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EFFECT OF DRY YEAST AND WHEY APPLICATIONS ON HERB GROWTH AND ESSENTIAL OIL YIELD OF ROSEMARY

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ABSTRACT

A 3 x 3 factorial experiment was conducted during two successive growing seasons 2011 and 2012 at the Expt. Farm, Medicinal and Aromatic Plants, Fac. of Pharmacy, Cairo Univ. to evaluate to what extant active dry yeast, whey and their interaction treatments affect growth and volatile oil production of rosemary plant. The 3 tested activated dry yeast levels (0, 4, and 8 g yeast/ liter) were foliar sprayed; while the 3 tested levels of whey (0, 10, and 20 cm^3/ L.) were soil drenched. Each of yeast and whey were applied monthly tell the experiment ended.

Generally, plant growth expressed as: plant height, branches number/ plant and fresh and dry weights/ plant were significantly increased under the effect of active dry yeast or whey applications, each alone. Gradual increases in the abovementioned parameters were recorded as the tested levels of yeast or whey were increased up to the highest level of each. This was confirmed during the two cuts. Also, yeast or whey applications increased herb yield/ fad and oil % and oil yield/ plant and/ fad.

More enhancements were noticed when spraying active dry yeast interacted with whey soil drenching. The highest stimulate effects on growth and essential oil production were, generally, recorded when the highest yeast level (8 g/ L) interacted with the highest whey level (20 cm^3/ L).

For the main components of produced volatile oil, most interaction treatments between yeast and whey levels increased 1- 8 cineol %. While, spraying yeast at 8 g/ L alone or interacted with 10 or 20 cm^3 whey/ L increased Linalool %. Camphor % was increased only under the effect of 8 g yeast/ L + 10 or 20 cm^3 whey/ L interaction treatment.

Key words: Dry yeast, herb growth, *essential* oil yield, rosemary.

INTRODUCTION

Rosemary (*Rosmarinus officinalis* L.) is a perennial herb plant belongs to family *Lamiaceae*, it is known for its volatile oil which is used for treating headaches, abdominal colic, inhibiting carcinogens and tumors, anti-inflammatory activities and muscle contraction as well as, improving the circulation and strengthening the fragile blood vessels (Chen and Ho, 1992).

Whey is a liquid portion of milk that separates from the curd during cheese manufacture. It is used as an additive in many processed foods, including breads, crackers and commercial pastry. In addition, whey is used as an animal feed (Kosikowski, 1979). Whey contains about 17% of the total protein in milk. It is comprised of four major protein fractions and six minor protein fractions. However, it contains 59% beta-lactoglobuling, 13% alpha lactoglobuling, 6% bovine serum albumin and 12 immunoglobulins (Tong *et al* 2000). Whey protein is a complete protein, it contains all of the cellular responses seem to be greatly enhanced with its supplementation. It also, plays a role as an antioxidant (Tong *et al.*, 2000). It also, contains lactose (4.5- 4.9%) vitamins { as microgram B_1(0.37- 0.45), B_2 (1.8- 2.5), B_6 (1.2- 1.5), C (4.7), B_{12} (2.2- 2.9), A (0.02- 0.04), E (0.20- 0.29), K (0.04) and H (0.01)} and minerals (0.52-0.60% as ash which consists of Ca, P, Na, K, Mg and Cl in addition some trace elements as: Fe, Cu, Co and I) along with traces of fat (0.02- 0.40%) (Leveille and Cloutier, 1987).

Whey can improve plant growth and the physical properties of soils (Lehrsch and Robbins, 1996). Since, Ahmed and Abdel Wahid (2007) on *Calendula officinalis* L. plant indicated that application of whey as soil drench increased vegetative growth and herb content of β carotene as well as N and P percentages. Additionally, spread whey in varying amounts on fallow and sod soil planted with corn and hay improved plant growth and soil structure (Kenneth *et al*., 1977). Also, Sharratt *et al*. (1959) found that whey applications increased corn yield and benefited the soil physical status.

Active dry yeast is a natural safety bio-fertilizer causes various promotive effects on plants. Yeast has been reported to be an enriched source for cytokinines, vitamins, enzymes, amino acids and minerals (Khedr and Farid, 2002). It was also reported about its stimulatory effects on cell division and enlargement, and synthesis of vitamin B, proteins, nucleic acids and chlorophyll (Castelfrance and Beale, 1983). It also releases Co_2 which improves net photosynthesis in illuminated plants (Kurtzman, and Fell, 2005). Heikal, (2005) reported that foliar spraying of active dry yeast increased growth and essential oil yield of thyme plant. Also, sprayed roselle plants with dry yeast at rate of 2g /L. yielded significant increases in calyxes comparing to untreated control plants (Ahmed *et al*., (1998).

However, such research was conducted aiming to evaluate to what extant active dry yeast as foliar spraying, whey as soil drenching and their interaction treatments affect growth and volatile oil production of rosemary plant.

MATERIALS AND METHODS

The present investigation was carried out during the two successive seasons of 2011 and 2012 at the Experimental Farm of Pharmacy College, Cairo University, Egypt to study effect of active dry yeast (zero, 4, and 8 g/ L) as foliar spraying and adding whey (zero, 10, and 20 cm^3/ L) as soil drench each alone or in combinations on rosemary herb growth and volatile oil production as well as its components of.

