RESULTS AND DISCUSSION

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This study was conducted to investigate the effect of extracted essential oils of medicinal and aromatic plants (eucalyptus, anise, fennel and thyme) on long storage periods and the case of fungal disease in potato sponta cv. compared with control (untreated) and refrigerator treatments. This study included three experiments first in store, second in the field and the third for the assigned disease.

I-Storage experiment:

A-Effect of different treatments on vegetative tubers characteristics during storage:

1- Tuber fresh weight (g):

Tuber fresh weight was decreased by increasing storage period **Table (1&2).** This reduction differed according to the used treatment. The most efficient treatment that showed the highest rate of reduction was the use of anise, fennel followed by eucalyptus treatments. The effect of these treatments in reducing the rate of los of tuber fresh weight during storage could be attributed to the ability of these materials to reduce the rate of respiration of tuber tissues during the 2004 and 2005 seasons **(Abad *et al.*, 2001a and Fathy *et al.*, 2005).**

2-Tuber Length (cm):

Data in **Tables (3&4)** showed clearly that the tuber length of control and different treatments were decreased by increasing the storage period. This reduction might be due to the reduction

Table (1): Effect of essential oils and their combinations on tubers fresh weight of potato stored at room temperature during 2004 season.

Treatments	Tuber fresh weight (g)				Loss of tuber fresh weight (g)					
	Starting storage	after 60 days of storage	after 120 days of storage	after 180 days of storage	from Starting to 60 days	Relative to control	from Starting to 120 days	Relative to control	from Starting to 180 days	Relative to control
Control	155.33	143.83	134.22	125.82	11.50	0.00	21.11	0.00	29.51	0.00
Refrigerater	125.55	116.44	112.10	103.88	9.11	79.22	13.45	63.71	21.67	73.43
Ess-oils : A-separatly										
Eucalyptus	134.71	132.65	129.03	121.36	2.06	17.91	5.68	26.91	13.35	45.24
Anise	133.10	132.65	126.59	118.90	0.45	3.91	6.51	30.84	14.20	48.12
fennel	136.70	134.74	131.47	123.11	1.96	17.04	5.23	24.77	13.59	46.05
Thyme	140.19	137.01	132.11	126.20	3.18	27.65	8.08	38.28	13.99	47.41
B- combinations:										
Eucalyptus+ansie	137.90	133.05	122.13	119.92	4.85	42.17	15.77	74.70	17.98	60.93
Eucalyptus +fennel	141.96	133.75	128.23	121.87	8.21	71.39	13.73	65.04	20.09	68.08
Eucalyptus +thyme	136.55	134.09	129.07	121.70	2.46	21.39	7.48	35.43	14.85	50.32
Anise+fennel	144.24	137.22	132.36	123.15	7.02	61.04	11.88	56.28	21.09	71.47
Anise+thyme	134.39	130.84	127.56	122.31	3.55	30.87	6.83	32.35	12.08	40.94
Fennel+thyme	143.89	140.88	137.58	127.90	3.01	26.17	6.31	29.89	15.99	54.19
Eucalyptus+anise+fennel	149.61	146.62	143.27	133.17	2.99	26.00	6.34	30.03	16.44	55.71
Eucalyptus+anise+thyme	155.91	153.41	148.71	135.10	2.50	21.74	7.20	34.11	20.81	70.52
Eucalyptus+fennel+thyme	146.64	142.19	138.53	127.84	4.45	38.70	8.11	38.42	18.80	63.71
Anise+fennel+thyme	159.27	151.07	146.05	137.54	8.20	71.30	13.22	62.62	21.73	73.64
Eucalyptus+anise+fennel+thyme	149.17	143.95	139.97	131.27	5.22	45.39	9.20	43.58	17.90	60.66
LSD at 5% for:										
Treatment	10.63				2.54					
Storage period	5.15				1.23					
Interaction TxS	21.25				5.08					

Table (2): Effect of essential oils and their on tubers fresh weight of potato stored at room temperature during 2005 season.

Treatments	Tuber fresh weight (g)				Reduction in tuber fresh weight (g)					
	Starting storage	after 60 days of storage	after 120 days of storage	after 180 days of storage	from Starting to 60 days	Relative to control	from Starting to 120 days	Relative to control	from Starting to 180 days	Relative to control
Control	157.11	144.64	134.31	123.92	12.47	12.47	22.80	22.80	33.19	33.19
Refrigerator	123.20	113.17	107.27	98.71	10.03	80.43	15.93	69.87	24.49	73.79
Essen.-oils: A-separatly										
Eucalyptus	145.20	142.76	138.17	131.05	2.44	19.57	7.03	30.83	14.15	42.63
Anise	128.61	128.16	120.81	113.52	0.45	4.49	7.80	34.21	15.09	45.46
fennel	145.10	142.89	139.39	130.33	2.21	17.72	5.71	25.04	14.77	44.50
Thyme	140.03	136.65	131.55	124.05	3.38	27.11	8.48	37.19	15.98	48.15
B-combinations										
Eucalyptus+ansie	144.21	139.15	127.04	125.66	5.06	40.58	17.17	75.31	18.55	55.89
Eucalyptus +fennel	153.16	143.38	137.59	130.26	9.78	78.43	15.57	68.29	22.90	69.00
Eucalyptus +thyme	138.78	135.98	130.71	121.18	2.80	22.45	8.07	35.40	17.60	53.02
Anise+fennel	143.90	135.37	129.93	120.39	8.53	68.40	13.97	61.27	23.51	70.84
Anise+thyme	145.01	140.33	136.32	131.33	4.68	37.53	8.69	38.11	13.68	41.58
Fennel+thyme	140.04	136.69	132.77	122.30	3.35	26.87	7.27	31.89	17.74	53.45
Eucalyptus+anise+fennel	147.63	144.95	139.10	124.96	2.68	21.49	8.53	37.41	22.67	68.30
Eucalyptus+anise+thyme	155.57	150.39	145.87	134.96	5.18	41.53	9.70	42.54	20.61	62.10
Eucalyptus+fennel+thyme	155.49	145.79	140.00	132.27	9.70	77.79	15.49	67.93	23.22	69.96
Anise+fennel+thyme	157.00	153.30	149.99	142.82	3.70	29.67	7.01	30.75	14.18	42.72
Eucalyptus+anise+fennel+thyme	152.79	146.76	141.98	133.15	6.03	48.28	10.81	47.41	19.64	59.17
L.S.D. at 5% for:										
Treatments	10.75				2.66					
Storage periods	5.21				1.29					
Interaction TxS	21.50				5.33					

Table (3): Effect of essential oils and their combinations on tuber length of potato stored at room temperature during 2004 season.

Treatments	Tuber length (cm)				Reduction in tuber length (%)					
	Starting storage	After 60 of storage	After 120 of storage	After 180 of storage	From starting to 60 days	Relative to control	From starting to 120 days	Relative to control	From starting to 180 days	Relative to control
Control	9.35	8.09	6.91	6.85	1.26	0.00	1.88	0.00	2.50	0.00
Refrigerater	6.52	5.72	4.96	5.08	0.80	63.49	0.64	66.43	1.44	79.78
Essen-oils: A-separatly										
Eucalyptus	8.98	8.36	7.39	7.86	0.62	24.80	0.50	26.06	1.12	32.80
Anise	8.31	8.08	7.24	7.89	0.23	18.25	0.19	18.62	0.42	14.80
fennel	9.10	8.65	7.70	8.29	0.45	36.00	0.36	336.70	0.81	29.20
Thyme	9.35	8.85	7.87	8.45	0.50	39.68	0.40	40.96	0.90	32.40
B-cobinations:										
Eucalyptus+ansie	9.35	8.85	7.87	8.45	0.50	46.03	0.40	47.34	0.90	37.60
Eucalyptus +fennel	9.10	8.42	7.43	7.87	0.68	53.97	0.55	55.85	1.23	44.00
Eucalyptus +thyme	9.55	9.34	8.38	9.17	0.21	16.67	0.17	17.02	0.38	13.60
Anise+fennel	9.56	9.05	8.04	8.64	0.51	40.48	0.41	42.02	0.92	33.20
Anise+thyme	9.16	9.01	8.10	8.89	0.15	11.90	0.12	13.21	0.27	9.60
Fennel+thyme	9.08	8.76	7.83	8.50	0.32	25.40	0.26	26.06	0.58	20.80
Eucalyptus+anise+fennel	9.08	8.76	7.83	8.50	0.32	16.67	0.26	18.02	0.58	13.60
Eucalyptus+anise+thyme	9.33	8.90	7.93	8.55	0.43	34.13	0.35	35.11	0.78	28.00
Eucalyptus+fennel+thyme	9.28	8.96	8.01	8.70	0.32	25.60	0.26	26.06	0.58	21.60
Anise+fennel+thyme	9.33	8.99	8.03	8.71	0.34	26.98	0.28	27.66	0.62	22.00
Eucalyptus+anise+fennel+thyme	9.36	8.69	7.69	8.15	0.67	53.18	0.54	54.79	1.21	43.60
LSD at 5% for:										
Treatment	0.66				0.06					
Storage period	0.32				0.03					
Interaction TxS	1.33				0.13					

Table (4): Effect of essential oils and their combinations on tuber length of potato stored at room temperature during 2005 season.

Treatments	Tuber length (cm)				Reduction in tuber length (cm)					
	Starting storage	after 60 ofstorage	after 120of storage	after 180 of storage	from Starting to 60 days	Relative to control	from Starting to 120 days	Relative to control	from Starting to 180 days	Relative to control
Control	9.35	8.01	8.01	6.73	1.34	0.00	1.90	0.00	2.62	0.00
Refrigerater	7.17	6.29	6.29	5.58	0.88	65.67	0.88	46.67	1.59	60.69
Essen-oils: A--separatly										
Eucalyptus	9.10	8.63	8.54	8.21	0.47	24.74	0.56	29.47	0.89	33.97
Anise	8.97	8.71	8.70	8.51	0.26	19.40	0.27	14.21	0.46	17.56
fennel	9.12	8.62	8.62	8.22	0.50	37.31	0.50	26.32	0.90	34.35
Thyme	9.21	8.66	8.66	8.20	0.55	41.05	0.55	28.95	1.01	38.55
B-combinations:										
Eucalyptus+ansie	8.80	8.16	8.16	7.65	0.64	47.76	0.64	33.68	1.15	43.89
Eucalyptus +fennel	9.38	8.63	8.63	8.03	0.75	55.97	0.75	39.47	1.35	51.52
Eucalyptus +thyme	9.37	9.13	9.13	8.95	0.24	17.91	0.24	12.63	0.42	16.03
Anise+fennel	9.37	8.80	8.80	8.30	0.57	42.53	0.57	30.00	1.07	40.84
Aaise+thyme	8.96	8.79	8.75	8.66	0.17	12.69	0.21	11.05	0.30	11.45
Fennel+thyme	9.41	9.05	9.00	8.77	0.36	26.87	0.41	21.58	0.64	24.43
Eucalyptus+anise+fennel	9.11	8.87	8.87	8.69	0.24	17.91	0.24	12.63	0.42	16.03
Eucalyptus+anise+thyme	9.40	8.92	8.92	8.54	0.48	35.82	0.48	25.26	0.86	32.82
Eucalyptus+fennel+thyme	9.36	9.00	9.00	8.72	0.36	26.89	0.36	18.94	0.64	24.42
Anise+fennel+thyme	9.33	8.95	8.95	8.65	0.38	28.36	0.38	20.00	0.68	25.95
Eucalyptus+anise+fennel+thyme	9.60	8.86	8.86	8.27	0.74	55.22	0.74	38.95	1.33	50.76
LSD at 5% for:										
Treatment	0.69				0.07					
Storage period	0.34				0.03					
Interaction TxS	1.39				0.14					

in tuber weight by increasing storage period during 2004 and 2005 seasons.

