



RESULTS & DISCUSSION



4. RESULTS AND DISCUSSION

4.1. Chemical composition of wheat flour:

The Chemical composition of wheat flour (72% extraction) used in the study for manufacture of cake and croissant, was determined and the obtained data are in Table (1). The results showed that protein content and total carbohydrate of wheat flour were 10.15 and 87.74%, respectively on dry weight basis, which classified it as a medium strength flour according to the classification of **Hamer (1991)** who classified Wheat flour according to their protein content into four group; strong (14-16%), medium strong (11-13%), Weak (8-10%) and very weak (7-9% on dry matter). Same data also Indicated that, the values of other chemical constituents of wheat flour were within the range reported for wheat flour by **Hussien (1995)**, **Soliman (1996)**, **Dawoud (1997)**, **Hamza (1999)**, **Mahmoud (2000)**, **Soliman (2000)**, **Ali (2000)** and **Abd-El Rahim *et al.*, (2001)**.

4.2. Chemical composition of cardamom fruit, cinnamon, bark, clove bud, marjoram, rosemary and thyme:

The chemical composition of cardamom, cinnamon, clove, marjoram, rosemary and thyme were determined and the obtained results are shown in Table (1). From these data it could be noticed that the higher moisture content was found in cardamom fruit (12.20%) while rosemary had lower percentages (5.70%) while cinnamon bark and clove buds were 9.23 and 9.10%, respectively, these results were agreed with the values reported by **Isa and Nazarifah (1986)**, **Kholief and Al-Afaleq**

Table (1): Chemical composition of wheat flour (72% extraction), cardamom fruit, cinnamon bark, clove bud, marjoram, rosemary and thyme on dry weight.

Constituents %	Wheat flour (72% extraction)	Cinnamon bark	Clove bud	Cardamom fruit	Marjoram	Thyme	Rosemary
Crude protein	10.15	9.24	6.38	9.24	12.07	9.5	4.5
Ether extract	0.74	2.42	7.41	2.96	7.7	6.9	15.2
Crude fiber	0.76	24.69	3.52	18.75	12.0	18.7	19.1
Ash	0.61	2.51	9.57	10.59	12.9	12.7	6.0
Total Carbohydrates	87.74	51.91	64.02	53.74	47.43	45.1	47.4
Moisture	13.84	9.23	9.1	12.2	7.9	7.1	5.7

(1988) and Farrell (1990), who found that, the moisture content in cardamom fruit were 8.30-14.20% while it was 9.50-11.00% in cinnamon bark, however it was 6.90-12.00% in clove buds. The data also indicated that there were no difference between crude protein contents of cardamom and cinnamon (9.24%) while both were higher than that of clove buds and rosemary by 6.38 and 4.5% respectively, but both were lower than marjoram and thyme by 12.07 and 9.50% respectively, On the other hand, ether extract in clove (7.41%) on dry weight was higher than that in cardamom, cinnamon and thyme by 2.69, 2.42 and 6.90%, on dry weight basis, respectively but it was lower than rosemary and marjoram by 15.20 and 7.70% respectively. Moreover, the results indicated that, crude fiber in cinnamon was 24.69% on dry weight basis, which was higher than that in rosemary, cardamom, thyme, marjoram and clove by 19.10, 18.75, 18.70, 12.00 and 3.52%, on dry weight basis respectively. Simultaneously, ash content in marjoram (12.90% on dry weight basis) was higher than that in thyme, cardamom, clove, rosemary and cinnamon by 12.70, 10.59, 9.57, 6.00% and 2.51% and on dry weight basis, respectively. In addition total carbohydrate in cinnamon (60.14% on dry weight basis) was higher than that in clove, cinnamon, marjoram, rosemary and thyme by 59.16, 53.46, 47.43, 47.40, and 45.10% on dry weight basis, respectively. These results were agreed with those reported by Pursclove *et al.* (1981), Isa and Nazarifah (1986), Kholief and Al-Afaleq (1988), Farrell (1990) and Badei *et al.* (1991a).

From data in Table (1) it is clear that, the cardamom, cinnamon, clove, marjoram, rosemary and thyme had higher

contents of ether extract, ash and fiber (on 14.00% moisture basis) over those corresponding components in wheat Flour. Meanwhile, they had lower contents of protein and carbohydrate than those of wheat flour.

4.3. Minerals content of raw materials.

The minerals contribute 3 to 4% of the human body weight, and they play an important role in regulation of body liquid, acid base balance and metabolic process.