On March 1st during the two tested seasons, well rooted uniform rosemary (*Rosmarinus officinalis* L.) terminal cuttings (10 cm length and 0.5 to 0.7 mm thickness) were planted on rows in experimental plots (2 X 2.5 m). Each experimental plot contained three rows, and rooted cuttings were planted on rows in 30 cm apart (24 plant /plot). Then, plants were overhead irrigated three times / week during the next two weeks to protect them from drought and enhance growth. Physical and chemical properties of the experimental soil are shown in Table 1.

Table 1. Physical and chemical analysis of the experimental soil

Course sand (%)	**Fine sand (%)**	**Silt (%)**	**Clay (%)**	**Texture**	**O.M (%)**	**$CaCO_3$ (%)**
2.25	61.93	8.32	27.50	Sand clay loam	0.62	3.20

pH (1:2:5)	**EC (dS/m)**	**Cations (meq/L)**				**Anions (meq/L)**		
		Ca^{++}	**Mg^{++}**	**Na^{+}**	**K^{+}**	**HCO^{-}_3**	**Cl^{-}**	**SO^{--}_4**
7.78	3.14	5.40	6.52	18.10	1.38	4.85	10.63	15.92

Available macronutrients (mg kg^{-1})			**Available micronutrients (mg kg^{-1})**		
N	**P**	**K**	**Fe**	**Mn**	**Zn**
41.58	7.29	195	2.85	4.97	0.83

For yeast applications, the commercial active dry yeast was activated at the tested levels (0, 4, and 8 g activated yeast/ liter) for 48 hours in 20% sucrose solution just before applications. Plants were monthly foliar sprayed with the prepared activated yeast according to the designed levels. Control plants (zero activated yeast level) were sprayed with 20% sucrose solution. Plants were foliar sprayed using hand-held sprayer to achieve through coverage of the leaves and stems. Each plot was received 1200 cm^3 yeast solution (average 50 cm^3/ plant).

Of whey treatments, whey was supplied from Dairy Department, Faculty of Agric., Cairo University, Egypt. Whey analysis (according to same Dairy Department) was: 93-94% water, 6-6.5% dry matter, 4.5 - 5% lactose, 0.8-1% total protean, o.1citric acid, o.5-o.7 minerals, sodium (ml/L) 260, Potassium (ml/L) 1300, calcium (m/L) 291, fat % .2, total proteins 0.53 and PH 6.2-6.4. Whey was prepared, using tape water, at three tested rates of zero, 10, and 20 cm^3/L. Whey applications were carried out as monthly soil drench, and each plot was received 1200 cm^3 whey (average 50 cm^3/plant) according to design treatments.

There were 7 days interval between whey soil drenching and yeast spraying throughout the monthly yeast and whey applications.

The experimental layout was as a factorial experiment between the 3 activated yeast levels and the 3 whey levels in a complete randomized block design including nine interactions treatments with three replicates.

All treatments were received cattle manure at rate of 30 kg/*fad* during soil preparation, beside N, P and K at the recommend dose for rosemary plant (400, 300 and 100 kg/ *fad*, respectively). Ammonium sulphate (20.5% N) was used as a source of nitrogen, calcium superphosphate (15.5% P2O5) as a source of phosphorus, and potassium sulphate (48% K2O) as a source of potassium. Phosphorus fertilizer was added during soil preparation, while nitrogen and potassium fertilizers were added as two equal doses during the growing season. The first N and K dose was done at one month after rooted cuttings sowing and the second one was at 2 days after the first cut. Additionally, all agriculture practices were done when ever needed through the experimental period.

Recorded date:

In both experimental seasons, herb was twice harvested per season (first and second cuts) on August 5th and November 28th. The following data were recorded in the two cuts**:**

Vegetative growth: It was recorded as: plant height (cm), number of branches /plant, herb fresh and dry weights/ plant (g) and herb dry weight yield/ *fad* (ton).

Essential oil:Essential oil percentage was determined using the method of the British Pharmacopoeia (1963), then, essential oil yield/ plant (g) and /fad. (kg) were calculated. In addition, volatile oil components and their percentages were chromatographically analyzed (GC) in oil samples of the second cut in the second tested season only.

Statistical analysis

The collected data of the two cuts during the two tested seasons were statistically analyzed according to Steel and Torrie (1980). Mean separation was done using least significant difference test at 5% level (LSD 0.5).

RESULTS AND DISCUSSION

Effect of active dry yeast spraying, whey soil drenching and their interaction treatments on vegetative growth:

1- Plant height (cm):

Data presented in Table (2) showed that, rosemary plant height was significantly affected by monthly foliar spraying of active dry yeast and by whey as monthly soil drenching. Plant height was gradually increased as concentration of yeast and/ or whey increased. The tallest plants were those applied with the highest active dry yeast dose (8 g/ L) combined with the highest whey dose (20 cm^3/L).