3-Tuber diameter (cm):

Regarding tuber diameter, data in **Tables (5&6)** showed that tubers of control and different treatments showed a reduction in tuber diameter by increasing the storage period. This reduction in tuber diameter by increasing storage period might be due to that reduction in tubers weight by increasing storage period during 2004 and 2005 seasons.

4-Sprouting percentage:

Data in **Table (7)** clearly show that different applied oil treatments significantly reduced the rate of sprouting of potato tubers during storage compared either with the control or stored in refrigerator. The best results were obtained by the treatment of eucalyptus+ fennel +thyme, anise+ fennel, eucalyptus+ anise +fennel +thyme, and eucalyptus+ anise + fennel arranged in ascending order. This reduction might be due to the effect of used materials in reducing the synthesis of growth promoting substances or the low level of sugars in potato tuber buds during the two seasons (**Boylston *et al.*, 2001; Mehta and kaul, 2002 and Sardo, 2006)**

5-Number of sprout eyes:

Table (8) indicates that all treatments of essential oils and combination between them significantly reduced number of sprouted eyes compared with untreated tubers (control) and refrigerator treatment in storage period of the two seasons (2004 & 2005).

Table (5): Effect of essential oils and their combinations on tuber Diameter of potato stored at room temperature during 2004 season.

Treatments	Tuber dimeter (cm)				Reduction of tuber diameter (cm)					
	Starting storage	after 60 days of storage	after 120 days of storage	after 180 days of storage	from Starting to 60 days	Relative to control	from Starting to 120days	Relative to control	from Starting to 180 days	Relative to control
Control	5.47	5.07	3.97	2.97	0.40	0.00	1.50	0.00	2.50	0.00
Refrigerator	4.18	3.81	2.98	2.38	0.37	92.50	1.20	80.00	1.80	76.19
Essen.-oils: A-separatly										
Eucalyptus	5.22	5.01	4.90	4.69	0.21	52.25	0.32	20.67	0.53	21.20
Anise	5.05	4.88	4.79	4.63	0.17	42.50	0.26	26.00	0.42	17.20
fennel	5.49	5.29	5.19	4.99	0.20	50.00	0.30	20.00	0.50	20.00
Thyme	5.16	4.87	4.72	4.43	0.29	72.50	0.44	29.33	0.73	29.20
B-combinations										
Eucalyptus+ansie	5.22	4.90	4.74	4.42	0.32	80.00	0.48	32.00	0.80	30.22
Eucalyptus +feanel	5.33	5.03	4.88	4.58	0.30	75.00	0.45	30.00	0.75	28.88
Eucalyptus +thyme	5.10	4.99	4.93	4.83	0.11	27.50	0.17	42.50	0.27	11.20
Anise+fennel	5.25	5.02	4.90	4.67	0.23	57.50	0.35	23.33	0.58	23.20
Anise+thyme	5.24	5.14	5.09	4.99	0.10	25.00	0.15	10.00	0.25	10.70
Fennel+thyme	5.23	4.93	4.78	4.48	0.30	75.00	0.45	30.00	0.75	28.30
Eucalyptus+anise+fennel	5.35	5.23	5.17	5.05	0.12	30.00	0.18	12.00	0.30	13.10
Eucalyptus+anise+thyme	5.44	5.24	5.14	4.94	0.20	50.00	0.30	20.00	0.50	17.90
Eucalyptus+fennel+thyme	5.34	5.18	5.10	5.27	0.16	40.00	0.24	16.00	0.07	16.30
Anise+fennel+thyme	5.54	5.27	5.13	4.86	0.27	47.50	0.41	27.33	0.68	26.90
Eucalyptus+anise+fennel+thyme	5.10	4.91	4.81	4.63	0.19	47.50	0.29	19.33	0.47	19.20
LSD at 5% for:										
Treatmeat	0.40				0.05					
Storage period	0.19				0.02					
Interaction TxS	0.79				0.10					

Table (6): Effect of essential oils and their combinations on tuber Diameter of potato stored at room temperature during 2005 season.

Treatments	Tuber diameter (cm)				Reduction in tuber diameter (cm)					
	Starting storage	after 60 days of storage	after 120days of storage	after 180 days of storage	from Starting to 60 days	Relative to control	from Starting to 120days	Relative to control	from Starting to 180 days	Relative to control
Control	5.43	4.98	3.75	2.82	0.45	0.00	1.68	0.00	2.61	0.00
Refrigerator	4.60	4.17	3.20	2.70	0.43	95.56	1.40	83.33	1.90	72.97
Essen-oils: A- separatly										
Eucalyptus	5.15	4.92	4.81	4.58	0.23	51.11	0.34	20 .23	0.57	21.84
Anise	5.20	5.02	4.93	4.75	0.18	40.00	0.27	16.07	0.45	17.24
fennel	5.25	5.03	4.92	4.70	0.22	48.00	0.33	19.64	0.55	21.07
Thyme	5.22	4.91	4.76	4.45	0.31	89.00	0.46	27.38	0.77	29.50
B-combinations:										
Eucalyptus+ansie	5.15	4.80	4.63	4.28	0.35	68.89	0.52	30.95	0.87	33.33
Eucalyptus +fennel	5.56	5.23	5.07	4.74	0.33	77.78	0.49	29.17	0.82	31.41
Eucalyptus +thyme	5.13	5.01	4.95	4.83	0.12	73.33	0.18	10.71	0.30	11.49
Anise+fennel	5.17	4.92	4.80	4.55	0.00	26.67	0.37	22.02	0.62	23.75
Anise+thyme	5.42	5.31	5.26	5.15	0.11	55.56	0.16	9.52	0.27	10.34
Fennel+thyme	5.25	4.92	4.76	4.43	0.33	24.45	0.49	29.17	0.82	31.42
Eucalyptus+anise+fennel	5.24	5.11	5.05	4.92	0.13	73.33	0.19	11.24	0.32	12.26
Eucalyptus+anise+thyme	5.14	4.92	4.81	4.59	0.22	28.89	0.33	19.64	0.55	21.07
Eucalyptus+fennel+thyme	5.36	5.18	5.09	4.91	0.18	48.89	0.27	16.07	0.45	17.24
Anise+fennel+thyme	5.45	5.16	5.02	4.73	0.29	40.00	0.43	25.60	0.72	27.59
Eucalyptus+anise+fennel+thyme	5.30	5.10	5.00	4.80	0.20	64.44	0.30	17.86	0.50	19.16
LSD at 5% for:										
Treatment	0.39				0.05					
Storage period	0.19				0.03					
Interaction TxS	0.78				0.11					

Table (7): Effect of essential oils and their combinations on sprouting percentage of potato stored at room temperature during 2004 and 2005 seasons.

Treatments	sprout %							
	Frist season				Second season			
	After 120 days of storage	Relative to control	After 180 days of storage	Relative to control	After 120 days of storage	Relative to control	After 180 days of storage	Relative to control
Control	38.00	0.00	70.00	0.00	33.59	0.00	65.63	0.00
Refrigerator	30.00	78.95	50.00	71.43	44.00	130.99	60.00	91.42
Essen-oils:A-separatly								
Eucalyptus	22.98	60.47	27.03	38.61	24.62	73.30	30.77	46.88
Anise	22.66	59.63	34.38	49.11	22.86	68.06	31.43	47.89
fennel	28.90	76.05	32.40	46.29	30.04	89.43	31.80	48.45
Thyme	23.90	62.89	32.17	45.96	36.36	108.25	36.36	55.40
B-combinations								
Eucalyptus+ansie	23.90	62.89	32.17	45.96	25.24	75.14	28.46	43.36
Eucalyptus +fennel	24.37	64.13	29.40	42.00	23.48	69.90	29.38	44.77
Eucalyptus +thyme	22.03	57.97	29.66	42.37	22.81	67.91	28.95	44.11
Anise+fennel	19.44	51.16	23.19	33.13	18.06	53.77	23.65	36.04
Anise+thyme	26.36	69.37	30.77	43.96	24.00	71.45	28.80	43.88
Fennel+thyme	22.22	58.47	36.81	52.59	22.56	67.16	26.78	40.80
Eucalyptus+anise+fennel	16.00	42.11	24.73	35.33	18.46	54.96	29.08	44.31
Eucalyptus+anise+thyme	20.00	52.63	29.43	42.04	18.00	53.59	26.40	40.23
Eucalyptus+fennel+thyme	17.69	46.55	22.88	32.69	17.71	52.72	22.68	34.56
Anise+fennel+thyme	18.46	48.58	25.85	36.93	15.00	44.66	25.00	38.09
Eucalyptus+anise+fennel+thyme	17.86	47.00	28.29	40.41	17.86	53.17	24.00	36.57
LSD at 5% for:								
Treatments	2.37				2.43			
Storage periods	1.15				1.18			
Interaction TxS	4.15				4.85			

Table (8): Effect of essential oils and their combinations on number of sprouted eyes of potato stored at room temperature during 2004 and 2005 seasons.

Treatments	Number of sprouting eyes							
	Frist season				second season			
	After 120 days of storage	Relative to control	After 180 daysof storage	Relative to control	After 120 days of storage	Relative to control	After 180 days of storage	Relative to control
Control	1.90	0.00	3.50	0.00	2.15	0.00	5.15	0.00
Refrigerator	1.80	94.74	3.00	85.71	2.20	102.33	4.80	93.20
Essen-oils: A-separatly								
Eucalyptus	1.70	89.47	2.17	62.00	1.60	74.42	4.50	87.38
Anise	1.45	76.32	2.20	62.86	1.60	74.42	4.40	85.44
fennel	1.65	86.84	1.85	52.86	1.70	79.07	4.77	92.62
Thyme	1.30	68.42	1.75	50.00	1.45	67.44	4.55	88.35
B-combinations:								
Eucalyptus+ansie	1.25	65.79	1.85	52.86	1.30	60.47	4.90	95.15
Eucalyptus +fennel	1.45	76.32	1.75	50.00	1.35	62.79	4.65	90.29
Eucalyptus +thyme	1.30	68.42	1.75	50.00	1.30	60.47	4.58	88.93
Anise+fennel	1.40	73.68	1.67	47.71	1.30	60.47	4.58	88.93
Anise+thyme	1.45	76.32	2.00	57.14	1.50	69.77	4.60	89.32
Fennel+thyme	1.60	84.21	1.50	42.86	1.55	72.09	4.69	91.07
Eucalyptus+anise+fennel	1.20	63.16	1.78	50.86	1.20	55.81	4.77	92.62
Eucalyptus+anise+thyme	1.40	73.68	2.06	58.86	1.35	62.79	4.78	92.82
Eucalyptus+fennel+thyme	1.15	60.53	1.39	39.71	1.00	46.51	3.80	73.79
Anise+fennel+thyme	1.20	63.16	1.68	48.00	1.05	48.84	4.65	90.29
Eucalyptus+anise+fennel+thyme	1.20	63.16	1.68	48.00	1.05	48.84	4.65	90.29
L.S.D. at 5% for:								
Treatments	0.15				0.26			
Storage periods	0.07				0.13			
Interaction TxS	0.30				0.53			

Also, data in **Table (8)** clearly show that the best treatment was eucalyptus+ fennel+ thyme oil (1.15and 1.39 sprouted eye / tuber after 120 and 180 days of storage time, respectively) followed by the combination between anise + fennel + thyme and eucalyptus+ anise + fennel + thyme oils (1.2 and 1.68 sprouted eye/tuber) and eucalyptus+ anise + fennel oils (1.2 and 1.78 sprouted eye/tuber) in 2004 season. In this respect **(Daniels-lake *et al.*, 1996 and Carol *et al.*, 1997)** reported that all experiment interaction of thyme, caraway, dill, other aromatic essential oils and/or their basic constituents x low concentration current vapor low or medium concentration of oil. Emulsion through spraying or dipping methods x rebatied (reapplying) applications were the most potent treatment in suppressing sprouting (number of sprouts) and as well as in controlling fungal infection through out the period of storage of seed potatoes at 25-25°C..