Results in Table (2) show that wheat flour has lower amounts of minerals than spices with some exceptions. Mineral content of wheat flour was 17.50, 4.92, 2.10, 0.35, 2.11, 27.02, 61.30 and 0.13 mg/100 g on dry matter of magnesium, sodium, zinc, manganese, iron, calcium, potassium and copper, respectively. These results are agreed with **Hamza (1999)**, **Mahmoud (2000)**, **Soliman (2000)** and **Ali (2000)** were found iron content range 1.27 to 1.89, zinc range 0.39 to 3.83 and manganese range 0.63 to 0.72 mg/100 g.

Iron content of thyme confirmed with the finding of **Farrell (1990)** and **Soliman (2000)**. They reported that iron content of thyme range from 122.30 to 124.00 mg/100 g (on dry weight basis). It's also confirmed with **Abd El-Lateef et al. (2001)** they reported that Ca, Na, Mg, K and Fe in Marjoram and thyme were 1983, 75, 345, 1516 and 81.69 and 1900, 202, 50, 220, 818 and 124.67, respectively.

shown in Table (2), it was followed by thyme then rosemary while clove and wheat flour had a lower content.

The results also showed that, the marjoram that was also the highest values in content of potassium (K), it was followed by cardamom fruit then clove, while cinnamon bark and wheat flour had a lower content in (K) as shown in Table (2). While the order of raw materials rich in zinc (Zn) component is as follows cardamom fruit then thyme, marjoram, rosemary, wheat flour, cinnamon bark and finally clove bud as shown in Table (2).

Results showed also that, the spices was the richer than wheat flour in the content of almost mineral. Also when we comparing the results with Recommended Daily Dietary Allowances for children 7-10 years (**R.D.D.A., 1989**) in Table (2) we found these spices rich in various minerals.

The high contents of minerals in these spices raise the nutritive value of wheat flour used for cake and croissant pastry making. 1gm(on dry basis) of marjoram, thyme, cardamom fruit and cinnamon bark add to wheat flour give 2.74, 6.83, 0.95 and 0.38%, thyme give 2.31, 10.0, 0.51 and 0.69%, cardamom fruit give 0.48, 1.17, 0.7 and 0.74% and cinnamon bark give 1.54, 3.27, 0.31 and 0.193% of Ca, Fe, K and Zn, respectively of Recommended Daily Dietary Allowances (**R.D.D.A., 1989**) for children 7-10 years, 28 Kg weight and 132 cm height, while wheat flour give only 0.03, 0.176, 0.038 and 0.21% of Ca, Fe, K and Zn, respectively of (**R.D.D.A., 1989**). This illustrates the importance of adding these spices to flour to raise the proportion of those minerals

4.4. Chemical composition of cardamom volatile oil:

The chemical constituents of cardamom volatile oil were fractionated and identified by using Gas Liquid Chromatography-Mass Spectrometry technique, in order to define the identity and its importance as antioxidant and antimicrobial agent. The obtained results are tabulated in Table (3) and illustrated in Figure (1). These results indicated that, 110 components were isolated from cardamom volatile oil, but just 12 components were identified, these identified components represented 87.09% of the chemical components of cardamom fruit volatile oil, these components could be classified to six chemical categories namely, cyclic terpenes (3.87%), terpene esters (39.41%), aliphatic terpene alcohols (2.41%), oxides (34.5%), sesquiterpene (3.92%) and sesquiterpene alcohols (2.98%). On the other hand, the remaining portion of this volatile oil 12.91%, represented 98 unknown compounds might be considered as trace compounds in such oil.

Results in Table (3) showed that the first chemical group identified in cardamom oil was cyclic terpenes, in which two compounds were found namely, α -pinene (1.62%) and sabinene (2.15%). These compounds were reported before as constituents of cardamom volatile oil by **Purseglove *et al.* (1981)**, **Farrell (1990)** and **Gopalakrishnan and Narayanan (1991)**.

The second identified chemical group in cardamom volatile oil was oxides one compound was found, belonged to this group, namely 1,8 cineol. This compound represented the major component in cardamom volatile oil, 34.5%. These results are in agreement with those reported by **Purseglove *et al.***

(1981), Farrell (1990) and Badei *et al.* (1991a) who found that, 1,8 cineol represented from 20% to 60% of cardamom volatile oil.

The third chemical group of cardamom volatile oil was found to be aliphatic terpene alcohols, of which one compound was found namely, linalool (2.41%). These data are in harmony with those reported by Purselove *et al.* (1981 and 1984), Badei *et al.* (1991a) and Gopalakrishnan and Narayanan (1991) who found that, linalool percentage in cardamom volatile oil was ranged from 1.0% to 8%.