Table 2. Effect of spraying active dry yeast, whey as soil drench and their interactions on rosemary plant height (cm) during 2011 and 2012 seasons**.**

Treatments	Whey cm^3 /L. (W)							
Dry yeast g/L. (Y)	0	10	20	Means	0	10	20	Means
	First cut				Second cut			
				First season				
0	55.3	61.00	62.00	**59.44**	47.67	54.00	56.33	**52.56**
4	57.33	64.67	68.67	**68.67**	50.67	59.67	62.67	**57.67**
8	59.33	73.67	83.67	**83.67**	52.67	65.00	71.00	**62.89**
Mean	**57.33**	**66.45**	**71.44**	-	**50.34**	**59.56**	**63.22**	-
L.S.D at 0.05	W=3.62 Y=5.11			WxY=7.12		W= 3.41 Y= 4.20		
				Second season				
0	52.00	57.67	59.33	**56.33**	43.00	49.67	51.67	**48.11**
4	54.33	61.67	63.33	**59.78**	45.33	54.00	59.67	**53.00**
8	56.33	71.67	74.33	**67.44**	47.67	62.67	66.67	**59.00**
Mean	**54.22**	**63.67**	**65.66**	-	**45.33**	**55.45**	**59.34**	-
L.S.D at 0.05	W = 3.05 Y = 4.433			Y×W = 6.030		W= 2.36	Y= 3.174	

2-Number of branches /plant:

Data in Table (3) cleared that active dry yeast and whey treatments significantly increased number of branches/ plants in the two cuts compared to untreated control plants. The highest branches number/ plant was recorded in plants received 8 g/ L active dry yeast combined with whey at 20 cm^3/ L. This was confirmed during the two tested seasons. Obtained results are in accordance with those reported by El-Tohamy *et al.* (2008), and Ghoname *et al*. (2010).

3-Herb fresh and dry weights /plant (g):

Results presented in Tables (4 & 5) showed effect of treatments of active dry yeast and whey on herb fresh and dry weights of rosemary plant. The data illustrated that herb fresh and dry weights were significantly

Table 3. Effect of spraying active dry yeast, whey as soil drench and their interactions on number of branches/ rosemary plant during 2011 and 2012 seasons.

Treatments	Whey cm3 /L. (W)							
Dry yeast g/L. (Y)	0	10	20	Means	0	10	20	Means
	First cut				Second cut			
				First season				
0	9.67	16.00	16.33	**14.00**	11.00	18.33	19.00	**16.11**
4	12.33	17.67	18.33	**16.11**	14.67	20.67	22.00	**19.11**
8	14.00	19.67	21.33	**18.33**	16.67	23.33	26.00	**22.00**
Mean	**12.00**	**17.78**	**18.66**	-	**14.11**	**20.78**	**22.33**	-
L.S.D at 0.05	W=1.81	Y=2.40	WxY=3.13		W=2.52	Y=3.46	WxY=4.07	
				Second season				
0	8.67	14.33	16.00	**13.00**	10.33	15.67	17.33	**14.44**
4	10.67	17.33	18.33	**15.44**	12.00	19.00	20.33	**17.11**
8	12.67	19.67	20.33	**17.56**	13.67	21.00	24.00	**19.56**
Mean	**19.67**	**17.11**	**18.22**	-	**12.00**	**18.56**	**20.55**	-
L.S.D at 0.05	W=134	Y= 2.03	Y×W = 2.77		W=2.01	Y= 2.21	WxY= 3.56	

Table 4. Effect of spraying active dry yeast, whey as soil drench and their interactions on herb fresh weight/ rosemary plant (g) during 2011 and 2012 seasons.

Treatments	Whey cm3 /L. (W)							
Dry yeast g/L. (Y)	0	10	20	Means	0	10	20	Means
	First cut				Second cut			
				First season				
0	114.67	141.00	144.00	**133.22**	121.00	157.00	161.33	**146.44**
4	126.00	149.67	157.00	**144.22**	136.33	171.33	184.00	**163.89**
8	132.33	166.33	188.33	**162.33**	151.00	190.67	203.33	**181.67**
Mean	**124.33**	**152.33**	**163.11**	-	**136.11**	**173.00**	**182.89**	-
L.S.D at 0.05	W=9.62	Y= 1.25	Y×W=14.25		W=12.43	Y=13.51	WxY=16.63	
				Second season				
0	110.67	133.33	138.33	**127.44**	118.00	138.33	145.00	**133.78**
4	118.33	141.67	145.00	**135.00**	126.00	148.33	160.00	**144.78**
8	123.67	163.33	177.00	**154.67**	134.67	168.33	199.00	**167.33**
Mean	**117.56**	**146.11**	**153.44**	-	**126.22**	**151.66**	**168.00**	-
L.S.D at 0.05	W=7.42	Y= 9.85	Y×W=11.31		W=9.	Y=9.64	WxY=12.46	

increased by increasing the tested concentration of dry yeast and whey. This result is agreed with Ahmed and Abdel Wahid (2007).

As for interaction effects, the highest values of fresh and dry weights were recorded in plants treated with 8 g /L active dry yeast and 20 cm^3 /L whey. On the other hand, the lowest values were recorded in control plants. These results were recorded in two cuts during two seasons. These results are in agreement with those reported by Heikal, (2005).

Table 5: Effect of spraying active dry yeast, whey as soil drench and their interactions on herb dry weight/ rosemary plant (g) during 2012 and 2013 seasons.