6-Sprout length (cm):-

Data in **Table (9)** illustrates the effect of essential oils and combination between them compared with the control (treated with water) and refrigerator treatments on sprout length, during successive storage seasons (2004 and 2005).

The obtained data also cleared that all treatments of essential oils and combination between them were significantly reduced sprout length compared with the control and refrigerator treatments.

The best treatments were anise+ fennel and eucalyptus+ anise+ fennel those treatments reduced sprout length after 120 and 180 days of storage time (0.87, 0.89 and 1.93,2.15 cm,

Table (9): Effect of essential oils and their combinations on sprouting length of potato stored at room temperature during 2004 and 2005 seasons.

Treatments	Sprout length (cm)							
	Frist season				Second season			
	After 120 days of storage	Relative to control	After 180 days of storage	Relative to control	After 120 days of storage	Relative to control	After 180 days of storage	Relative to control
Control	2.63	0.00	5.00	0.00	2.69	0.00	5.50	0.00
Refrigerator	2.34	88.97	4.25	85.00	2.52	93.68	4.93	89.64
Essen-oils: A-separatly								
Eucalyptus	1.25	47.53	2.54	50.80	1.41	52.42	3.05	55.45
Anise	1.38	52.47	2.70	54.00	1.54	57.25	3.22	58.56
fennel	1.59	60.46	2.15	43.00	1.76	65.43	2.62	47.64
Thyme	1.24	47.15	2.34	46.80	1.40	52.04	2.83	51.45
B-combinations:								
Eucalyptus+ansie	0.95	36.12	2.28	45.60	1.10	40.89	2.76	50.18
Eucalyptus +fennel	1.20	45.63	2.34	46.80	1.36	50.56	2.83	51.45
Eucalyptus +thyme	1.15	43.73	2.31	46.20	1.31	48.70	2.79	50.73
Anise+fennel	0.87	33.08	1.93	38.60	1.02	37.92	2.37	43.09
Anise+thyme	0.90	34.22	2.45	49.00	1.05	39.03	2.95	53.64
Fennel+thyme	0.90	34.22	2.25	45.00	1.05	39.03	2.73	49.64
Eucalyptus+anise+fennel	1.21	46.01	2.50	50.00	1.40	52.04	3.00	54.55
Eucalyptus+anise+thyme	0.89	33.84	2.31	46.20	1.04	38.66	2.79	50.73
Eucalyptus+fennel+thyme	1.24	47.15	2.55	51.00	1.40	52.04	3.06	55.64
Anise+fennel+thyme	1.23	46.77	2.44	48.80	1.39	51.67	2.94	53.45
Eucalyptus+anise+fennel+thyme	1.09	41.44	2.22	44.40	1.25	46.47	2.69	48.91
LSD at 5% for:								
Treatments	0.16				0.17			
Storage periods	0.08				0.08			
Interaction TxS	0.33				0.35			

respectively in season 2004 and 1.02,1.04 and 2.37,2.62 cm, respectively in 2005 season) compared with the control in2004 (2.63 and 5.00 cm after 120 and 180 days from storage, respectively) and 2005 season (2.69 and 5.50 cm after 120 and 160 days from storage, respectively). In this respect, **(Diepenhorst *et al.*, 1998 ;Mehta and Kaul, 2002 ; Baydar and Karadogen 2003 and Kleinkopf *et al.*, 2003)** nearly got similar results.

7-Sprout diameter (cm):

Data in **Table (10)** shows that all essential oil treatments increased sprout diameter compared with each of control and refrigerator especially anise and fennel oils by separately followed by thyme, anise+ fennel and fennel + thyme treatments in 2004 season and eucalyptus + fennel + thyme, anise + fennel, fennel, anise and eucalyptus + anise + fennel treatments in 2005 season.

8-Sprout fresh and dry weights (g):

Table (10) shows that all treatments of essential oils and their combinations between them decreased sprout fresh weight compared with the control. Also, the eucalyptus+ anise+ fennel treatment was the best treatment, it gave 1.39& 1.54 g of sprout fresh weight in 2004 and 2005 seasons, respectively followed by eucalyptus+ thyme.

Such data stated that the control treatment reduced sprout dry weight. Also the control treatment gave less dry weight of sprout than each of the refrigerator and all other treatments. That means that control weight was containing a high percentage of moisture, unlike all essential oils treatments. On the contrary, the

Table (10): Effect of essential oils and their combinations on sprout diameter, fresh and dry weighs of potato stored at room temperature during 2004 and 2005 seasons.

Treatments	1st season						2nd season					
	Sprout diameter (cm)	Relative to control	Sprout fresh weight (g)	Relative to control	Sprout dry weight (g)	Relative to control	Sprout diameter (cm)	Relative to control	Sprout fresh weight (g)	Relative to control	Sprout dry weight (g)	Relative to control
Control	0.40	0.00	2.65	0.00	0.20	0.00	0.42	0.00	2.50	0.00	0.22	0.00
Refrigerater	0.40	100.00	2.11	79.62	0.29	145.00	0.60	142.86	2.21	88.40	0.30	136.36
Essen-oils: A-separatly												
Eucalyptus	0.65	162.50	1.75	66.04	0.40	200.00	0.62	147.62	1.86	74.40	0.43	195.45
Anise	0.81	202.50	1.67	63.02	0.62	310.00	0.76	180.95	1.73	69.20	0.65	295.45
fennel	0.81	202.50	1.91	72.08	0.40	200.00	0.77	183.33	1.75	70.00	0.38	172.73
Thyme	0.76	190.00	1.97	74.34	0.40	200.00	0.64	152.38	1.82	72.80	0.37	168.18
B-combinations:												
Eucalyptus+ansie	0.65	162.50	1.56	58.87	0.45	225.00	0.61	145.24	1.68	67.20	0.36	163.64
Eucalyptus +fennel	0.55	137.50	1.75	66.04	0.34	170.00	0.53	126.19	1.66	66.40	0.32	145.45
Eucalyptus +thyme	0.64	160.00	1.47	55.47	0.20	100.00	0.64	152.38	1.30	52.00	0.24	109.09
Anise+fennel	0.75	187.50	1.53	57.74	0.30	150.00	0.79	188.10	1.78	71.20	0.35	159.09
Anise+thyme	0.54	135.00	1.47	55.47	0.28	140.00	0.70	166.67	1.58	63.20	0.32	145.45
Fennel+thyme	0.73	182.50	1.86	70.19	0.36	180.00	0.72	171.43	1.79	71.60	0.42	190.91
Eucalyptus+anise+fennel	0.56	140.00	1.39	52.45	0.25	125.00	0.74	176.19	1.54	61.60	0.29	131.82
Eucalyptus+anise+thyme	0.72	180.00	2.10	79.25	0.41	205.00	0.70	166.67	2.40	96.00	0.46	209.09
Eucalyptus+fennel+thyme	0.60	150.00	1.58	59.62	0.34	170.00	0.80	190.48	1.67	66.80	0.36	163.64
Anise+fennel+thyme	0.56	140.00	1.64	61.89	0.30	150.00	0.52	123.81	1.70	68.00	0.32	145.45
Eucalyptus+anise+fennel+thyme	0.54	135.00	1.65	62.26	0.31	155.00	0.64	152.38	1.66	66.40	0.32	145.45
LSD	0.12		0.29		0.50		0.10		0.29		0.05	

content of T.S.S. (total soluble solids) was increased in all essential oils treatments. The highest value was in anise (0.62 & 0.62 g) followed by fennel, eucalyptus, thyme and eucalyptus+ anise+ thyme treatments in the two seasons of the present study.

The obtained Results were in accordance with those of **Vanes and Hartmans, 1987 Hartmans *et al.*, 1990; Vaughn and Spencer, 1991; Vaughn and Spencer, 1993; Oosterhaven *et al.*, 1995 a & b &c; Daniels-lake *et al.*, 1996; Ali *et al.*, 1997;Carlo *et al.*, 1997; Lewis *et al.*, 1997 and El-Awady, 2002.**

B-Chemical analysis:

1-Total carbohydrates:

Data in **Table (11)** clear that most treatments of essential oils, combination between them and refrigerator were significantly increased total carbohydrate in different storage periods compared with the control (untreated tubers) except that of eucalyptus + anise+ thyme, anise, eucalyptus+ anise, thyme, anise+ thyme and refrigerator treatments in first storage period (after 60 days). Also, data showed that the total carbohydrates were decreased in all treatments with increasing the storage period.

2- Reducing, non- reducing and total sugars:

Table (12) shows the effect of essential oils and combination between them compared with the refrigerator and control treatments on reducing, non- reducing and total sugars in potato tubers during storage in 2005 season.

Table (11): Effect of essential oils and their combinations on total carbohydrates of potato stored at room temperature during 2004 and 2005 seasons.

Treatments	Total carbohydrates (mg/g d.w.)		
	After 60 days of starting	After 120 days of starting	After 160 days ofstarting
Control	115.20	100.30	66.67
Refrigerator	116.28	104.80	85.80
Essen-oils: A-separatly			
Eucalyptus	115.29	114.30	101.50
Anise	117.23	113.17	100.00
fennel	115.28	110.40	99.76
Thyme	116.50	109.21	100.70
B-combinations:			
Eucalyptus+ansie	116.66	110.76	103.75
Eucalyptus +fennel	115.45	113.80	102.76
Eucalyptus +thyme	114.99	111.90	106.40
Anise+fennel	116.25	112.90	107.77
Anise+thyme	116.44	109.80	98.67
Fennel+thyme	115.42	113.80	99.70
Eucalyptus+anise+fennel	116.20	103.80	105.90
Eucalyptus+anise+thyme	117.55	114.40	110.60
Eucalyptus+fennel+thyme	114.60	110.44	101.65
Anise+fennel+thyme	114.60	111.50	103.70
Eucalyptus+anise+fennel+thyme	115.35	109.23	99.80

d.w. = Dry weight.

Table (12): Effect of essential oils and their combinations on sugars in potato tubers stored at room temperature during 2004 and 2005 seasons.

