8.3%); (47.6, 23.8, 16.7 and 11.9%) for coriander, anise, cumin and caraway seeds, respectively. The proper percentage of extracting oil was in coarse seeds because it has high percentage of extracting oil in the lowest time, which is about two hours.

Table (2) and Fig. (8) shows that the extraction oil percentages from investigated seeds at different cases such as sound, coarse and fine seeds is made by using distillation unit. They were as follows: (0.08, 0.12, 0.09%); (1.36, 1.96, and 1.68%); (2.66, 3.84 and 3.48%) and (0.84, 1.84 and 1.76%) for coriander, anise, cumin and caraway seeds, respectively. So, the proper

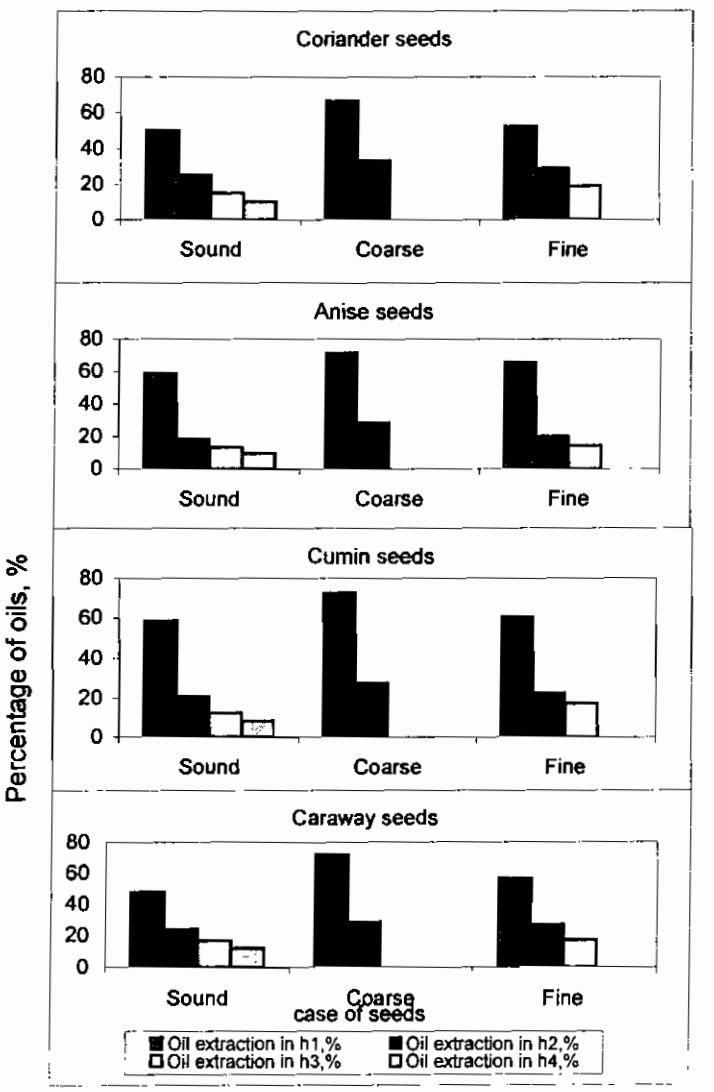


Fig. (7): Percentages of extraction oil at different milled seed through water distillation period for investegated seeds