Treatments	Whey cm3 /L. (W)							
Dry yeast g/L. (Y)	0	10	20	Means	0	10	20	Means
	First cut				Second cut			
				First season				
0	47.53	63.70	65.43	**58.89**	53.00	80.43	82.33	**71.92**
4	57.83	76.93	80.83	**71.86**	65.70	89.90	98.27	**84.62**
8	62.53	88.74	113.38	**88.22**	74.17	100.00	144.43	**106.20**
Mean	**55.96**	**76.46**	**86.55**	-	**64.29**	**90.11**	**108.34**	-
L.S.D at 0.05	W=3.12	Y=5.14	WxY=8 .14		W= 4.87	Y= 7.44	WxY= 10.05	
				Second season				
0	58.96	69.77	76.10	**68.28**	64.60	78.80	82.52	**75.31**
4	63.83	85.33	82.50	**77.22**	68.63	90.18	96.48	**85.09**
8	68.46	94.40	98.40	**87.09**	75.73	100.43	114.11	**98.77**
Mean	**63.75**	**82.22**	**86.61**	-	**69.65**	**89.82**	**79.70**	-
L.S.D at 0.05	W=2.45	Y=4.68	W×Y=6.72		W=3.33	Y=6.15	WxY=8.31	

Increases of plant growth after whey applications might be due to whey direct effect of its chemical components since, whey proteins and their essential amino acids participate in cell enlargement and cell division. In addition, both hormonal and cellular responses seem to be greatly enhanced with whey protein supplementation. It also plays a role as an antioxidant (Tong *et al.*, 2000). Also, it contains lactose, vitamins, minerals and trace elements which play important roles in enhancing plant growth (Leveille, and cloutier, 1987). Beside, whey may play indirect role in enhancing plant growth through its favorable effects on soil physical properties (Kenneth *et al*., 1977 and Lehrsch and Robbins, 1996).

As for active dry yeast effects, Fathy *et al.* (2002) stated that activated yeast considered as a natural source of cytokinins that stimulate cell division and enlargement and enhance synthesis of protein, nucleic acids and chlorophyll. Also, yeast contains sugar, protein, amino acids and vitamins (Shady, 1978). So, the improvement of vegetative growth characters in response to foliar application of active dry yeast may be attributed to its content of different nutrients, high percentages of proteins, high values of vitamins, especially "B" which may play an important role in improving growth and controlling the incidence of fungi diseases (SubbaRao, 1984). Also, yeast reduced infestation numbers of white fly and thrips on potato plants (Gomaa *et al.* 2005).

4-Herb dry weight /fad. (Ton):

The results presented in Table 6 showed that, in the two seasons, control plants recorded significantly lower values of dry herb yield/ *fad*

comparing to plants applied with any of active dry yeast levels. Moreover, raising the active dry yeast application rate caused a steady increase in dry herb weight /*fad*.

Also, data of the same Table 6 showed that whey treatments had a considerable effect on herb dry weight /*fad*. Regarding the interaction between active dry yeast and whey treatments on herb dry weight/ *fad*, it is clear that, in the two seasons, plants received most active dry yeast and whey combination treatments gave significantly higher values than untreated control plants. The highest herb dry weight /*fad* was recorded in plants supplied with 8 g/L active dry yeast and 20 cm^3/ L whey. The obtained results were observed during the two cuts in the two tested seasons. These results are in agreement with those reported by Heikal, (2005).

Table 6. Effect of spraying active dry yeast, whey as soil drench and their interactions on herb dry weight/ *Fad* (Ton) of rosemary plant during 2012 and 2013 seasons.

Treatments	**Whey cm3 /L. (W)**							
Dry yeast g/L. (Y)	**0**	**10**	**20**	**Means**	**0**	**10**	**20**	**Means**
	First cut				**Second cut**			
				First season				
0	1.141	1.570	1.940	**1.550**	1.272	1.930	1.976	**1.726**
4	1.388	1.529	1.130	**1.682**	1.577	1.110	2.358	**2.015**
8	1.501	1.847	1.362	**1.903**	1.780	1.399	2.738	**2.306**
Mean	**1.343**	**1.694**	**1.144**	**-**	**1.543**	**2.146**	**2.357**	**-**
L.S.D at 0.05	W=0.31	Y=0.63	WxY=1.04		W=0.50	Y=0.85	WxY=1.10	
				Second season				
0	1.415	1.674	1.826	**1.638**	1.551	1.891	1.980	**1.807**
4	1.532	1.980	2.048	**1.853**	1.647	2.164	2.316	**2.042**
8	1.643	2.266	2.362	**2.091**	1.818	2.410	2.738	**2.322**
Mean	**1.530**	**1.973**	**2.079**	**-**	**1.672**	**2.155**	**2.345**	**-**
L.S.D at 0.05	W=0.29	Y=0.45	W×Y=1.01		W=0.53	Y=0.72	WxY=1.08	

Effect of active dry yeast spraying, whey soil drenching and their interaction treatments on essential oil production:

1- Essential oil percentage:

Data of Table (7) show that dry yeast at 4 or 8 g/ L and whey at 10 or 20 cm^3/ L increased oil percentage and of rosemary plant compared with control treatment. In general, increasing the tested rate of yeast from 0 to 4 g / L or whey from 0 to 10 cm^3/ L showed significant increases in oil percentage. Moreover, the highest rate of yeast or whey gave the highest values of oil percentage in the two cuts during both seasons.

Table 7. Effect of spraying active dry yeast, whey as soil drench and their interactions on essential oil percentage of rosemary plant during 2012 and 2013 seasons.