Treatments	After 60 days of starting			After 120 days of starting			After 180 days of starting		
	Total sugars (mg/g d.w.)	Reducing sugars (mg/g)	Non-Reducing sugars (mg/g)	Total sugars (mg/g)	Reducing sugars (mg/g)	Non-Reducing sugars (mg/g)	Total sugars (mg/g)	Reducing sugars (mg/g)	Non-Reducing sugars (mg/g)
Control	7.80	3.67	4.13	14.66	10.78	3.88	25.89	23.50	2.39
Refrigerator	6.80	3.60	3.20	14.30	11.78	2.52	28.56	26.30	2.26
Essen-oils: A-separatly									
Eucalyptus	6.69	2.90	3.79	8.50	5.30	3.20	14.90	11.89	3.01
Anise	7.10	3.10	4.00	7.90	5.20	2.70	16.98	15.10	1.88
fennel	6.50	3.20	3.30	8.50	5.90	2.60	16.70	14.70	2.00
Thyme	6.80	3.80	3.00	9.60	5.70	3.90	18.45	16.22	2.23
B-combinations:									
Eucalyptus+ansie	5.90	2.60	3.30	8.90	5.30	3.60	16.90	14.56	2.34
Eucalyptus +fennel	8.60	3.90	4.70	9.60	5.12	4.48	15.44	13.67	1.77
Eucalyptus +thyme	6.20	3.20	3.00	7.70	4.10	3.60	17.56	14.76	2.80
Anise+fennel	6.78	2.90	3.88	8.90	6.10	2.80	14.89	13.89	1.00
Anise+thyme	7.84	3.20	4.64	10.00	5.43	4.57	14.50	12.30	2.20
Fennel+thyme	7.20	3.20	4.00	10.60	7.50	3.10	18.50	15.40	3.10
Eucalyptus+anise+fennel	6.50	3.70	2.80	8.99	6.90	2.09	17.66	14.88	2.78
Eucalyptus+anise+thyme	7.11	3.02	4.09	10.70	6.56	4.14	16.89	14.60	2.29
Eucalyptus+fennel+thyme	7.20	3.65	3.55	9.77	6.70	3.07	18.23	16.30	1.93
Anise+fennel+thyme	6.50	3.90	2.60	8.90	4.20	4.70	20.00	17.40	2.60
Eucalyptus+anise+fennel+thyme	6.00	2.80	3.20	8.90	5.90	3.00	17.06	15.20	1.86

d.w. = Dry weight.

Data in **Table (12)** clear that reducing, non-reducing and the total sugars were increased in all treatments of essential oils, refrigerator and control (untreated tubers) with increasing storage period especially the refrigerator treatment followed by the control.

All treatments of essential oils and combination between them were significantly decreased reducing, non-reducing and total sugars compared with the control and refrigerator treatments in all storage periods i.e. after 180 days from starting.

Data in **Table (12)** show that reducing, non-reducing and total sugars were significantly differed in all treatments at the two seasons.

Herein the highest sugars content of the mentioned all treatments might due to that efficiently and continuously supplying potato tubers and the hade space of storage (storing boxes) with sufficient oil and / or vapour (of potent and current inhibition effect) throughout the whole period of storage. In which, the enzymatic and biochemical reactions within tuber tissues especially those of control (carbohydrate degradation and depletion, energy metabolism, as well as other metabolic process) might be inhibited or slowed.

Similar results were obtained by **Daniels-lake *et al.*, (1996), Barakat (1996), Herrman *et al.*, (1996), Hertog *et al.*, (1997), Yang *et al.*, (1999) and Coleman *et al.*, (2001).**

3- Polysaccharides and starch:

Data in **Table (13)** show that all treatments of essential oils and their combinations significantly increased

polysaccharides and starch compared with the control and refrigerator treatments.

These data indicated also that combination of eucalyptus + anise + thyme oils followed by anise + fennel oils gave the highest significant increase of polysaccharides especially after 180 days from storage starting.

Generally, it was known that essential oils and / or their basic constituents slowing down the activity of most enzymatic systems, especially those which related with respiration and energy metabolism **(El-Awady 2002)**.

This means that such treatments could be reduce carbohydrate, sugars, polysaccharides and starch degradation or mobilization and depletion via sprouting and respiration processes during storage especially at relatively higher temperatures.

The same results were in agreement with the finding of **Daniels-lake *et al.*, (1996) and El-Awady (2002).**

On the other hand, the differences in the effect of such oils on the tuber carbohydrate and sugars content might be due to the differences in their basic components (ratio, activity and species) as mentioned by **Vokou *et al.*, (1993) ; Bouwmeester *et al.*, (1995) ; Daniels-lack *et al.*, (1996) and El-Awady (2002).**

4-Phenol contents:-

In general, for total phenols, it could be noticed that its content was usually increased in stored tubers during different periods of storage i.e., at 60,120,180 days. Also could be notice that phenol content at 60 days was higher than the other two periods of storage. In this respect, for example the treatments of

Table (13): Effect of essential oils and their combinations on polysaccharides and starch in potato tubers stored at room temperature during 2004 and 2005 seasons.

Treatments	Polysaccharides (mg/g d.w.)			Starch (mg/g)		
	After 60 days of starting	After 120 days of starting	After 180 days of starting	After 60 days of starting	After 120 days of starting	After 180 days of starting
Control	91.90	73.74	30.91	15.50	11.90	9.87
Refrigerator	94.78	77.70	46.44	14.70	12.80	10.80
Essen-oils: A-separatly						
Eucalyptus	92.50	90.80	73.80	16.10	15.00	12.80
Anise	93.91	91.27	69.12	16.22	14.00	13.90
fennel	93.08	86.50	69.84	15.70	15.40	13.22
Thyme	93.15	85.81	70.55	16.55	13.80	11.70
B-combinations						
Eucalyptus+ansie	96.10	89.64	76.28	14.66	12.22	10.57
Eucalyptus +fennel	92.45	90.10	74.92	14.40	14.10	12.40
Eucalyptus +thyme	93.19	90.30	76.24	15.60	13.90	12.60
Anise+fennel	92.97	84.80	81.54	16.50	12.70	11.34
Anise+thyme	97.42	88.55	70.17	15.80	15.00	14.00
Fennel+thyme	92.42	88.55	68.50	15.80	14.65	12.70
Eucalyptus+anise+fennel	93.30	80.01	76.44	16.40	14.80	11.80
Eucalyptus+anise+thyme	95.34	90.00	83.11	15.10	13.70	10.60
Eucalyptus+fennel+thyme	91.40	86.80	71.62	16.00	13.87	11.80
Anise+fennel+thyme	93.55	89.84	73.00	14.55	12.76	10.70
Eucalyptus+anise+fennel+thyme	93.15	84.43	70.30	16.20	15.90	12.44

d.w. = Dry weight.

eucalyptus + fennel + thyme and anise + fennel + thyme gave 0.461 and 0.522 mg/g dry weight at 60 days of storage. Meanwhile, the same two treatments gave 0.344&0.393 and 0.326&.387 mg/g dry weight for 120 and 180 days, respectively **(Table 14).**

In addition, the treatment of storage of refrigerator at 4°C exhibited the lowest phenol content at the three periods of storage i.e. 60, 120 and 180 days of storage.

This interpretation for the general effect of treatments was in consistent with the findings of **Gulleen and Manzanos (1996) and Fathy *et al.*, (2005)**

5- Mineral composition:-

a-Potassium percentage:-

Data in **Table (15)** show the effect of different essential oils and combinations between them on potassium % of potato seed tubers stored at room temperature during 2004 and 2005 seasons.

These data cleared that the potassium percentage was minimized with increasing the storage period i.e., the highest value was after 60 days from storage starting in 2005-2006 season.

Meanwhile, the treatment of thyme exhibited the highest content of potassium (2.996%). Also, in this respect, the treatments of eucalyptus, fennel and fennel + thyme gave the lowest potassium content at 60 days.

Meanwhile, each of anise, fennel + thyme, eucalyptus + anise + fennel, anise + fennel + thyme and eucalyptus + anise +fennel + thyme exhibited the lowest potassium content at 120 days.

Table (14): Effect of essential oils and their combinations on phenols in potato tubers stored at room temperature during 2004 and 2005 seasons.

Treatments	After 60 days			After 120 days			After 180 days		
	Total phenols (mg/g d.w.)	conjugate phenols (mg/g)	Free phenols (mg/g)	Total phenols (mg/g d.w.)	conjugate phenols (mg/g)	Free phenols (mg/g)	Total phenols (mg/g d.w.)	conjugate phenols (mg/g)	Free phenols (mg/g)
Control	0.175	0.096	0.079	0.122	0.090	0.032	0.089	0.044	0.045
Refrigerator	0.209	0.087	0.122	0.163	0.153	0.010	0.103	0.066	0.037
Essen-oils: A-separatly									
Eucalyptus	0.382	0.138	0.244	0.314	0.070	0.244	0.247	0.003	0.244
Anise	0.351	0.141	0.210	0.283	0.073	0.210	0.216	0.006	0.210
fennel	0.348	0.150	0.198	0.280	0.082	0.198	0.213	0.015	0.198
Thyme	0.339	0.163	0.176	0.271	0.095	0.176	0.204	0.028	0.176
B-combinations:									
Eucalyptus+ansie	0.360	0.180	0.180	0.292	0.112	0.180	0.225	0.045	0.180
Eucalyptus +fennel	0.377	0.143	0.234	0.309	0.075	0.234	0.242	0.008	0.234
Eucalyptus +thyme	0.352	0.163	0.189	0.284	0.095	0.189	0.217	0.028	0.189
Anise+fennel	0.441	0.151	0.290	0.373	0.083	0.290	0.306	0.016	0.290
Anise+thyme	0.370	0.182	0.188	0.302	0.114	0.188	0.235	0.047	0.188
Fennel+thyme	0.381	0.180	0.201	0.313	0.112	0.201	0.246	0.045	0.201
Eucalyptus+anise+fennel	0.391	0.161	0.230	0.323	0.093	0.230	0.256	0.026	0.230
Eucalyptus+anise+thyme	0.412	0.142	0.270	0.344	0.074	0.270	0.277	0.007	0.270
Eucalyptus+fennel+thyme	0.461	0.262	0.199	0.393	0.194	0.199	0.326	0.127	0.199
Anise+fennel+thyme	0.522	0.142	0.380	0.454	0.074	0.380	0.387	0.007	0.380
Eucalyptus+anise+fennel+thyme	0.441	0.151	0.290	0.373	0.083	0.290	0.306	0.016	0.290

d.w. = Dry weight.

Table (15): Effect of essential oils and their combinations on potassium %, phosphorus and nitrogen % of potato tubers stored at temperature during 2004 and 2005 seasons.

Treatments	Potasum %			Phosphore %			Nitrogen %			Crude proten		
	After 60 days of startiog	After 120 days of starting	After 180 days of starting	After 60 days of starting	After 120 days of starting	After 180 days of starting	After 60 days of starting	After 120 days of starting	After 180 days of starting	After 60 days of starting	After 120 days of starting	After 180 days of starting
Control	2.15	2.82	1.85	0.90	0.89	0.67	3.40	2.20	2.20	21.27	13.76	13.76
Refrigerator	2.64	2.53	1.62	0.90	0.77	0.54	2.89	2.60	1.88	18.06	16.26	11.75
Essen-oils: A-separatly												
Eucalyptus	1.89	2.19	2.49	1.81	1.78	1.55	4.61	4.55	3.40	28.78	28.44	21.27
Anise	1.92	1.97	2.28	1.56	1.23	0.90	3.60	2.92	2.55	22.53	18.26	15.95
fennel	1.85	1.93	2.19	0.61	0.48	0.90	2.20	2.40	2.31	13.76	15.02	14.46
Thyme	2.27	2.57	3.00	0.94	1.66	0.84	2.60	2.20	1.61	16.26	13.78	10.06
B-combinations:												
Eucalyptus+ansie	1.98	2.29	2.14	0.79	0.69	0.56	1.80	1.40	1.60	11.25	8.75	10.01
Eucalyptus +fennel	1.72	2.66	2.44	0.90	0.66	0.61	3.00	3.00	2.60	18.77	18.75	16.25
Eucalyptus +thyme	2.07	2.59	2.74	0.56	0.74	0.80	1.80	1.70	1.56	11.26	10.59	9.75
Anise+fennel	2.48	2.57	2.19	1.05	0.98	0.93	2.60	2.32	2.30	16.27	14.52	14.38
Anise+thyme	2.07	2.15	2.31	1.03	0.56	0.62	2.40	3.00	2.55	15.01	18.77	15.94
Fennel+thyme	1.98	1.93	1.84	0.33	0.54	0.69	2.20	2.46	2.50	13.76	15.39	15.63
Eucalyptus+anise+fennel	2.29	1.97	2.66	1.51	1.48	1.23	3.60	2.98	2.77	22.51	18.63	17.31
Eucalyptus+anise+thyme	2.36	2.50	2.69	0.59	0.70	0.93	2.82	2.00	1.87	17.63	12.51	11.67
Eucalyptus+fennel+thyme	2.16	2.23	2.38	0.79	0.70	0.61	1.40	2.00	2.00	8.75	12.51	12.50
Anise+fennel+thyme	2.32	1.97o	2.61	0.74	0.88	0.80	2.60	2.80	2.40	16.26	17.51	15.01
Eucalyptus+anise+fennel+thyme	2.10	1.98	3.00	1.61	0.94	0.84	3.80	3.20	2.80	23.76	20.03	17.51

As for 180 days, only the storage in refrigerator at 4°C decreased K content when compared with the control.

b-Phosphorus percentage:-

Data in **Table (15)** show that phosphor percentage was decreased in all treatment with increasing the storage periods i. e., 60, 120 and 180 days from starting.

