POST-HARVEST STUDIES ON GARLIC *ALLIUM SATIVUM* L. II. CHEMICAL COMPOSITION OF GARLIC OIL

SHADIA KOTB

Horticulatural Research Institute, Agricultural Research Centre , Giza, Egypt.

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Abstract

Experimental work was carried out at Medicinal and Aromatic plant Section, Dokki Egypt. The effect of different kinds of containers named jute and plastic nets with 2m mesh and storage period were studied, during 1988 and 1989. Samples were taken monthly to determine volatile oil of the garlic and gas liquid chromatography of the extracted oil was carried out every two months.

Results show that the essential oil percentage increased from the beginning of storage till the fifth month and then decreased. Storage period had a clear effect on the chemical composition of extracted garlic oil. Some components increased such as dimethyl thiophene, 2 proponyl -2 propane thiosulphonate allyl., dipropyl trisulphide, methyl propyl trisulphide, thiophene and diallyl disulphide, Also some components disappeared after 4 months from the storage such as methyl thiophene, allyl thiophene and dimethyl thiophene. Diallyl trisulphide decreased after 2 months.

Types of containers had a great effect on the chemical components of garlic oil either as to their appearance or disappearance, increase or decrease.

INTRODUCTION

Garlic is considered as one of the major vegetables for local consumption and exportation. It is essentially used as species and condiment. Sulphur compounds in garlic oil have recommended a lot of attention because of their potential and flavour

properties (Stoll and Seebeck 1950).

Beside its uses in culinary purpose it is also used for the medecinal purpose as, regularly as dietary supplement, helps to maintain physical activity and fitness, prevents premature senility, improved blood circulation and is of value for hypertensive patient and for those with higher lipid and chloesterol blood levels. With regard to the essential oil percentage, Geunther (1952), Stoll and Seebeck (1950) and Mokhtar (1987) mentioned that the distillation of fresh garlic bulbs produced up to 0.2% of volatile oil. Essential oil is very sensitive and is affected by many factors, such as packing and duration. No much literature was found dealing with garlic volatile oil however, Geunther (1961) mentioned that any loss of oil during storage of air dried plant material depended upon several factors, condition of material, method of storing and the chemical composition of the oil.

Fehr (1980) on fennel and carawy also round that oil of anise fruit decreased during the storage period by the rate of 1% per month, however in carawy fruits the rate was 2.8% per month and in fennel samples ranged from 0.01-0.53% per month. On garlic, Ramadan (1973) stated that the volatile oil content of the bulbs decreased during storage.

Also the constituents of garlic volatile oil have been affected by many factors that is why in the literature large variation was noticed, Vernin *et al.* (1986) analysed oil of garlic and found that the major constituent were diallyl disulphide (29.5-50.5%), diallyl trisulphide (30.1-42%) allyl methyl trisulphide (4.2-14.4%), diallyl sulphide (1.6-10.4%) and allyl methyl disulphide (0.6-7.4%). Recently, Habashy (1988) found that G.L.C. analysis of fresh garlic volatile oil contained methyl trisulphide, 0.13%, dipropyl trisulphide 3.03%, 2 proponyl -2 propane thiosulphonate 18.61%, diallyl sulphide 0.370%, methyl allyl disulphide 0.13%, diallyl disulphide 12.1%, thiophene 0.3% methyl thiophene 0.07%, dimethyl thiophene 19.1%, trimethyl thiophene 20%, allyl thiophene 0.170% and diallyl thiophne 24.05%.

This work aimed to study the effect of packing and storage period on the essential oil and the chemical constituents of the extracted oil of *Allium sativum* (garlic).

MATERIALS AND METHODS

This work has been conducted in the Aromatic and Medicinal plant section, Agriculture Research Centre, Dokki, Egypt. Cured drug garlic was obtained from Seds Research Station, Beni-Suef Governorate in July (1988). The experiment was carried out to study the effect of type containers named jute and plastic nets with 2 mm meshes on the oil percent and its constituents and the treatments were as follows:

1. Bulbs with vegetative growth stored in jute containers.
2. Bulbs without vegetative growth stored in jute containers.
3. Bulbs with vegetative growth stored in plastic containers.
4. Bulbs without vegetable growth stored in plastic containers.