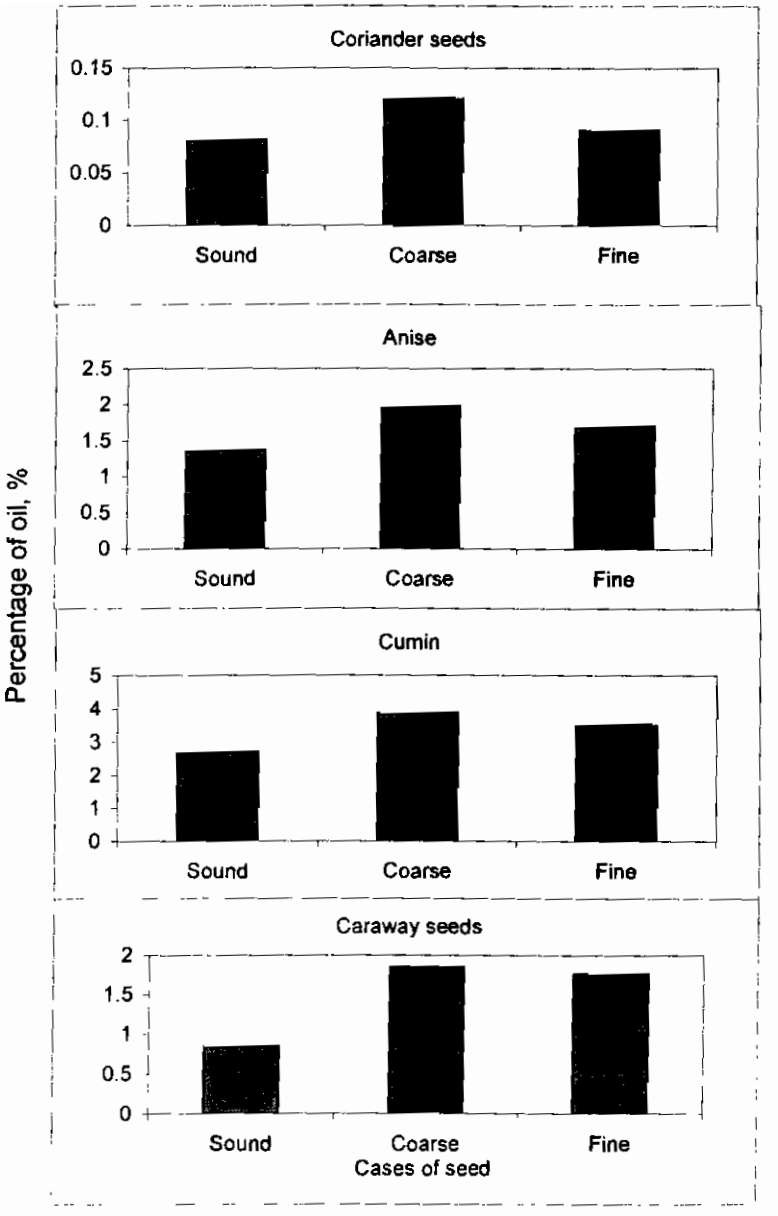


Fig. (8): Percentages of extraction oils at different cases of milled seed for investigated seeds.

case of seeds was coarse seeds because it has the highest oil percentage extraction than in the case of fine or sound seeds for investigated seeds.

CONCLUSION

Summary of results was as follows for water distillation of investigated seeds (Coriander, Anise, Cumin and Caraway seeds) by using water distillation unit:

1) The largest hardness of seeds was in caraway seeds of 51.2 N, while it was lowest in coriander seeds of 11.6 and it ranged from 12.1 and 12.8 N. for anise and cumin, respectively.

2) The increases in the extraction efficiency of oil, decreased the extraction losses of oils.

3) The extraction efficiency of oil for coarse seeds was more than fine or sound seed. It was the lowest value for sound seeds..

4) Time of extracting oil from coarse seed decreased with 50% of sound /coarse. While, it decreased in the case of the coarse seeds with 33.3 % of sound/fine for all investigated seeds.

5) The density of oils as a Bume' degree for extracted oil from investigated seeds were 30, 12.1, 18.8 and 23.3 °Be' for coriander, anise, cumin and caraway seeds, respectively.

6) Generally, percentages of extracted oil in the case of coarse seeds were the lowest time (about two hours), and in the case of fine seed the time of extracting oil was three hours. While, in the case of sound seeds, it was largest time (about four hours).

7) The proper percentage of extracting oil was in coarse seeds because it has of high percentage of extraction oil in the lowest time oil extraction (about two hours). So, the proper case of seeds was coarse seeds because it has the highest extraction of oil percentage than in the case of fine or sound seeds for investigated seeds.

8) Using distillation unit made coarse and fine seeds the extracting oil percentages for sound. They were as follows: (0.08, 0.12 and 0.09%); (1.36, 1.96, and 1.68%); (2.66, 3.84 and 3.48) and (0.84, 1.84 and 1.76%) for coriander, anise, cumin and caraway seeds, respectively.