Such data indicate that most treatments of essential oils only increased the phosphorus percentage except the fennel treatment compared with the control and refrigerator treatments. Meanwhile, the treatments of combination between the essential oils were decreased the phosphor percentage except the anise+ fennel, anise+ thyme and eucalyptus+ anise+ fennel+ thyme oils after 60 days from starting.

Also, the phosphorus percentage increased in most treatments of essential oils and their combinations compared with the control and refrigerator treatments except the eucalyptus+ anise, eucalyptus+ fennel, anise+ thyme and eucalyptus+ fennel+ thyme.

Such data in **Table (15)** clear that the refrigerator treatment gave to lowest value in phosphorus percentage compared with the control in all time of storage and lowest value from all treatments of essential oils and their combinations after 180 days from starting.

c-Nitrogen percentage and crude protein:-

Data in **Table (15)** show that the nitrogen percentage and crude protein were decreased in all treatments with increasing storage period i.e. 60, 120 and 180 days.

These data cleared that the eucalyptus, eucalyptus+ anise+ fennel+ thyme, anise and eucalyptus+ anise+ fennel treatments gave the highest significance of nitrogen percentage and crude protein especially after 60 days from storage (4.605, 3.802, 3.604 and 3.601, respectively). Meanwhile, the same treatments decreased the percentages with increasing storage period i.e., 120 and 180 days.

Also, the control treatment increased nitrogen percentage and crude protein compared with the refrigerator treatment in all storage periods.

This interpretation for the general effect of essential oils and combinations between them were in consistent with the findings of **Barakat (1996), Daniels- lake *et al.*, (1996), Herrman *et al.*, (1996), Hertog *et al.*, (1997) and El- Awady (2002).**

II-Field experimental

Two field experiments were conducted in winter seasons of 2004/2005 and 2005/2006 to study the effect of preceded storage technique of potato seeds Spunta cv. tubers of all applied treatments (essential oils and combinations between them, control and refrigerator treatments) on vegetative and reproductive growths.

A- Vegetative growth:

1- Number of main stems /plant:-

Data in **Tables (16 & 17)** clearly show that different applied treatments showed irregular trend regarding the number of branches per plant as it was increased by the treatment of anise + Thyme followed by eucalyptus +anise + fennel,

Table (16): Effect of some storage treatments and refrigerator (4°C) on growth characteristics of potato plants during winter plantation of 2004/2005 season.

Treatments	main stem length	Relative to control	No. of main stems / plant	Relative to control	No. of leaves / plant	Relative to control	Total leaf area / plant (cm)	Relative to control	fresh weight of plant (gm)	Relative to control	Dry weight of plant (gm)	Relative to control
Control	25.5	0.0	3.0	0.0	38.0	0.0	1391.3	0.0	224.0	0.0	11.4	0.0
Refrigerater	36.8	144.3	3.0	100.0	42.2	111.1	1858.6	133.6	256.5	114.5	12.2	107.0
Essen-oils: A-separatly												
Eucalyptus	40.3	158.0	6.0	200.0	43.9	115.5	2366.6	170.1	319.6	142.7	21.8	191.2
Anise	53.0	207.8	5.0	166.7	45.0	118.4	2775.8	199.5	243.3	108.6	34.6	303.5
fennel	33.7	132.2	5.0	166.7	44.6	117.4	2625.8	188.7	276.8	123.6	28.4	249.1
Thyme	28.4	111.4	4.0	133.3	41.9	110.3	2353.0	169.1	171.7	76.7	19.7	172.8
B-combinations:												
Eucalyptus+ansie	31.9	125.1	5.0	166.7	41.0	107.9	2230.1	160.3	198.0	88.4	18.3	160.5
Eucalyptus +fennel	37.7	147.8	6.0	200.0	42.7	112.4	2462.1	177.0	247.9	110.7	26.9	236.0
Eucalyptus +thyme	31.6	123.9	5.0	166.7	42.8	112.6	2475.7	177.9	166.0	74.1	19.5	171.1
Anise+fennel	24.9	97.6	4.0	133.3	40.1	105.5	2243.8	161.3	133.7	59.7	19.9	174.6
Anise+thyme	24.3	95.3	8.0	266.7	39.3	103.4	2452.2	176.2	153.0	68.3	17.6	154.3
Fennel+thyme	32.0	125.5	6.0	200.0	41.4	108.9	2284.7	164.2	172.0	76.8	23.7	207.9
Eucalyptus+anise+fennel	22.4	87.9	7.0	233.3	40.2	105.8	2407.5	173.0	145.5	65.0	12.6	110.5
Eucalyptus+anise+thyme	24.1	94.5	5.0	166.7	41.2	108.4	2257.4	162.2	233.7	104.3	23.1	202.6
Eucalyptus+fennel+thyme	29.0	113.7	4.0	133.3	41.8	110.0	2339.3	168.1	121.8	54.4	20.9	183.6
Anise+fennel+thyme	23.1	90.6	5.0	166.7	39.2	103.0	2157.2	155.0	128.8	57.5	16.9	148.2
Eucalyptus+anise+fennel+thyme	28.8	112.9	5.0	166.7	40.9	107.6	2216.5	159.3	219.3	97.9	20.4	178.7
LSD	5.25		0.71		1.59		20.07		35.48		3.21	

Table (17): Effect of some storage treatments and refrigeration (4°C) on growth characteristics of potato plants during winter plantation of 2005/2006 season.

Treatments	main stem length	Relative to control	No. of main stems / plant	Relative to control	No. of leaves / plant	Relative to control	Total leaf area / plant (cm)	Relative to control	fresh weight of plant	Relative to control	Dry weight of plant	Relative to coatrol
Control	28.40	0.00	3.00	0.00	41.50	0.00	1530.43	0.00	213.70	0.00	13.70	0.00
Refrigerater	43.00	151.41	2.50	83.33	44.10	106.27	2177.19	142.26	263.95	123.51	13.89	101.39
Essen-oils: A-separatly												
Eucalyptus	42.70	150.35	5.50	183.33	43.50	104.82	2735.95	178.77	337.55	157.96	20.20	147.45
Anise	53.90	189.79	4.50	150.00	45.20	108.92	3186.05	208.18	243.33	113.87	29.10	212.41
fennel	34.40	121.13	5.00	166.67	40.90	98.55	3021.07	197.40	228.85	107.09	28.90	210.95
Thyme	32.40	114.08	4.00	133.33	40.50	97.59	2720.95	177.79	157.60	73.75	19.10	139.42
B-combinations:												
Eucalyptus+ansie	31.90	112.32	5.00	166.67	42.10	101.45	2585.81	168.96	224.00	104.82	19.70	143.80
Eucalyptus +fennel	37.43	131.80	5.50	183.33	45.80	110.36	2840.94	185.63	351.86	164.65	25.60	186.86
Eucalyptus +thyme	33.00	116.20	5.00	166.67	43.20	104.10	2855.94	186.61	160.60	75.15	17.50	127.74
Anise+fennel	23.20	81.69	3.50	116.67	41.20	99.28	2600.81	169.94	246.10	115.16	19.70	143.80
Anise+thyme	25.20	88.73	7.33	244.33	39.42	94.99	2830.07	184.92	219.78	102.85	20.40	148.91
Fennel+thyme	33.90	119.37	5.00	166.67	42.80	103.13	2645.81	172.88	188.45	88.18	21.00	153.28
Eucalyptus+anise+fennel	21.50	75.70	6.50	216.67	38.79	93.47	2780.94	181.71	119.20	55.78	13.70	100.00
Eucalyptus+anise+thyme	29.90	105.28	5.50	183.33	41.70	100.48	2615.81	170.92	223.83	104.74	23.90	174.45
Eucalyptus+fennel+thyme	26.60	93.66	4.00	133.33	40.40	97.35	2705.95	176.81	110.46	51.69	13.00	94.89
Anise+fennel+thyme	26.10	91.90	4.50	150.00	39.70	95.66	2505.62	163.72	158.45	74.15	18.44	134.60
Eucalyptus+anise+fennel+thyme	28.82	101.48	5.50	100.00	40.30	97.11	2570.82	167.98	205.33	96.08	25.50	186.13
LSD	5.63		0.77		1.71		29.80		36.74		3.18	

eucalyptus + fennel, eucalyptus and fennel+ thyme in descending order, while the other used treatments recorded a reduction in the number of main steams per plant compared with the control plants.

The increase in number of main steams per plant by the used treatments might be due to the effect of the used subextracts in cell division and cell elongation.

In other meaning applied treatments might affected the level of all requirements needed for vigorous growth of many eyes such as phytohormons, valuable sugars ....etc. or even or reactivate subsidiary buds round the main one in the compound bud.

2-Main steam length:

Regarding the effect of the used treatments on the length of branches of potato plants under the study, data in **Tables (16& 17)** show that most treatments caused an increase in branch length of potato plants compared with the control ones. The highest increase was obtained by the use of anise, eucalyptus, Refrigerator, and eucalyptus + anise arranged in descending order.

The increase in main stem length of potato plants as a result of using different treatments might be due to the enhancing effects of such materials in plant cell division and or elongation. This indicates that these materials may have an auxinic effect on plant cells.

3- Number of leaves / plant:

Data in **Tables (16 & 17)** show that different used treatments affected differently the number of leaves of potato plants as it increased by using anise, refrigerator, eucalyptus

+fennel, eucalyptus, eucalyptus + thyme and finally eucalyptus +anise +fennel arranged in a descending order. While the other treatments seemed to have no effect compared to the control plants.

In this respect, the increase of leaves number by any treatment is being of great interest. Since, that will be reversed upon maximizing leaf area i.e., the photosynthetic are thereby that could significantly arise the created photosynthetic, hence, the yielded tubers.

4- Leaf area (cm^2) / plant

Data in **Tables (16& 17)** illustrate the effect of essential oil and interactions on number of leaves / plant and leaf area (cm^2).

Data indicate that anise, fennel oils, respectively were the treatments which significantly induced the highest values of leaf area (cm^2) / plant relative to other treatments including refrigerator at the two seasons.