Treatments	Whey cm3 /L. (W)							
Dry yeast g/L. (Y)	0	10	20	Means	0	10	20	Means
	First cut				Second cut			
				First season				
0	0.177	0.213	0.227	**0.206**	0.203	0.273	0.297	**0.258**
4	0.193	0.260	0.277	**0.243**	0.230	0.323	0.340	**0.298**
8	0.200	0.313	0.333	**0.282**	0.250	0.377	0.380	**0.336**
Mean	**0.190**	**0.262**	**0.279**	-	**0.228**	**0.324**	**0.339**	-
L.S.D at 0.05	W=0.03 Y=0.03		WxY=0.09		W=0.05 Y=0.05		WxY=0.10	
				Second season				
0	0.153	0.190	0.213	0.165	0.170	0.207	0.227	**0.201**
4	0.173	0.227	0.233	0.211	0.187	0.240	0.253	**0.227**
8	0.180	0.267	0.290	0.246	0.197	0.280	0.313	**0.263**
Mean	**0.02**	**0.03**	**0.08**	-	**0.03**	**0.05**	**0.09**	-
L.S.D at 0.05	W=2.45 Y=4.68		W×Y=6.72		W= 3.33 Y=6.15		WxY=8.31	

2- Essential oil yield /plant (g) and /fad (kg):

The main trend of tested treatments on oil yields/ plant and/ *fad* (Tables 8 & 9) were generally similar to their effect on the oil percentage. In both seasons, plants supplied with active dry yeast, whey or their combinations resulted the greatest oil yield/ plant and/ *fad* compared to control plants. The maximum mean values under study have been recorded with applying 8 g/ L of dry yeast interacted with 20 cm^3/ L of whey in both cuts during the two seasons. These results are agree with Sharratt *et al.* (1959) respecting of whey and Azza and Hendawy (2005) regarding to yeast effect.

Table 8. Effect of spraying active dry yeast, whey as soil drench and their interactions on essential oil yield/ rosemary plant (g) during 2012 and 2013 seasons.

Treatments	Whey cm3 /L. (W)							
Dry yeast	0	10	20	Means	0	10	20	Means
	First cut				Second cut			
				First season				
0	0.202	0.301	0.327	**0.277**	0.246	0.430	0.479	**0.365**
4	0.247	0.389	0.434	**0.357**	0.313	0.555	0.626	**0.498**
8	0.265	0.521	0.627	**0.471**	0.378	0.715	0.756	**0.616**
Mean	**0.238**	**0.404**	**0.463**	-	**0.312**	**0.567**	**0.620**	-
L.S.D at	W=0.06 Y=0.11		WxY=0.04		W=0.10Y=0.20		WxY= 0.16	
				Second season				
0	0.170	0.253	0.295	**0.239**	0.201	0.286	0.329	**0.272**
4	0.205	0.321	0.339	**0.288**	0.235	0.356	0.407	**0.333**
8	0.222	0.437	0.513	**0.391**	0.265	0.473	0.635	**0.458**
Mean	**0.199**	**0.337**	**0.382**	-	**0.234**	**0.372**	**0.457**	-
L.S.D at	W =0.04 Y =0.13		W×Y =0.07		W=0.05 Y= 0.14		WxY=0.81	

Table 9. Effect of spraying active dry yeast, whey as soil drench and their interactions on essential oil yield/ *fad* (Kg) of rosemary plant during 2012 and 2013 seasons.

Treatments	Whey cm3 /L. (W)							
Dry yeast g/L. (Y)	0	10	20	Means	0	10	20	Means
	First cut				Second cut			
				First season				
0	5.856	7.224	7.848	**6.976**	10.320	10.320	11.496	**9.240**
4	5.848	9.344	10.408	**8.533**	13.312	13.312	15.032	**11.955**
8	6.352	12.503	15.040	**11.298**	17.168	17.168	18.152	**14.795**
Mean	**6.019**	**9.690**	**11.099**	**-**	**7.496**	**13.600**	**14.893**	**-**
L.S.D at 0.05	W=1.75	Y=2.42	WxY=3.62		W=2.24	Y=4.31		
				Second season				
0	4.080	6.080	7.072	5.744	4.816	6.864	7.896	**6.525**
4	4.928	7.704	8.136	6.923	5.640	8.552	9.760	**7.984**
8	5.336	10.480	12.304	9.373	6.352	11.352	15.240	**10.981**
Mean	**4.781**	**8.088**	**9.171**	**-**	**5.603**	**8.923**	**10.965**	**-**
L.S.D at 0.05	W =1.62	Y =2.34	W×Y = 2.05		W= 2.45	Y= 3.24		

3- Chromatographic analysis:

Data in Table (10) and Figures (1-9) showed presence 18-23 components in essential oil samples of different treatments. However, it could be concluded that the maximum amount of 1,8 cineol component (17.1 %) was obtained from essential oil samples of plants subjected to the combination treatment between whey at 20 cm^3 / L and active dry yeast at

Table 10. The obtained components of rosemary volatile oil and their percentages as affected by active dry yeast and whey during the second harvest at 2012 season.