Storage period has been studied which began from July 1988 till April 1989. Volatile oil percent was recorded monthly during the storage period while G.L.C. analysis of extracted oil was done every two months.

These samples were stored at room temperature, the temperature and humidity were recorded daily during the experiments.

The volatile oil percentage was determined by steam distillation according to the method described in the British Pharmacopeia (1963). G.L.C. analysis of the extracted oil was recorded by Nair and Banlli (1969).

The statistical analysis of the data was performed according to Snedecor (1956).

RESULTS AND DISCUSSION

Effect of type of containers and storage period on the essential oil:

Date in Table 1 indicate that the essential oil percentage of fresh garlic bulbs in all treatments gradually increased from the beginning of the experiment in July

till September, then a highly increase took place in November. Thereafter, oil percentage showed a noticeable decrease in December. Starting in January a gradual decrease was detected till the end of the experiment in April, where the least oil percentage was recorded.

It could be stated that in most cases differences in the percentage of volatile oil due to storage period were significant. Generally, the oil percentage of intact bulbs was higher in most period studied than those topped when stored wither in jute or plastic containers. While in most periods, the least oil percentage was detected when the whole plants were stored in containers. In most cases, differences were significant. These records were in agreement with those mentioned by Guenther (1952), who demonstrated that the oil percentage resulting from distillation of fresh garlic bulbs ranged from 0.1 to 0.2%.

The interaction between the data and the different treatments was significant and the best treatment was the intact bulb treatment stored in plastic with 2 mm

Table 1. Effect of container types on oil percentage (fresh weight) of garlic bulbs during storage.

Month	Jute container		plastic container		Mean
	Intact	Topped	Intact	Topped	
Jul.	0.130	0.103	0.150	0.120	0.126
Aug.	0.180	0.150	0.180	0.170	0.170
Sept.	0.187	0.150	0.200	0.183	0.180
Octo.	0.166	0.127	0.173	0.193	0.165
Nov.	0.233	0.213	0.217	0.183	0.211
Dec.	0.193	0.187	0.213	0.207	0.200
Jan.	0.167	0.163	0.203	0.203	0.154
Feb.	0.140	0.100	0.180	0.160	0.145
Mar.	0.137	0.083	0.163	0.127	0.128
Apr.	0.097	0.063	0.103	0.073	0.084
Mean	0.240	0.134	0.178	0.162	

L.S.D. for dates 5% : 0.028 , %1 : 0.036
L.S.D. T 5% : 0.053 , %1 : 0.66

mesh.

Effect of storage period on the components of volatile oil:

Gas liquid chromatography has been utilized extensively in the studies of the volatile components of garlic oil extracted from fresh cloves by many investigators (Bladrate *et al.* 1970, Brodnity *et al.* 1971, Vernin *et al.* 1986 and Habashy 1988).

The gas liquid chromatography determination of this oil at the beginning of the experiment is shown in Fig. 1 and the identified compounds of this oil are shown in Table 2.

They were diallyl trisulphide (77.4%) as the major component and another minor components were identified. After two months, it could be noticed that some components increased such as, dimethyl thiophene by (695.3%), 2- proponyl 2-Propane thiosulphonate by (568.8%) methyl propyl trisulphide by (1630.8%) thiophene by (383.3%), diallyl disulphide by (834%) and methyl allyl disulphide by (565.7%), while dipropyl trisulphide and diallyl trisulphide decreased by (30.6%) and (33.3%) respectively. Data in the same table also indicated that methyl dithiophene, trimethyl thiophene and allyl thiophene appeared.

Table 2. The effect of storage period on the chemical composition of garlic oil by gas liquid chromatographic analysis.