Herein it could be suggested that the best treatments with the best superior effect on vegetative growth of Nili potato in comparison with treatments of cold stored seed, and others were those of seeds stored using treatments of anise and fennel oils.

5-Fresh weight of plant (g):

Regarding the effect of different used treatments on the fresh weight of potato plant, data in **Tables (16& 17)** clearly show that some treatments, i.e., eucalyptus, eucalyptus +fennel, refrigerator, anise+ fennel, anise, fennel and eucalyptus + anise+ thyme, caused an increase in the fresh weight of the above ground part of the plant, compared with the control plants. The

data also showed that the other used treatments reduced the fresh weight of plant shoot in comparison with the control one.

The increase in shoot fresh weight per plant that caused by some treatments might be due to the increase number of leaves and area as well, in which reversed upon the increase in the photosynthetic rate of the treated plants thereby could results in the accumulation of the photosynthates in plant cells, also it might be due to the increase in shoot content from water.

6- Dry weight of plant (g):-

Data in **Tables (16&17)** clearly show that all treatments of essential oils combination and refrigerator treatments as well gave significant increase in plant dry weight when compared with to the control (untreated tubers).

These data also indicate that anise, fennel and eucalyptus + fennel treatments, respectively were the treatments in which significantly gave the highest values of plant dry weight (34.60, 29.10 gm and 28.4, 28.9 gm and 26.9, 25.6 gm/ plant, respectively in two seasons) relative to other treatments including refrigerator treatment at the two seasons.

Such results could be confirmed by the findings of **Hartmans *et al.*, (1990); Vokou *et al.*, (1993) and El-Awady (2002).**

B- Yield and Yield components:-

1-Number of tubers produced / plant:

Number of tubers produced per plant as shown in **Tables (18 & 19)** was found to be greatly affected by different applied treatments. Since treatments were found to increase the number of tubers produced per plant. This increase may be due to the enhancing effect of such subextracts on cell division, elongation

Table (18): Effect of some storage treatments and refrigeration (at 4°C) on tubers yield and its components of potato plants during winter plantation of 2004/2005 season.

Treatments	No. of tubers / plant	Relative to control	Tubers fresh weight / plant (g)	Relative to control	Tubers dry weight / 100g fresh weight (g)	Relative to control	Moisture percentage / 100 g fresh weight	Relative to control
Control	8.90	0.00	882.95	0.00	12.33	0.00	80.90	0.00
Refrigerater	9.20	103.37	894.64	101.32	16.70	135.44	79.23	97.94
Essen-oils: A-separatly								
Eucalyptus	12.50	140.45	839.45	95.07	22.90	185.73	76.64	94.73
Anise	15.00	168.54	1133.10	128.33	23.67	191.97	75.81	93.71
fennel	14.50	162.92	1045.48	118.41	22.76	184.59	76.74	94.86
Thyme	13.50	151.69	1007.10	114.06	18.88	153.12	80.15	99.07
B-combinations:								
Eucalyptus+ansie	10.97	123.26	974.64	110.38	17.99	145.90	81.26	100.44
Eucalyptus +fennel	12.00	134.83	1280.25	145.00	18.90	153.28	80.50	99.51
Eucalyptus +thyme	10.50	117.98	886.73	100.43	19.48	157.99	79.26	97.97
Anise+fennel	11.00	123.60	813.50	92.13	17.88	145.01	81.61	100.88
Anise+thyme	11.50	129.21	804.78	91.15	17.89	145.09	81.18	100.35
Fennel+thyme	13.00	146.07	874.40	99.03	16.56	134.31	82.41	101.87
Eucalyptus+anise+fennel	10.50	117.98	772.50	87.49	17.30	140.31	81.25	100.43
Eucalyptus+anise+thyme	9.00	101.12	905.10	102.51	18.18	147.45	80.87	99.96
Eucalyptus+fennel+thyme	10.00	112.36	871.40	98.69	18.36	148.91	80.38	99.36
Anise+fennel+thyme	10.00	112.36	816.85	92.51	18.14	147.12	86.54	106.97
Eucalyptus+anise+fennel+thyme	12.50	140.45	930.40	105.37	19.78	160.42	82.34	101.78
LSD	0.80		73.42		3.08		1.88	

Table (19): Effect of some storage treatments and refrigeration (at 4°C) on tubers yield and its components of potato plants during winter plantation of 2005/2006 season.

Treatments	No. of tubers / plant	Relative to control	Tubers fresh weight / plant (g)	Relative to control	Tuber dry weight / 100g fresh weight (g)	Relative to control	Moisture percentage / 100 g fresh weight	Relative to control
Control	8.80	0.00	1000.85	0.00	14.50	0.00	80.54	0.00
Refrigerator	9.50	107.95	1071.77	107.09	18.00	124.14	78.91	97.98
Essen-oils: A-separatly								
Eucalyptus	11.00	125.00	931.60	93.08	21.98	151.59	76.95	95.54
Anise	14.50	164.77	1159.48	115.85	22.87	157.72	76.07	94.45
fennel	13.60	154.55	1095.75	109.48	21.98	151.59	77.00	95.60
Thyme	13.00	147.73	1071.25	107.03	19.92	137.38	79.82	99.11
B-combinations:								
Eucalyptus+ansie	9.50	107.95	950.18	94.94	18.43	127.10	81.12	100.72
Eucalyptus +fennel	12.00	136.36	1220.33	121.93	20.76	143.17	80.65	100.14
Eucalyptus +thyme	10.00	113.64	776.58	77.59	21.31	146.97	78.65	97.65
Anise+fennel	11.00	125.00	967.21	96.64	17.61	121.45	81.70	101.44
Anise+thyme	11.80	134.09	831.40	83.07	18.89	130.28	80.85	100.38
Fennel+thyme	10.50	119.32	862.30	86.16	18.80	129.66	81.93	101.73
Eucalyptus+anise+fennel	11.53	131.02	693.30	69.27	19.20	132.41	80.86	100.40
Eucalyptus+anise+thyme	11.00	125.00	928.11	92.73	19.20	132.41	80.53	99.99
Eucalyptus+fennel+thyme	10.50	119.32	752.63	75.20	20.30	140.00	79.73	98.99
Anise+fennel+thyme	11.97	136.02	914.55	91.38	19.22	132.55	85.81	106.54
Eucalyptus+anise+fennel+thyme	12.03	136.70	1028.95	102.81	17.90	93.13	81.94	101.74
LSD	1.13		75.9		3.19		3.56	

and differentiation. **(Hartmans *et al.*, 1990; Barakat, 1996 and El- Awady, 2002).**

2-Tubers fresh weight (g)/ plant:

With respect to the effect of different applied treatments on the fresh weight of produced tubers per plant. Data in **Tables (17& 18)** clearly indicate that most treatments increased the fresh weight of produced tubers per plant as compared with the control ones. The highest increase was reported by the treatments of eucalyptus+ fennel, anise, Fennel, thyme, eucalyptus+ anise and eucalyptus+ anise + fennel + thyme which ranked the last in this respect arranged in a descending order.

Such increase might be attributed partially to the increased dry matter content in the tuber tissue resulting from the increased photosynthates translocation from leaves **(Hartmans *et al.*, 1990)** or partially due to the increase in water content of tuber tissue which results from the increased water movement to the tuber tissue that contains more photosynthates having higher osmotic pressure force.

3-Total tuber fresh weight kg /plot and Total tuber fresh weight ton/ feddan.

Data in **Tables (18&19 Continue)** showed that all treatments of essential oils and their combination were significantly increased total yield kg/plot and total yield ton/feddan compared with the refrigerator and control treatments of potato plants during summer season of 2004/2005.

The high tuber yield in essential oil treatments could be expected in the present work. Since, the same superior treatments were also showed the highest No. of leaves and leaf surfaces area **(Tables 16&17)**; as well as the highest

Table (18, Continue) Total tubers fresh weight / plot (kg), total tubers weight / Feddan (Ton), economical and biological yields.

Treatments	Total tubers weight (kg) /plot	Relative to control	Total tubers weight (ton) /fedden	Relative to control	Economical yield	Relative to control	Biological yield	Relative to control
Control	26.49	0.00	16.00	0.00	108.87	0.00	120.27	0.00
Refrigerator	26.84	101.32	16.21	101.32	149.40	137.23	161.60	134.36
Essen-oils: A-separatly								
Eucalyptus	25.18	95.07	15.21	95.06	192.23	176.57	214.03	177.96
Anise	33.99	128.32	20.53	128.31	268.20	246.35	302.80	251.77
fennel	31.36	118.38	18.94	118.37	237.95	218.56	266.35	221.46
Thyme	30.21	114.05	18.25	114.06	190.14	174.65	209.84	174.47
B-combinations:								
Eucalyptus+ansie	29.24	110.38	17.66	110.37	175.34	161.05	193.64	161.00
Eucalyptus +fennel	38.41	144.99	23.20	145.08	241.97	222.25	268.87	223.55
Eucalyptus +thyme	26.60	100.41	16.07	100.44	172.74	158.66	192.24	159.84
Anise+fennel	24.41	92.15	14.74	92.12	145.45	133.60	165.35	137.48
Anise+thyme	24.14	91.14	14.58	91.12	143.98	132.25	161.57	134.34
Fennel+thyme	26.23	99.02	15.84	99.00	144.80	133.00	168.50	140.10
Eucalyptus+anise+fennel	23.18	87.49	14.00	87.50	133.64	122.75	146.24	121.59
Eucalyptus+anise+thyme	27.15	102.49	16.40	102.50	164.55	151.14	187.65	156.02
Eucalyptus+fennel+thyme	26.14	98.68	15.79	98.67	159.99	146.95	180.92	150.43
Anise+fennel+thyme	24.51	92.52	14.80	92.51	148.18	136.10	165.08	137.26
Eucalyptus+anise+fennel+thyme	27.91	105.36	16.86	105.37	184.03	169.04	204.40	169.95

Table (19, Continue) Total tubers fresh weight / plot (kg), total tubers weight / Feddan (Ton), economical and biological yields.

Treatments	Total tubers weight (kg) /plot	Relative to control	Total tubers weight (ton) /fedden	Relative to control	Economical yield	Relative to control	Biological yield	Relative to control
Control	30.03	0.00	18.14	0.00	145.12	0.00	158.82	0.00
Refrigerater	32.15	107.07	19.42	107.06	192.92	132.94	206.81	130.22
Essen-oils: A-separatly								
Eucalyptus	27.95	93.07	16.88	93.05	204.77	141.10	224.97	141.65
Anise	34.78	115.83	21.01	115.82	265.17	182.73	294.27	185.29
fennel	32.87	109.47	19.85	109.42	240.85	165.96	269.75	169.84
Thyme	32.14	107.02	19.41	107.01	213.39	147.05	232.49	146.39
B-combinations:								
Eucalyptus+ansie	28.51	94.92	17.22	94.93	175.12	120.67	194.82	122.67
Eucalyptus +fennel	36.61	121.91	22.11	121.88	253.34	174.57	278.94	175.63
Eucalyptus +thyme	23.30	77.58	14.07	77.56	165.49	114.04	182.99	115.22
Anise+fennel	29.02	96.62	17.53	96.63	170.33	117.37	190.03	119.65
Anise+thyme	24.94	83.06	15.06	83.02	157.05	108.22	177.45	111.73
Fennel+thyme	25.87	86.14	15.62	86.10	162.11	111.71	183.11	115.30
Eucalyptus+anise+fennel	20.80	69.26	12.56	69.23	133.11	91.73	146.81	92.44
Eucalyptus+anise+thyme	27.84	92.72	16.82	92.72	178.20	122.79	202.10	127.25
Eucalyptus+fennel+thyme	22.58	75.19	13.64	75.10	152.78	105.28	165.78	104.38
Anise+fennel+thyme	27.44	91.36	16.57	91.34	175.78	121.12	194.22	122.29
Eucalyptus+anise+fennel+thyme	30.87	102.79	18.64	102.76	184.18	126.92	209.68	132.02

photosynthetic product in plant leaves, and plant are being accumulated more dry matter.