Peak No.	The component	The treatments								
		Control	Y+W 0+10	Y+W 0+20	Y+ W 4+0	Y+W 4+10	Y+W 4+20	Y+W 8+0	Y+W 8 +10	Y+W 8 +20
1	**α-Pinene**	14.1	10.0	15.4	14.3	13.1	15.12	14.9	12.3	9.90
2	**Camphene**	4.52	3.70	5.00	4.54	4.03	4.77	4.68	4.19	3.52
3	**β-Pinene**	3.47	3.16	3.80	3.94	3.57	4.02	3.51	3.73	3.16
4	**Limonene**	1.60	1.11	1.78	1.56	1.35	1.79	1.65	1.14	1.34
5	**1,8 Cineol**	12.9	12.9	13.6	13.7	13.6	17.1	14.0	13.9	14.1
6	**Linalool**	4.37	5.06	4.35	5.32	5.47	4.80	5.01	5.00	6.18
7	**Camphor**	18.5	18.6	18.8	16.8	17.8	17.1	17.9	18.4	19.7
8	**α- Terpineol**	13.7	16.1	14.4	13.2	14.0	11.9	14.0	14.9	16.4
9	**Borneol**	11.5	12.2	9.07	10.6	6.41	9.97	11.9	11.9	9.08
10	**Bornyl acetate**	7.36	2.11	4.96	6.84	5.15	4.34	4.18	6.16	5.65
11	**Eugenol**	0.47	5.04	1.92	0.74	0.42	0.48	0.49	0.67	0.34
12	**β- Caryophellen**	1.11	1.53	1.26	1.21	1.55	1.54	1.15	1.76	0.84
*	**Unidentified**	6.39	8.46	5.76	7.36	13.5	7.10	6.65	5.84	9.82

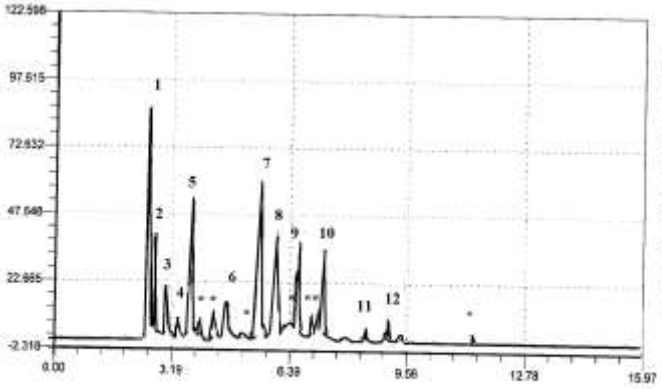

Figure (1): Chromatogram of rosemary essential oil extracted from control plants in the second cut during 2012 season

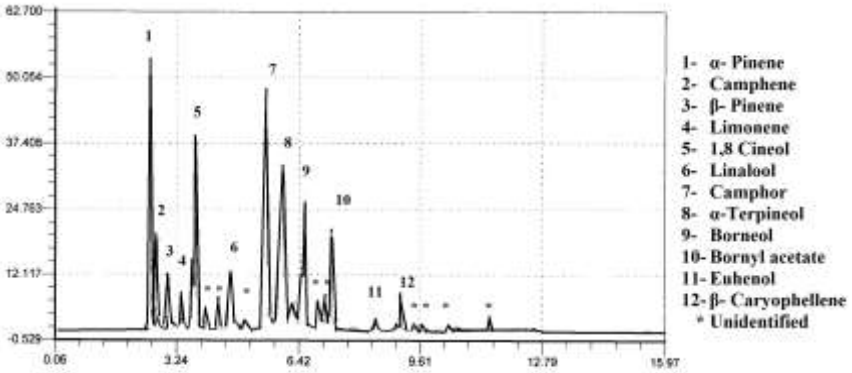

Figure (2): Chromatogram of rosemary essential oil extracted from 0Y+ 10 W treatment in the second cut during 2012 season.

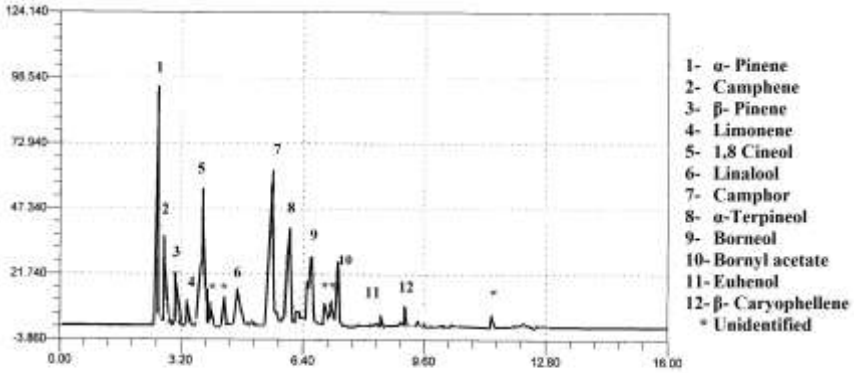

Figure (3): Chromatogram of rosemary essential oil extracted from 0 Y+ 20 W treatment in the second cut during 2012 season.