Componenets %	Storage Months				
	Jul.	Sept.	Nov.	Jan.	Mar.
Diallyl trisulphide	77.40	51.6	51.54	0.0	19.2
Dimethyl thiophene	8.60	68.4	72.65	0.0	0.0
2-Proponyl-2-Propane thiosulphonate allyl	5.90	39.46	50.53	116.46	17.4
Dipropyl trisulphide	0.98	0.68	11.94	10.88	19.33
Methyl propyl trisulphide	0.78	13.5	5.3	24.57	34.24
Thiophene	0.78	3.77	14.82	6.6	13.0
Diallyl disulphide	0.35	3.27	1.36	11.51	34.74
Methyl allyl disulphide	0.35	2.33	2.03	0.0	26.84
Methyl dithiophene	0.0	4.95	0.0	0.0	0.0
Trimethyl thiophene	0.0	74.72	0.0	0.0	0.0
Allyl thiophene	0.0	6.87	0.0	0.0	0.0

2. Methyl propyl trisulphide
3. Dipropyl trisulphide
6. 2-proponyl-2-propane thiosulphonate allyl
7. Diallyl disulphide
8. Methyl allyl disulphide
9. Diallyl trisulphide
10. Thiophene
11. Methyl dithiophene
16. Dimethyl thiophene
17. Trimethyl thiophene
18. Allyl thiophene.

1,4,5,12,13,14,15,19,20,22,23,24,25 unknown.

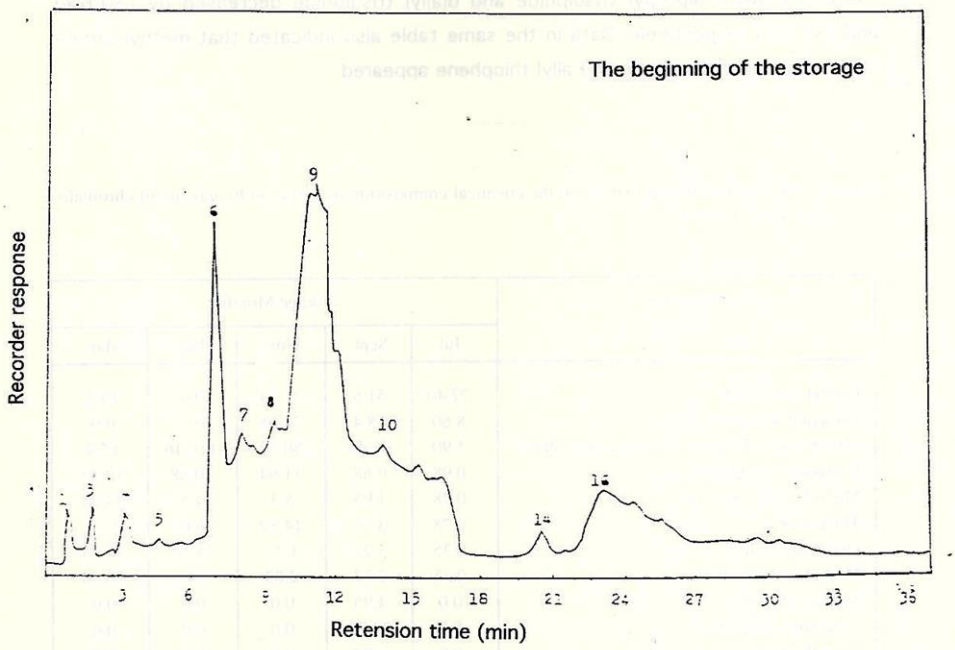

Fig. 1. Chromatogram of garlic oil at the beginning of the storage.

After four months from storage, a considerable increase took place in the main components compared with 2 months storage such as, dimethyl thiophene by (6.3%), 2-proponyl 2-propane thiosulphonate allyl by (28.5%), dipropyl trisulphide by (1655.8%) thiophene by (293.1%), where methyl propyl trisulphide, diallyl. disulphide and methyl allyl disulphide by (60.74%), (58.4%) and (12.78%) respectively.