In this case, plants of these treatments might be in efficient photosynthetic status and assimilated more photo-metabolites and ground organs **(Barakat, 1996).**

On the other hand, these treatments are being the best ones with positive effect on their potato seeds during storage (those of the best sprout characters also, short and thick sprouts), of the best seeds storability (with the least weight loss). Also, these treatments characterized with higher reserve materials (carbohydrate, sugars, polysaccharides, starch **(Tables11, 12 and 13)**, Protein and minerals **(Table, 15).** Similar results were obtained by **Hartmans *et al.*, (1990); Barakat, (1996) and El-Awady, (2002).**

4-Economical and biological yields:-

Tables (18&19 Continue) showed that most treatments of essential oils and their combination were significantly increased the economical and biological yields compared with the refrigerator at 4°c and the control (untreated tubers).

These data clearly show that the best treatments with the best superior effect on economical and biological yields of summer potato in comparison with treatments of cold stored potato seeds and others were those of potato seeds stored using treatment of anise oil followed by eucalyptus+ fennel, fennel and eucalyptus+ anise+ fennel+ thyme (302.80, 268.87, 266.35, 204.40), respectively in 2004-2005 season and 294.27, 278.94, 269.75, 209.68) respectively in 2005-2006 season).

Also, data in Tables (**18&19 Continue**) suggested that the eucalyptus+ fennel+ thyme and eucalyptus+ thyme oils treatments gave the lowest value of economical and biological yields of winter potato in the two seasons.

Once again it could be suggested that most of the used essential oil storage treatments as well as cold storage treatment exhibited beneficial effect for improving yield and yield component of the harvested winter potato tubers. Such beneficial effect of these treatments on tubers could be attributed to their beneficial effect on potato seed (mother tubers) quality during storage **(Tables 7, 8, 9, 10,11,12,13 and 14)** and their beneficial effect on growth and accumulation of tuber dry weight during the two growing seasons **(Table 16 & 17).**

C- Chemical analysis:

- (Carbohydrate, sugars contents, polysaccharides and starch mg/g dry weight) in potato tubers:-

Data in **Table (20)** showed that the effect of essential oils (eucalyptus, anise, fennel and thyme) and their combinations as well on carbohydrate and its fractions of potato tuber produced from winter season 2005/2006.

These data cleared that all treatments of essential oils as compared with control (untreated tubers) and refrigerator one (from 4°C cold storage), the best treatment was anise treatment when applied separately this treatment gave highest value of the total carbohydrates, total sugars, polysaccharides and starch (136.55, 11.44, 110.25mg and 14.86mg respectively) compared with the control (78.34, 5.2, 66.81 and 6.33mg respectively) and the refrigerator treatment (99.85, 6.31, 85.68 and 7.86mg

Table (20): Effect of essential oils and their combinations on total carbohydrates, sugars, Polysaccharides and starch of potato tubers stored at room temperature during 2004/ 2005 season.

Treatments	Total carbohydrates (mg/g)	Total sugars (mg/g)	Reducing sugars (mg/g)	Non-Reducing sugars (mg/g)	Poly-saccharides (mg/g)	Starch (mg/g)
control	78.34	5.20	3.10	2.10	66.81	6.33
Refrigerater	99.85	6.31	3.90	2.41	85.68	7.86
Essen-oils: A-separatly						
Eucalyptus	119.72	9.73	5.00	4.73	101.34	8.65
Anise	136.55	11.44	6.33	5.11	110.25	14.86
fennel	128.00	10.80	5.32	5.48	103.28	13.92
thyme	121.30	7.60	4.98	2.62	101.31	12.39
B-combinations:						
eucalyptus+Ansie	119.90	8.21	5.90	2.31	101.60	10.09
Eucalyptus +Fennel	123.07	7.55	5.60	1.95	104.72	10.80
Eucalyptus +Thyme	121.33	7.76	5.30	2.46	104.24	9.33
Anise+Fennel	135.22	10.54	6.80	3.74	112.62	12.06
Anise+Thyme	124.10	9.30	4.78	4.52	103.60	11.20
Fennel+Thyme	122.67	8.60	4.70	3.90	103.57	10.50
Eucalyptus+Anise+Fennel	121.76	8.88	5.12	3.76	103.18	9.70
Eucalyptus+Anise+thyme	119.96	9.60	5.20	4.40	100.24	10.12
Eucalyptus+Fennel+thyme	120.77	9.20	4.80	4.40	101.80	9.77
Anise+fennel+Thyme	119.57	8.90	4.90	4.00	99.80	10.87
Eucalyptus+Anise+Fennel+Thyme	120.23	8.59	5.30	3.29	101.87	9.77

respectively). On the other hand combinations between the essential oils showed different results.

This result in total carbohydrates and its fractions caused by anise treatment could be attributed to increases the number of leaves (61.24 leaf/ plant) and leaf area (2775.79 cm^2/ plant). **Table (16)** Theory that could reversed upon the increase of photosynthates in the sinks of plant i. e. in tubers.
Similar results were obtained by **Daniels--lake *et al.*, (1996); Hertog *et al.*, (1997) and El-Awady (2002).**

In general, the rate of sprouting was increased by increasing the storage period for both control and treated potato tubers. So, the results of this study, it is clearly show that, these treatments could be used for storing potato tubers for two purposes, firstly for storing potato tubers for human consumption and the storing period for this purpose should not exceed firstly 60 days (4 months) because the rate of sprouting during this period was very low. Secondly, for storing potato tubers to be used for potato plantation, and this period could be prolonged for 180 days (6 months) without any deleterious effect for tuber content and thirdly percentage eyes out growth.

III-Pathological experiment:

1- Isolation and identification of the causal organism.

Different Fusarium species were isolated from diseased potato tubers with typical symptoms of dry rot collected from four different locations in Egypt. A total of seventy five isolates of various *Fusarium spp.* and *Alternaria spp* were established in pure cultures. *Fusarium spp.* were identified on the bases of the morphological characteristics. **(Booth 1971).**

Data presented in **Table (21)** indicate that seventy one isolates of *Fusarium spp.* and four *Alternaria spp* isolates were also isolated from tubers. The main isolated from potato tubers belonged to six species of genus Fusarium i.e., *Fusarium oxysporum, F. semitectum, F. sambucium, F. solani, Fusarium culmorum* and *F. equista.* While four isolates of *Alternaria spp.* were isolated from potato tubers **(Kawchuk *et al.*, 2002 and Vitale *et al.*, 2003)**.

Fusarium solani was the most frequently isolated fungi (32%). It was isolated from all the four Governorates followed by *Fusarium sambucinum* (18.7%). While, *Alternaria spp.* was the least frequency ranged from (5.3%) from the four governorates.

2- Pathogenicity tests:

Pathogenicity test of the isolated fungi was carried out under laboratory conditions. Healthy potato tubers cv. Spunta was used.

Data in **Table (22)** showed that variations of Pathogenicity of 25 isolates of Fusarium and Alternaria isolated from potato tubers were tested. Of them 16 isolate of them were pathogenic to potato tubers and the remaining 9 isolates were not pathogenic. The highly pathogenic isolates were *Fusarium sambucinum* (isolated from Sharkiya and Ismaliya Governorates) and *Fusarium solani* (isolated from Behaira and Ismaliya Governorates) caused the highly disease incidence (100%)and disease severity (98.5, 96, 98.5 and 97.5 respectively).

The results of the present study indicate that *F. sambucinum* and *F. solani* were the major Fusarium species

Table (21): Frequency of Fungi associated with dry rot of potato in four Governorates in Egypt.

Causal organism	Qalubiya	Sharkiya	Ismailiya	Behaira	Total
F. oxysporum	2	2	4	1	9
F. semitectum	1	2	-	3	6
F.Sambucinum	3	3	5	3	14
F .Solani	7	6	4	7	24
F. cumorum	2	-	3	3	8
F. Eguista	1	4	4	1	10
Alternaria sp	-	1	2	1	4
Total	16	18	22	19	75

Table (22): Pathogencity of different *Fusarium spp.* isolated from potato tubers cv. Spunta.

Tested fungi	location	%disease incidence	%disease severity
Alternaria sp	-	0.00	0.00
F. oxysporum (1)	Qalubiya	0.00	0.00
F. oxysporum (2)	Sharkiya	0.00	0.00
F. oxysporum (3)	Behaira	0.00	0.00
F. oxysporum (4)	Ismaliya	0.00	0.00
F. semitectum (1)	Qalubiya	15.00	3.50
F. semitectum (2)	Sharkiya	30.00	7.50
F. semitectum (3)	Behaira	0.00	0.00
F. semitectum (4)	Ismaliya	10.00	3.00
F. sambucinum (1)	Qalubiya	80.00	77.50
F. sambucinum (2)	Sharkiya	100.00	98.50
F. sambucinum (3)	Behaira	70.00	62.50
F. sambucinum (4)	Ismaliya	100.00	96.00
F. solani (1)	Qalubiya	60.00	58.50
F. solani (2)	Sharkiya	80.00	75.00
F. solani (3)	Behaira	100.00	98.50
F. solani (4)	Ismaliya	100.00	97.50
F. culmorum (1)	Qalubiya	7.50	1.50
F. culmorum (2)	Sharkiya	0.00	0.00
F. culmorum (3)	Behaira	5.00	1.50
F. culmorum (4)	Ismaliya	10.00	2.50
F. equista (1)	Qalubiya	0.00	0.00
F. equista (2)	Sharkiya	5.00	2.00
F. equista (3)	Behaira	0.00	0.00
F. equista (4)	Ismaliya	7.50	3.00
LSD at5 %		19.63	16.80

associated with dry rot disease of potato tubers. **(Desjardins, 1995 and El-Hassan *et. al.*, 2004).**

3- Effect of essential oils on the linear growth of the potato dry rot pathogens:-

Three concentrations (10, 25 and 50%) of four essential oils after sterilizing by filtration to study their effect on the linear growth of tested pathogens and data are tabulated in **Table (23)**.Data in **Table (22)** showed that all tested essential oils at any concentration significantly reduced the mycelia growth of tested fungi.

Among the four essential oils tested, Eucalyptus oil strongly retarded the fungal growth of the pathogen (*F. solani* and *F. sambucinum*) followed by Anise oil. At the same time Eucalyptus and anise oil at 50% concentrations completely suppressed the mycelia growth of the pathogenic fungi. On the other hand, fennel exhibited the moderate effect in decreasing the mycelia growth of the tested pathogens. Thyme oil at all tested concentrations gave the test effect with reducing the mycelia growth of the tested fungi **(Carol *et al.*, 1997; Bang, 2005; Singh *et al.*,2006 and Bang 2007).**

4- Effect of some sodium salts on mycelia growth of potato dry rot pathogens:

This study was carried out to evaluate the effects of three concentrations of four salts on linear growth of the pathogenic fungi and the obtained results are tabulated in **Table (24).**

Sodium benzoate was the most effective salt in suppressing the mycelia growth of fungi also sodium sorbate at 0.2 M completely inhibited mycelia growth of pathogenic fungi.