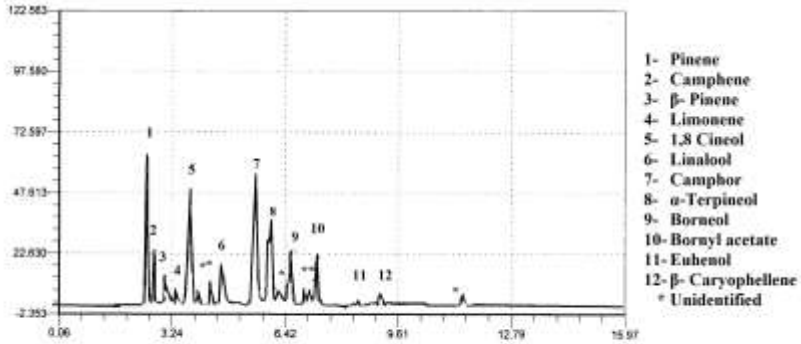

Figure (4): Chromatogram of rosemary essential oil extracted from 4 Y+ 0 W treatment in the second cut during 2012 season.

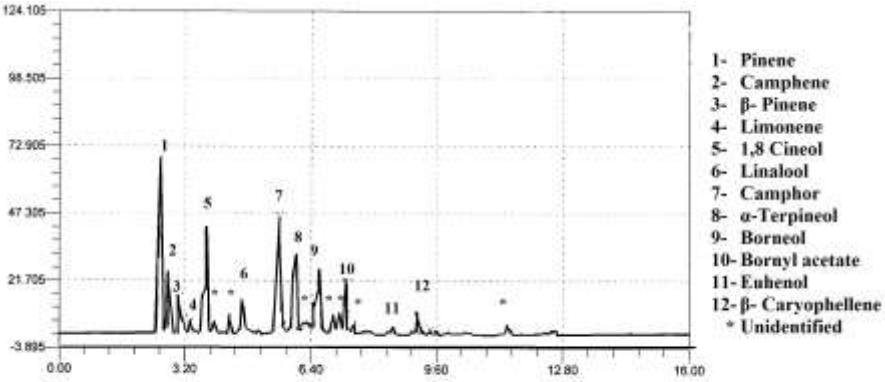

Figure (5): Chromatogram of rosemary oil extracted from 4 Y+ 10 W treatment in the second cut during the second season

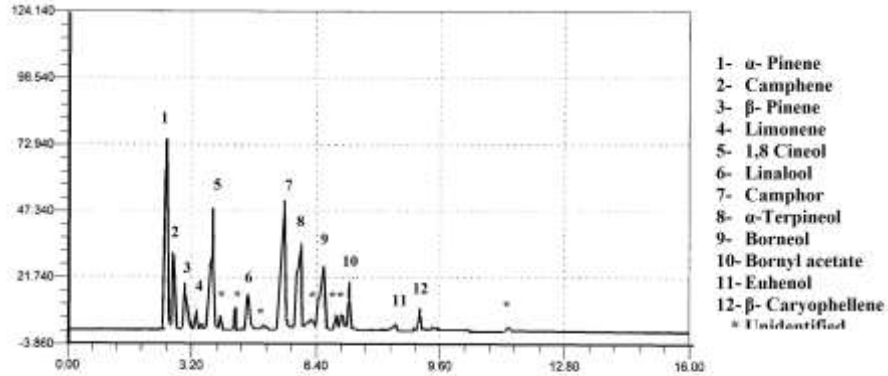

Figure (6): Chromatogram of rosemary oil extracted from 4 Y+ 20 W treatment in the second cut during the second season

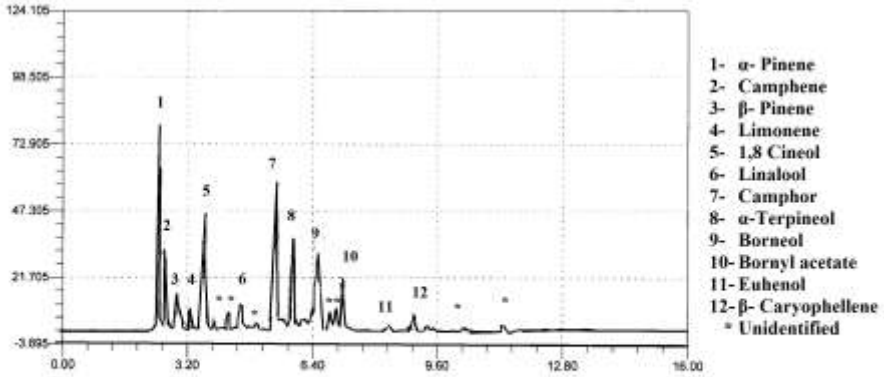

Figure (7): Chromatogram of rosemary essential oil extracted from 8 Y+ 0 W treatment in the second cut during 2012 season.

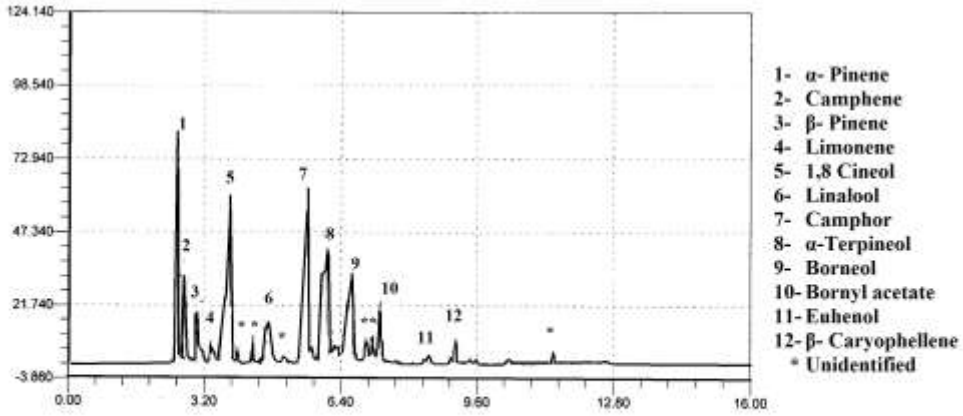

Figure (8): Chromatogram of rosemary essential oil extracted from 8 Y+ 10 W treatment in the second cut during 2012 season.