Data in the same table indicated that there was a great increase was recorded in the main components after six months storage such as, 2 proponyl -2 propane thiosulphonate allyl, methyl propyl trisulphide and diallyl disulphide by (130.4%), (363.6%) and (746.3%) respectively. While dipropyl trisulphide and thiophene decreased by (8.9%) and (55.5%) respectively, and dimethyl thiophene disappeared.

Regarding garlic oil components after eight months storage, there was a sharp decrease was recorded in 2-proponyl-2-propane thiosulphonate allyl by 85.1%, where as dipropyl trisulphide, methyl propyl trisulphide, thiophene and diallyl disulphide increased by (77.7%), (39.4%), (97%) and (462.5%) respectively than the values before.

It could be concluded that some components which were identified after 2 months storage in September disappeared in the following months such as methyl dithiophene, into trimethyl thiophene and allyl thiophene. It might be due to that these components changed into another components.

Effect of container types on the constituents of garlic oil:

From the results shown in Table 3 and Fig. 2, there were 24 components identified on September i.e. the second month from storage. The highest values of the compound trimethyl thiophene (30.63%) and allyl thiophene were obtained from topped bulbs stored in plastic containers 2-proponyl-2 propan thiosulphonate allyl 15.78% and diallyl trisulphide (17.81%) were obtained with highest value from intact cloves in plastic container. The highest values of methyl dithiophene (3.4%) and dimethyl thiophene (26.79%), were obtained from a bulbs in jute container.

The identified components by gas liquid chromatography were the same as those obtained by Habashy (1988) in garlic. Data in Table 4 and Fig. 3 reveal that after four months from the storage some components disappeared and reached 16 components, such as methyl dithiophene, trimethyl thiophene and allyl thiophene.

The components methyl propyl trisulphide (2.10%), thiophene (7.96%) and

Table 3. Effect of container types on the chemical composition of garlic oil after two months storage from the beginning of the experiment.

No. of Peaks	Components %	Jute containers		Plastic containers	
		Intact	Topped	Intact	Topped
1	Unknown	2.8	5.11	1.62	1.76
2	Methyl propyl trisulphide	2.6	5.45	2.10	3.36
3	Dipropyl trisulphide	0.0	0.00	0.08	0.00
4	Unknown	6.2	5.75	2.60	8.06
5	Unknown	0.47	1.09	4.90	1.45
6	2-Proponyl-2-propane thio-sulphonate allyl	9.8	8.73	15.78	15.13
7	Diallyl disulphide	1.99	0.89	0.18	0.21
8	Methyl allyl disulphide	1.55	1.48	0.14	0.16
9	Diallyl trisulphide	6.70	14.59	17.81	12.51
10	Thiophene	1.40	0.29	2.08	0.00
11	Methyl dithiophene	0.62	3.47	0.33	0.53
12	Unknown	1.40	6.05	5.18	1.41
13	Unknown	3.1	0.99	0.18	0.85
14	Unknown	1.63	0.24	10.32	2.45
15	Unknown	0.00	5.70	0.00	0.00
16	Digethyl thiophene	16.8	26.79	19.45	5.28
17	Trimethyl thiophene	29.3	0.44	14.38	30.63
18	Allyl thiophene	2.40	1.40	0.00	2.99
19	Unknwon	0.26	1.78	0.07	0.16
20	Unknown	7.04	0.94	0.02	8.67
21	Unknown	1.48	0.74	0.00	0.00
22	Unknown	0.62	1.88	0.00	0.00
23	Unknown	1.97	0.00	0.30	2.61
24	Unknown	0.57	0.00	0.00	0.48
25	Unknown	0.00	0.00	0.00	1.28