Table (23): Effect of some essential oils on the linear growth of the potato dry rot pathogens

	Fusarium sambucinum			*Fusarium solani*		
	10%	25%	50%	10%	25%	50%
Anise	4.50	2.80	0.00	5.10	3.00	0.00
Eucalyptus	4.00	1.40	0.00	4.30	1.80	0.00
Fennel	6.90	5.30	1.00	6.80	4.90	1.10
Thyme	7.40	6.10	1.30	7.10	5.20	1.70
control	9.00	9.00	9.00	9.00	9.00	9.00
LSD at 5% for						
Fungi	6.00					
Conent.	15.30					
Treatment	8.30					
Fung x Conc.	5.20					
Treat.x Conc	2.10					
Fung xTreat.	2.50					
F xT x C	3.70					

Table (24): Effect of some sodium salts on the linear growth of the potato dry rot pathogens

	Fusarium sambucinum			*Fusarium solani*		
	0.01	0.1	0.2	0.01	0.1	0.2
Sodium benzoate	3.30	2.10	0.00	3.60	2.30	0.00
Sodium carbonate	8.00	4.50	2.00	7.90	4.80	2.30
sodium sorbate	3.80	2.60	0.00	4.10	2.80	0.00
Sodium acetate	7.40	5.50	2.80	8.10	5.90	3.10
control	9.00	9.00	9.00	9.00	9.00	9.00
LSD at 5% for						
Fungi	5.40					
Conent.	11.30					
Treatment	7.40					
Fung x Conc.	6.10					
Treat.x Conc	4.70					
Fung xTreat.	2.50					
F xT x C	7.30					

Sodium acetate and sodium carbonate salts were the least effective on the mycelia growth of two tested fungi **(Bang 2005).**

These salts were shown to inhibit mycelia growth on pathogenic fungi **(Hervieux *et. al.*, 2002).**

5- Effect of different essential oils on incidence and severity of potato tubers dry rot disease caused by *fusarium sambucium and F. Solani.*

In this experiment, essential oils of four aromatic plants (Anise, Eucalyptus, Fennel and Thyme) were used in order to test their efficiency in reducing disease incidence and disease severity caused by *F. solani* and *F. sambucinum* on potato cv. Sponta, obtained data are listed in **Table (25).**

Data in **Table (25)** indicated that the essential oils play an important role in controlling dry rot disease caused by *F. sambucinum* and *F. solani.* In general, all tested essential oils decreased the percentage of dry rot disease incidence and disease severity compared to the control.

In this respect, Eucalyptus oil was the best of all tested oils in reducing disease incidence and disease severity on tested fungi followed by anise oil.

On the other side thyme oil was the least effective in reducing the disease. The increase in essential oils concentrations resulted in an obvious decrease in disease incidence and disease severity **(Oosterhaven *et al.*, 1995 b; Oosterhaven *et al.*, 1996 and Tzortzakis and Economakis, 2007)**

Table (25): Effect of different essential oils incidence and severity of potato tuber dry rot disease.

	Fusarium sambucinum						Fusarium solani						control					
	Disease incidence			Disease severity			Disease incidence			Disease severity			Disease incidence			Disease severity		
	10%	20%	50%	10%	25%	50%	10%	25%	50%	10%	25%	50%	10%	25%	50%	10%	25%	50%
Anise	32.00	21.00	14.50	8.50	6.80	4.50	24.50	16.50	12.00	7.50	5.10	3.20	0.00	0.00	0.00	0.00	0.00	0.00
Euca.	26.00	18.50	10.00	7.80	5.40	1.80	20.00	13.00	7.50	6.50	4.50	1.10	0.00	0.00	0.00	0.00	0.00	0.00
Fen.	93.80	31.50	22.00	30.30	8.20	6.90	35.00	28.80	18.00	25.00	7.00	5.30	0.00	0.00	0.00	0.00	0.00	0.00
Thym	44.00	34.00	26.00	32.10	9.80	7.30	41.50	30.50	20.00	26.30	8.60	6.50	0.00	0.00	0.00	0.00	0.00	0.00
Ctrl	55.00	55.00	55.00	40.00	40.00	40.00	51.00	51.00	51.00	40.50	40.50	40.50	0.00	0.00	0.00	0.00	0.00	0.00
LSD at 5% for																		
Treatments	4.36			2.89			3.64			2.37			N.S					
Concent.	3.18			2.07			3.01			2.18			N.S					
Interaction TxC	6.77			6.28			7.19			7.01			N.S					

6- Effect of different salts in control of potato tuber dry rot development:-

In this study four salts (sodium sorbate, sodium carbonate, sodium benzoate and sodium acetate) each with three concentrations (0.01, 0.1 and 0.2M) were used to test their efficacy in reducing disease incidence and disease severity of potato tuber caused by dry rot pathogens. The obtained results are presented in **Table (26).**

In general, disease severity of potato tubers under study was reduced as a result of treatment by most the salts compared to control. Percentage of disease incidence and disease severity was decreased by increasing the concentration of all tested salts from 0.01 up to 0.2M. These treatments with salts reduce the development of potato dry rot.

In all cases, sodium benzoate and sodium sorbate were the most effective salts on disease incidence, acetate and sodium carbonate were least effective in this respect **(Mecteau, 2001).**

7- Effect of some salts on phenols content in potato tubers:

The results in **Table (27)** showed that, the free, conjugated and total phenols were effected significantly by salts treatment. All tested salts increased free phenols compared with untreated tubers (control). The highest increase in free phenols was treated with sodium sorbate (2.1 mg) followed by sodium benzoate (1.7 mg), sodium carbonate (1.62mg) and sodium acetate (0.892 mg).

As for the total phenols, all tested salts increased total phenols compared with control. The highest increase in total phenols compared with control. The highest increase in total phenols was treated by sodium sorbate (2.23 mg), followed by sodium

Table (26): Effect of different salts in controlling of potato tuber dry rot disease

Treatments	Fusarium sambucinum						Fusarium solani						control					
	Disease incidence			Disease severity			Disease incidence			Disease severity			Disease incidence			Disease severity		
	0.01	0.10	0.20	0.01	0.10	0.20	0.01	0.10	0.20	0.01	0.10	0.20	0.01	0.10	0.20	0.01	0.10	0.20
Na benzoate	25.50	18.00	12.50	9.30	4.00	3.60	22.00	17.00	10.00	8.00	3.10	2.80	0.00	0.00	0.00	0.00	0.00	0.00
Na carbonate	30.00	20.50	10.90	10.90	8.70	4.20	26.75	20.00	13.50	10.00	8.50	4.00	0.00	0.00	0.00	0.00	0.00	0.00
Na sorbate	20.50	13.75	8.00	8.50	3.90	1.50	18.00	12.00	5.50	7.50	2.80	1.10	0.00	0.00	0.00	0.00	0.00	0.00
Na acetate	32.00	28.00	20.75	12.10	10.50	8.60	28.00	24.50	16.50	11.50	9.50	7.10	0.00	0.00	0.00	0.00	0.00	0.00
Control	55.00	55.00	55.00	40.00	48.60	40.00	51.00	51.00	51.00	40.50	40.50	40.50	0.00	0.00	0.00	0.00	0.00	0.00
LSD at 5% for																		
Fungi	N.S			N.S			N.S			N.S			N.S					
Treatments	2.01			2.16			1.86			1.91			N.S					
Concent.	1.02			1.07			0.89			0.96			N.S					
FxT	2.81			2.36			1.91			1.85			N.S					
FxC	2.91			2.81			2.33			2.18			N.S					
TxC	3.07			3.18			3.01			2.96			N.S					
FxT x C	4.87			4.93			4.31			4.06			N.S					

Table (27): Effect of some essential oils and salts on total, conjugated and free phenols contents (mg/g) in potato tubers.

Treatments	Phenol contents		
	Free phenols	conjaated phenols	total phenols
Anise	1.790	0.110	1.900
Eucalyptus	1.920	0.180	2.100
fennel	1.600	0.200	1.800
thyme	1.340	0.210	1.550
Sodium benzoate	1.700	0.210	1.910
Sodium carbonate	1.620	0.900	1.710
Sodium sorbate	2.100	0.130	2.230
Sodium acetate	0.892	0.088	0.980
Control	0.823	0.057	0.880

benzoate (1.91 mg), sodium carbonate (1.71mg) and sodium acetate (0.98 mg).

Conjugated phenols were increased with all treatments the highest increase sodium benzoate (0.21mg) followed by sodium sorbate (0.13 mg), sodium carbonate (0.09mg) and sodium acetate(0.088).

8- Effect of some essential oils on phenols content in potato tubers:

The Data in **Table (27)** showed that all essential oils under study increased free, conjugated and total phenols content in potato tubers compared with untreated tubers (control). In this respect, the highest increase in free phenols was treated with eucalyptus oil (1.92mg) followed by anise oil (1.79mg), fennel oil (1.6mg) and thyme oil (134mg).

As for the total phenols, all treatments increased total phenols. The highest content of total phenols were treated by eucalyptus oil (2.1mg) followed by anise oil (1.9mg), fennel oil (1.8 mg) and thyme oil (1.55 mg).

All treatments increased conjugated phenols content compared with control. Thyme oil gave the highest content (0.21 mg) followed by fennel oil (0.20 mg), eucalyptus oil (0.18 mg) and anise oil (0.11 mg).

9- Effect of some salts on sugar content in potato tubers:-

Sugars content i.e. reducing, non-reducing and total sugars were quantitavily determined in tubers of potato treated with some salts.

Data in **Table (28)** indicated that sugars content was significantly affected by the tested treatment. All treatments increased reducing and total sugars content in potato tubers compared with control.

Table (28):Effect of some essential oils and some salts on reducing, non-reducing and total sugars content (mg/g) in potato tubers.

Treatments	sugers content		
	Reducing sugers	Non-reducing sugars	Total sugars
Anise	3.45	9.88	13.33
Eucalyptus	2.97	10.78	13.70
Fennel	2.99	9.10	12.09
thyme	2.17	8.81	10.98
Soduim benzoate	2.45	10.88	13.33
Sodium carbonate	1.45	9.80	11.25
Sodium sorbate	1.63	12.70	14.33
Sodium acetate	2.21	8.77	10.98
control	2.96	7.25	10.21

In this respect, Sodium sorbate showed the highest increase in reducing sugars (1270mg) followed by sodium benzoate (10.88 mg) while, sodium acetate was the lowest increase (8.77 mg).

Also, sodium sorbate gave the highest increase in total sugars (14.33 mg) followed by sodium acetate (10.98). on the other hand all salts under study decreased non-reducing sugars content in potato tubers compared with control.

Sodium carbonate was the highest in decrease of non-reducing sugars (1.45mg) followed by sodium sorbate (1.63 mg). While sodium benzoate (2.45mg) gave the lowest decrease **(Tina *et al.*, 2006)**

10- Effect of some essential oils on sugar content in potato tubers:

Data in **Table (28)** showed that sugars content was significantly affected by the tested treatments. All treatments increased reducing and total sugars content in potato tubers compared with control.

Eucalyptus oil gave the highest increase of reducing sugars content (10.73) while, thyme oil showed the least increase (8.81).

Also, eucalyptus oil gave the highest increase of total sugars content (13.7) followed by anise oil (13.33mg). while, thyme oil was the least one (10.98 mg). On the other hand, all essential oils were tested decreased non-reducing sugars content except fennel and thyme oils compared with control. The highest decrease was treated with thyme oil (2.17), while the least decrease was got by anise oil (3.45 mg) **(Tina et al., 2006).**