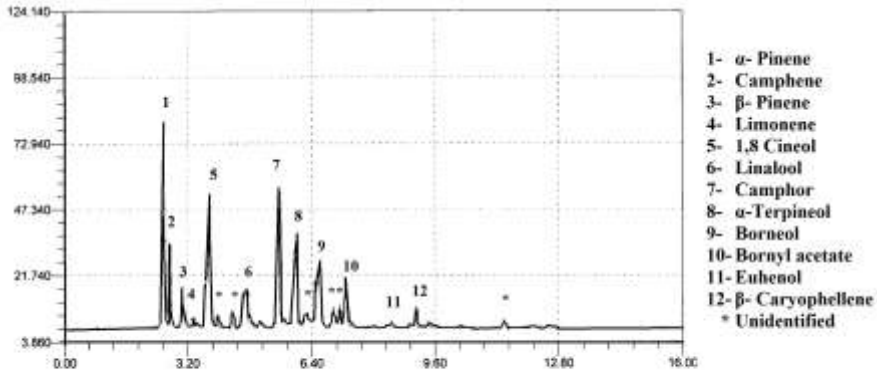

Figure (9): Chromatogram of rosemary essential oil extracted from 8 Y+ 20 W treatment in the second cut during 2012 season.

4 g/ L, while the minimum value of 1,8 cineol content (12.9 %) was recorded in samples of untreated control plants.

Conclusively, from the previous results it could be concluded that monthly foliar spraying of rosemary plants with active dry yeast at rate of 8g /L or monthly application of whey as soil drench at 20 cm^3/ L significantly increased plant growth, herb yield /plant and /*fad*, and oil % in herb, oil yield/ plant and/ *fad*, and the oil main components (1,8 Cineol, Camphor and α-Pinene). In addition, more enhancements in the above mentioned parameters were noticed under effect of interaction treatment of dry yeast at 8g /L X whey at 20 cm^3 /L.

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تأثير معاملات الخميرة الجافة النشطة والشرش على نمو العشب وانتاج الزيت العطرى لنبات حصا اللبان

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أُجريت تجربة عامليه ٣ x ٣ خلال الموسمين المتتاليين ٢٠١١ ، ٢٠١٢ فى المزرعة التجريبية للنباتات الطبية والعطرية بكلية الصيدلة جامعة القاهرة لتقييم إلى أى مدى تؤثر معاملات الخميرة النشطة الجافة وشرش اللبن والتفاعل بينهم على نمو وإنتاج الزيت الطيار لنبات حصا اللبان . عوُملت الثلاث مستويات من الخميرة الجافة النشطة (صفر ، ٤ ، ٨ جم خميرة جافه/ لتر) كرش ورقى بينما عُوملت مستويات الشرش (صفر ، ١٠ ، ٢٠ سم^3/ لتر) كإضافة للتربة ، استمرت معاملات كل من الخميرة والشرش كمعاملات شهرية متكررة حتى نهاية التجربة.

زاد معنويا نمو النباتات معبرا عنه كأرتفاع النبات وعدد الأفرع لكل نبات والوزن الغض والجاف لكل نبات تحت تأثير معاملات الخميرة الجافة النشطة أوا لشرش كل على حده ، سُجلت زيادات تدريجية في القياسات السابقة الذكر بزيادة المستويات المختبرة من كل من الخميرة أو الشرش حتى المستوى اللأعلى لكل منهما ، وتأكدت هذه النتيجة فى كلا الحشتين ، أيضاً أدت معاملات كل من الخميرة أو الشرش إلى زيادة كل من محصول العشب للفدان ونسبة الزيت العطرى ومحصوله الناتج من كل من النبات والفدان.

لوحظت زيادة فى تأثير المعاملات عن تفاعل رش الخميرة مع اضافة الشرش للتربة ، وسجل عموما اعلى تأثير على النمو وانتاج الزيت العطرى عند تفاعل المستوى الأعلى من الخميرة (٨ جم / لتر) مع المستوى الاعلى للشرش (٢٠ سم^3 / لتر).

التوصية: بخصوص المكونات الأساسية للزيت الطيار أدت معظم معاملات التفاعل بين مستويات الخميرة والشرش إلى زيادة النسبة المئوية لمركب 1- 8 cineol ، بينما أدى الرش بالخميرة بتركيز ٨ جم/ لتر وحدها أو متفاعلة مع ١٠ أو ٢٠ سم^3 شرش إلى زيادة نسبة مركب الـ Linalool . زادت نسبة مركب الـ Camphor بالزيت العطرى فقط تحت تأثير معاملة التفاعل بين ٨ جم خميرة/ لتر+١٠ أو ٢٠ سم^3 شرش/ لتر.