2. Methyl propyl trisulphide
3. Dipropyl trisulphide
6. 2-proponyl-2-propane thiosulphonate allyl
7. Diallyl disulphide
8. Methyl allyl disulphide
9. Diallyl trisulphide
10. Thiophene
11. Methyl dithiophene
16. Dimethyl thiophene
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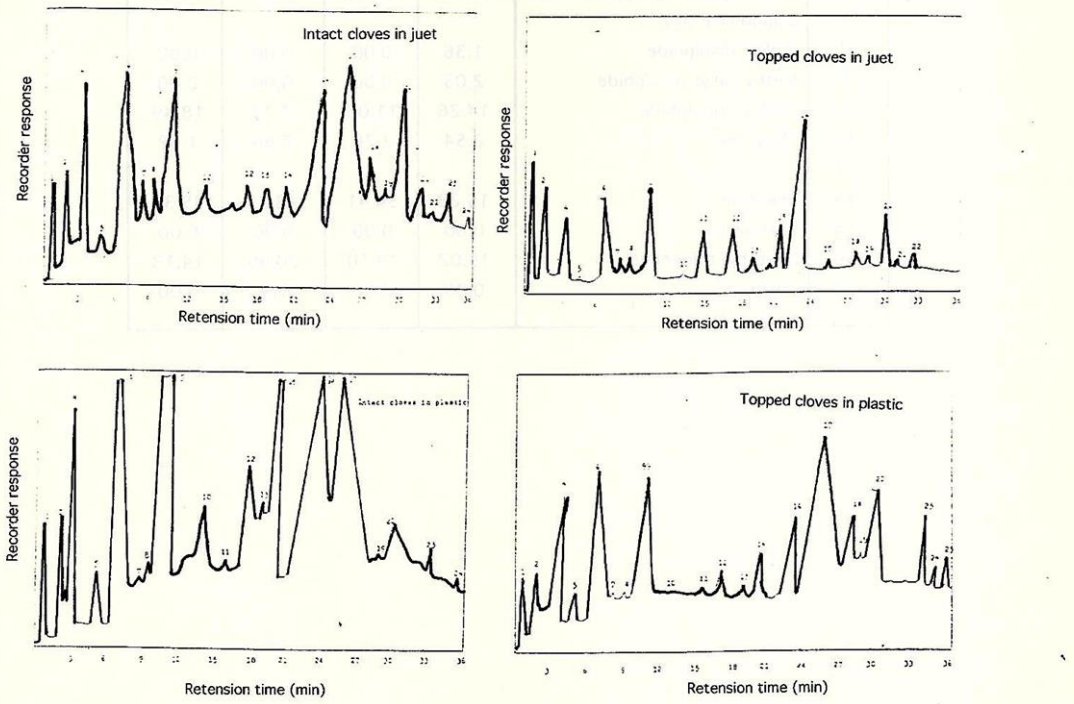

Fig. 2. Chromatogram of garlic oil after 2 months from the storage.

Table 4. Effect of types of containers on the chemical composition of garlic oil after four months from the beginning of the experiment.

No. of Peaks	Components %	Jute containers		Plastic containers	
		Intact	Topped	Intact	Topped
1	Unknown	6.79	4.43	0.39	5.23
2	Methyl propyl trisulphide	0.67	1.66	2.10	0.87
3	Dipropyl trisulphide	7.31	3.87	0.88	2.88
4	Unknown	10.18	7.38	2.21	4.90
5	Unknown	3.39	0.00	0.99	1.62
6	2-Proponyl-2-propane thio-sulphonate allyl	17.32	15.98	2.32	14.89
7	Diallyl disulphide	1.36	0.00	0.00	0.00
8	Methyl allyl disulphide	2.03	0.00	0.00	0.00
9	Diallyl trisulphide	14.26	11.06	7.73	18.49
10	Thiophene	2.54	2.70	7.96	1.62
11					
14	Unknown	15.28	34.41	48.23	35.33
15	Unknown	0.00	0.00	0.00	0.00
16	Dimethyl thiophene	19.02	18.50	20.99	14.13
20	Unknwon	0.00	0.00	619.	0.00