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بعض العوامل المؤثرة على عملية إستخلاص الزيوت الطيارة من بعض بذور النباتات الطبية والعطرية باستخدام وحدة التقطير المائى

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ترجع أهمية الزيوت المستخلصة من النباتات الطبية والعطرية للأهمية العظمى التى يستفاد بها ، حيث يستفيد منها النبات نفسة بيولوجيا من حيث المساعدة فى جذب الحشرات الى ازهارها لزيادة عملية التلقيح الخلطى بها وتعمل كمواد طبيعية طاردة أو قاتلة للأفات الفطرية والبكتيرية المسببة للأمراض ، كما تعمل كمادة لاحمة للأنسجة المجروحة فى النباتات نتيجة للعوامل الميكانيكية والطبيعية.. كما تستخدم الزيوت الطيارة المستخلصة فى صناعة العطور ومستحضرات التجميل وفى تصنيع المنتجات الزراعية والحيوانية والحلويات والصابون والمنظفات وكمواد مكسبة للطعم والرائحة.. كما تستخدم أيضا كمادة طاردة للحشرات وقاتله لها كمبيد حشرى خام. وتستخلص الزيوت من النباتات أو أحد اعضائها كالعشب الطازج او الجاف او الأزهار او الأوراق أو السوق أو البذور أو الثمار وذلك طبقا لأماكن تخزين الزيت.

فى هذه الدراسة تم استخدام أربعة أصناف من بذور نباتات الكزبرة والينسون والكمون والكراوية والتى تخزن الزيت فى القنوات أو الأنابيب الزيتية داخل هذه البذور.

والهدف من البحث هو دراسة تأثير بعض العوامل على عملية استخلاص الزيوت من بذور بعض النباتات الطبية والعطرية.. تمت دراسة بعض الخصائص الطبيعية والميكانيكية للبذور بالمعمل المركزى بمعهد بحوث الهندسة الزراعية ، واجريت تجارب استخلاص الزيت من بذور هذه النباتات موسم 2004 باستخدام وحدة تقطير مصنعة محليا بواسطة (عرفه ، 2001) ، مكونة من : سخان كهربائى ، خزان لغلى البذور والماء ، وانابيب استقبال البخار ، ومكثف للعمل على تبريد البخار وتكثيفه ، ودورق استقبال المتكثف من ماء وزيت.. وتعتمد عملية استخلاص الزيوت على أساس : خروج الزيت الطيار من أماكن تجمعه وتراكيبه الأفرازيه داخل الأنسجة النباتية على هيئة غازية أو بخارية محمولا مع البخار المائى ثم مروره على وحدات التكثيف متحولا الى خليط سائلى متكون من الزيت والماء.. حيث يتم استخدام طريقة التقطير المائى فى استخلاص الزيوت.. وكانت النتائج المتحصل عليها للبذور المستخدمة فى الدراسة وهى (الكزبرة والينسون والكمون والكراوية) كانت كالتالى :

1) درجة صلابة الحبوب كانت 11.6 ، 18.3، 19.6 ، 51.2 نيوتن عند محتوى رطوبى 11.1 ، 12.1، 12.8، 11.6% لبذور الكزبرة والينسون والكمون والكراوية على التوالى ، بهدف توصيف عملية الطحن.

2) كانت أعلى كفاءة استخلاص الزيت من البذور المجروشة حوالى 60، 65.3، 76.8، 92% وللبذور المطحونة 45، 56، 69، 88% بينما كانت أقل كفاءة للبذور السليمة 40، 45.3، 53.6، 42% على التوالى لبذور الكزبرة والينسون والكمون والكراوية على التوالى.

3) كفاءة الأستخلاص البذور السليمة/المجروشة كانت حوالى 66.66، 69.39، 45.65،69.79 % بينما كانت كفاءة الأستخلاص البذور المطحونة/المجروشة حوالى 75، 85.7، 90.63 ، 95.65.2% للبذور المختارة على التوالى.

4) يختلف زمن استخلاص الزيوت من البذور حسب حالة البذور ففى حالة البذور المجروشة كان زمن الأستخلاص حوالى ساعتين (الأولى والثانية) ، وفى البذور المطحونة حوالى ثلاث ساعتين (الأولى ، والثانية ، الثالثة) ، بينما كان فى البذور السليمة حوالى اربعة ساعات. للأصناف المختارة على التوالى.

5) يزيد زمن استخلاص الزيوت بحوالى 50% فى حالة الإستخلاص من بذور السليمة /المجروشة بينما تزيد النسبة بحوالى 33.3% فى حالة الإستخلاص من البذور المطحونة/المجروشة.

6) نسبة الأستخلاص للبذور السليمة والمجروشة والمطحونة كانت كالتالى (0.08، 0.12، 0.09%) ، (1.36 ، 1.96، 1.68%) ، (2.66، 3.84، 3.48%) ، (0.84، 1.84، 1.76%) للبذور المختارة على التوالى.. وبالتالى كانت أعلى نسبة أستخلاص فى حالة البذور المجروشة لجميع البذور المختارة.

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