2. Methyl propyl trisulphide
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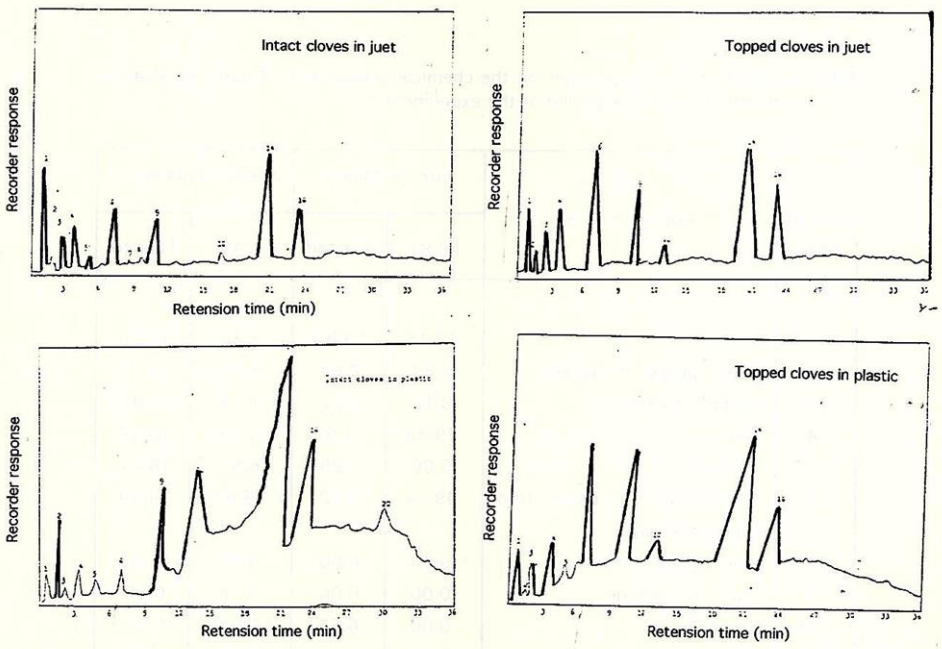

Fig. 3. Chromatogram of garlic oil after 4 months from the storage.

dimethyl thiophene (20.99%) were the highest values from the extracted oil from intact bulbs in plastic container.

While dipropyl trisulphide (7.31%) 2-propane 2 propan thiosulphonate allyl (17.32%) and methyl allyl disulphide were the highest value from intact bulbs in jute. Data also indicated that thiophene (7.96%) was the highest value from intact bulbs in plastic containers.

In January (after six months) data in Table 5 and Fig. 4 showed that the identified components were methyl propyl trisulphide, dipropyl trisulphide, 2 propyl 2-propane thiosulphonate allyl diallyl disulphide, diallyl trisulphide and thiopheneie. A sharp decrease happened in the number of the components appeared and which were identified before. The component 2- proponyl 2- propane thiosulphonate allyl (49.54%) was the highest value from the extracted oil from intact in jute.

In case of bulbs which were stored in plastic containers, methyl propyl trisul-

Table 5. Effect of containers types on the chemical composition of garlic oil after six months from the beginning of the experiment.

No. of Peaks	Components %	Jute containers		Plastic containers	
		Intact	Topped	Intact	Topped
1	Unknown	16.15	19.87	3.42	30.22
2	Methyl propyl trisulphide	1.83	4.64	2.99	15.11
3	Dipropyl trisulphide	3.12	6.62	1.14	0.00
4	Unknown	29.36	11.92	32.76	10.07
5	Unknown	0.00	1.99	6.55	18.71
6	2-Proponyl-2-propane thiosulphonate allyl	49.54	6.62	46.43	14.39
7	Diallyl disulphide	0.00	0.00	0.00	11.51
9	Diallyl trisulphide	0.00	0.00	5.56	0.00
10	Thiophene	0.00	6.62	6.62	0.00
14	Unknown	0.00	41.72	0.00	0.00

2. Methyl propyl trisulphide
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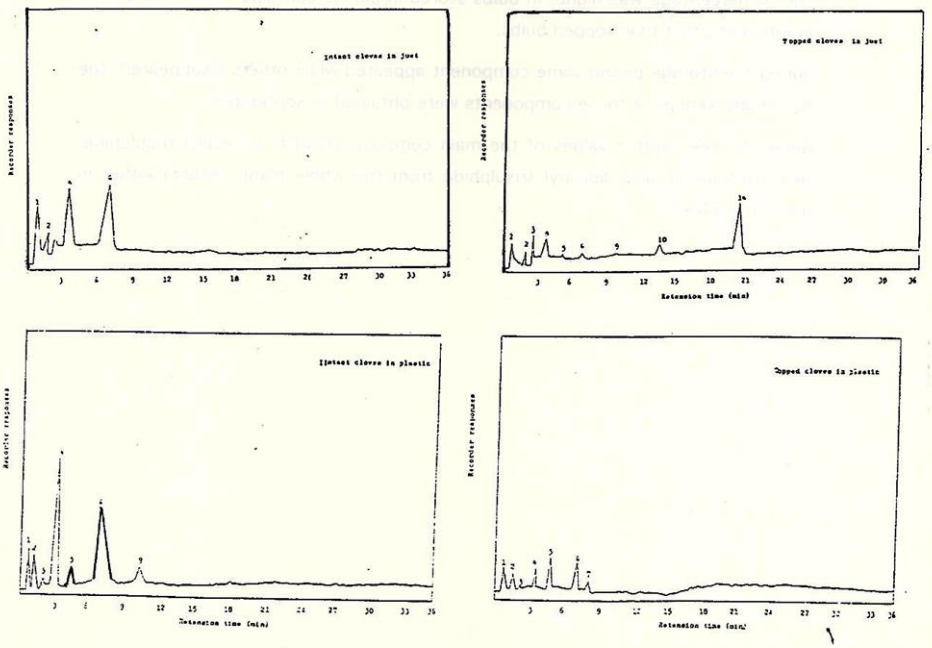

Fig. 4. Chromatogram of garlic oil after 6 months storage.

phide (15.11%) was the highest value, also the highest value of diallyl trisulphide (5.56%) was obtained from the extracted oil in intact bulbs stored in plastic.

Data in Table 6 and Fig. 5 showed that in March (after 8 months) the highest values of the main components were obtained from the extracted oil from intact stored in jute container, these components were, methyl propyl trisulphide (14.26%) dipropyl trisulphide (9.07%), 2-propyl 2 propane thiosulphonate allyl and diallyl trisulphide (11.34%).

Diallyl disulphide (25.96%) and thiophene (5.19%) were the highest values from bulbs stored in plastic.

These results were in agreement with those of Song *et al.* (1982) who mentioned that allyl sulphide content decreased from (2.87%) just prior to storage to (2.41-2.55%).

The main conclusion could be summarized as follows:

1. The oil percentage was higher in bulbs stored in plastic container than that stored in jute and intact than topped bulbs.
2. During the storage period some component appeared while others disappeared, the maximum number of these components were obtained in September.
3. Generally, the highest values of the main components such as, diallyl trisulphide, diallyl disulphide and dipropyl trisulphide from the whole plant (intact) either in jute or in plastic.

Table 6. Effect of container types on the chemical composition of garlic oil after eight months storage from the beginning of the experiment.

No. of Peaks	Components %	Jute containers		Plastic containers	
		Intact	Topped	Intact	Topped
1	Unknown	1.45	40.4	33.72	30.87
2	Methyl propyl trisulphide	14.26	10.5	4.52	4.92
3	Dipropyl trisulphide	9.07	4.4	3.44	2.19
4	Unknown	23.98	2.8	1.87	12.02
5	Unknown	24.03	0.00	19.58	10.38
6	2-Propyl-2-propane thiosul-phonate allyl	10.37	0.00	4.30	2.73
7	Diallyl disulphide	4.86	8.80	25.18	25.96
8	Methyl diallyll disulphide	0.00	21.10	0.00	5.74
9	Diallyl trisulphide	11.34	7.90	0.00	0.00
10	Thiophene	0.00	5.30	2.51	5.19
11	Methyl dithiophene				
12	Unknown	0.00	0.00	1.08	0.00
19	Unknown	0.00	0.00	2.87	0.00
20	Unknown	0.00	0.00	0.86	0.00

2. Methyl propyl trisulphide
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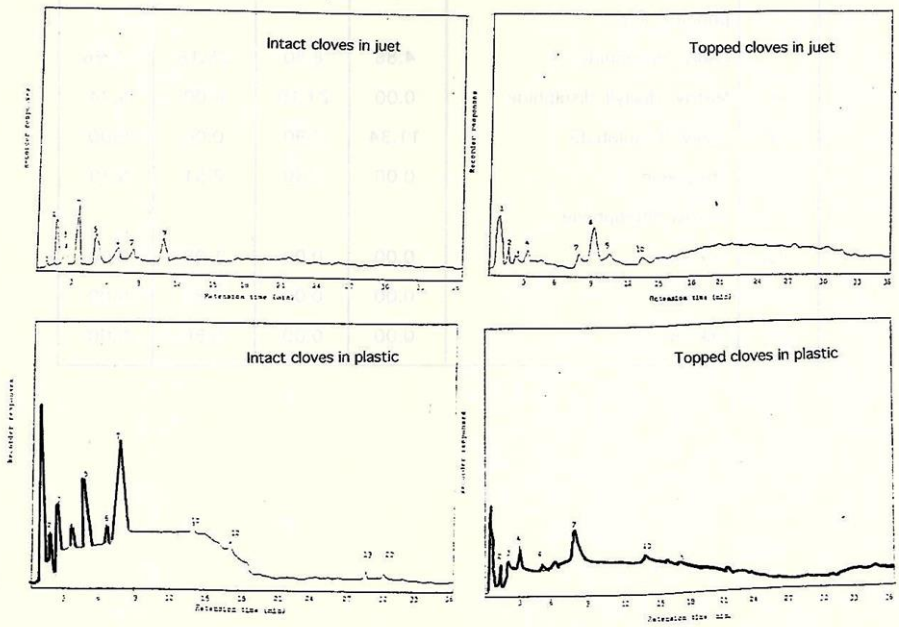

Fig. 5. Chromatogram of garlic oil after 8 months storage.

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معاملات مابعد الحصاد لنبات الثوم:
٢- التركيب الكيماوى لزيت الثوم

شادية قطب احمد

معهد بحوث البساتين - مركز البحوث الزراعية - الجيزة

أجرى هذا البحث فى قسم بحوث النباتات الطبية والعطرية لدراسة تأثير نوع العبوات المختلفة وفترات التخزين على التركيب الكيماوى لزيت الثوم عام ١٩٨٨ ، ١٩٨٩ .

وكان من أهم نتائج البحث ما يلى:

١ - وجد أن نسبة الزيت تتزايد من بداية التخزين حتى الشهر الخامس ثم بعد ذلك تناقصت.

٢ - وجد أن لفترة التخزين تأثير على مستخلص الزيت الطيار من رؤوس الثوم .. بعض المكونات حدث لها زيادة مثل باى مثيل ثيوفين ، ٢ بريونيل - ٢ برويين فيرسلفونات اليل ، باى بروبيل تراى بروبيل - مثيل بروبيل تراى سلفيد - ثيوفين - داى اليل داى سلفيد.

بعض المكونات اختفت بعد اربعة أشهر من التخزين مثل مثيل ثيوفين ، اليل ثيوفين ، داى مثيل ثيوفين.

كما وجد ايضا ان المركب داى اليل تراى سلفيد وهو من المكونات الاساسية لزيت الثوم حدث له نقص بعد شهرين من التخزين.

٣ - وجد ايضا بالبحث ان نوع العبوة له تأثير واضح على التركيب الكيماوى للزيت من ناحية الزيادة او النقص او الاختفاء او الظهور.