The fourth chemical group identified in cardamom volatile oil was terpene esters. Three compounds belonged to this group were found namely, linalyl acetate (1.91%), α -terpnyl acetate (33.74%) and geranyl acetate (3.77%). These compounds were represented 39.41% of the chemical composition of cardamom volatile oil. These compounds were reported previously as constituents of cardamom volatile oil by Farrell (1990), Badei *et al.* (1991a) and Gopalakrishnan and Narayanan (1991).

Concerning the fifth chemical group identified in cardamom volatile oil, it was sesquiterpenes. Three compounds belonged to these group were found namely, α -copane (1.36%), γ -Elemene (1.06%) and Allo-Aromodrene (1.50%). These compounds represented 3.92% of the chemical composition of cardamom volatile oil. These compounds were reported before as constituents of cardamom volatile oil by Gurudutt *et al.* (1996) who found that, α -copane, γ -Elemene and Allo-aromadendrene represented 4.46% of cardamom volatile oil.

Table (3): Chemical components of cardamom, cinnamon, clove, thyme, marjoram and rosemary essential oils fractionated and identified by GC/Mass technique.

Compounds	Cardmom oil	Cinnamon oil	Clove oil	Thyme oil	Marjoram oil	Rosemary oil
α -pinene	1.72	0.34	0.10	1.53		36.42
Sablnene	2.15					
1,8 cineol	34.50			0.4		3.98
Linalool	2.41	7.02		12.59	17.89	0.99
Linalyl acetate	1.91	1.29			0.32	
Terpinyl acetate	33.93					
Geranyl acetate	3.77			1.91		
α -copane	1.36					
γ -elemene	1.06				0.20	
Allo-aromadendrene	1.50					
Trans-nerolidol	2.33					
Cis-nerolidol	0.65					
Limonene		2.42		3.15		0.11
Camphene		0.17			1.55	0.25
β -cymene		0.86		11.30		0.14
Benzaldehyde		0.45				
Cinnamic aldehyde		57.66				
2-Propenall, 3(2-nlethoxy phenyl)		5.74				
2-methoxy benzaldehyde		0.55				
Eugenol		2.86	86.02			
Terpene-4-ol		0.68			23.11	0.69
α -terpineol		3.01		0.42	0.74	6.62
Phenyl ethyl alcohol		1.12				1.64
2-propene-1-ol-3-phenyl		2.52				
Phenyl ethyl formate		0.47				
Phenyl ethyl acetate		0.82				
2-Pronen-1-ol-3-phenyl acetate		2.15				
Benzy benzoate		1.02				
Acetone			2.51			
α -opaene			0.37			
Caryophyllene			7.68			
Humelene			2.11			
Cadinen			0.29			
Eugenol acetate			0.39			
Cerainol				0.56		
β -pinene				0.22	7.99	2.75
β -octanone				0.51	7.80	
α -terpinene				0.71		
γ -terpinene				5.45		0.38
Ho-trienol				0.61		
β -cyclohexene				0.58		
Estragol				1.71		
Methyl thymylether				1.88		
Carvacrol				14.50		

Table (3): Cont.

Compounds	Cardmom oil	Cinnamon oil	Clove oil	Thyme oil	Marjoram oil	Rosemary oil
Trans-anethol				0.30		
Thymol				39.18	12.95	
Thymyl acetate				0.50		
Neryl acetate				0.25		
α -caryophyllene				1.57		0.47
1-octen-3-ol					1.49	
α -thujone					0.54	
Myrcene					1.91	
Terpinolene					1.11	
Cis-linalool oxide					0.48	
Trans-sabinene hydrate					2.86	
1 octen-3-yl acetate					0.77	
β -ocimene					0.41	
Trans P-menth-2-en-1-ol					0.38	
Camphor					2.88	7.75
Cis-piperitol					0.28	
β -caryophyllene					3.71	
α -humufene					0.50	
Germacrene					0.74	
Carvacrol					0.19	
Bicylogermacrene					4.53	
Spathulenol					0.23	
3-octanol						1.79
Isopulegol						0.30
P-cymen-9-ol						0.65
Verbenone						2.45
Isocamphopinone						1.65
Borneol						0.29
P-cymen-2-ol						21.27
Trans carophyllene						0.81
γ -gmjunene						0.97
α -cubebene						0.18
Copaene						0.80
Methyleugenol						0.40
γ -cadidene						0.12
Cuparene						0.87
β -cubebene						0.92
α -muurolene						0.25
β -bisobolene						0.30
γ -muurolene						0.51
Calamenene						0.84
Cadalene						0.50
Abietatriene						0.74
Total known	87.09	91.35	99.47	99.83	96.34	95.50
Unknown	12.91	8.65	0.53	0.17	3.66	4.50

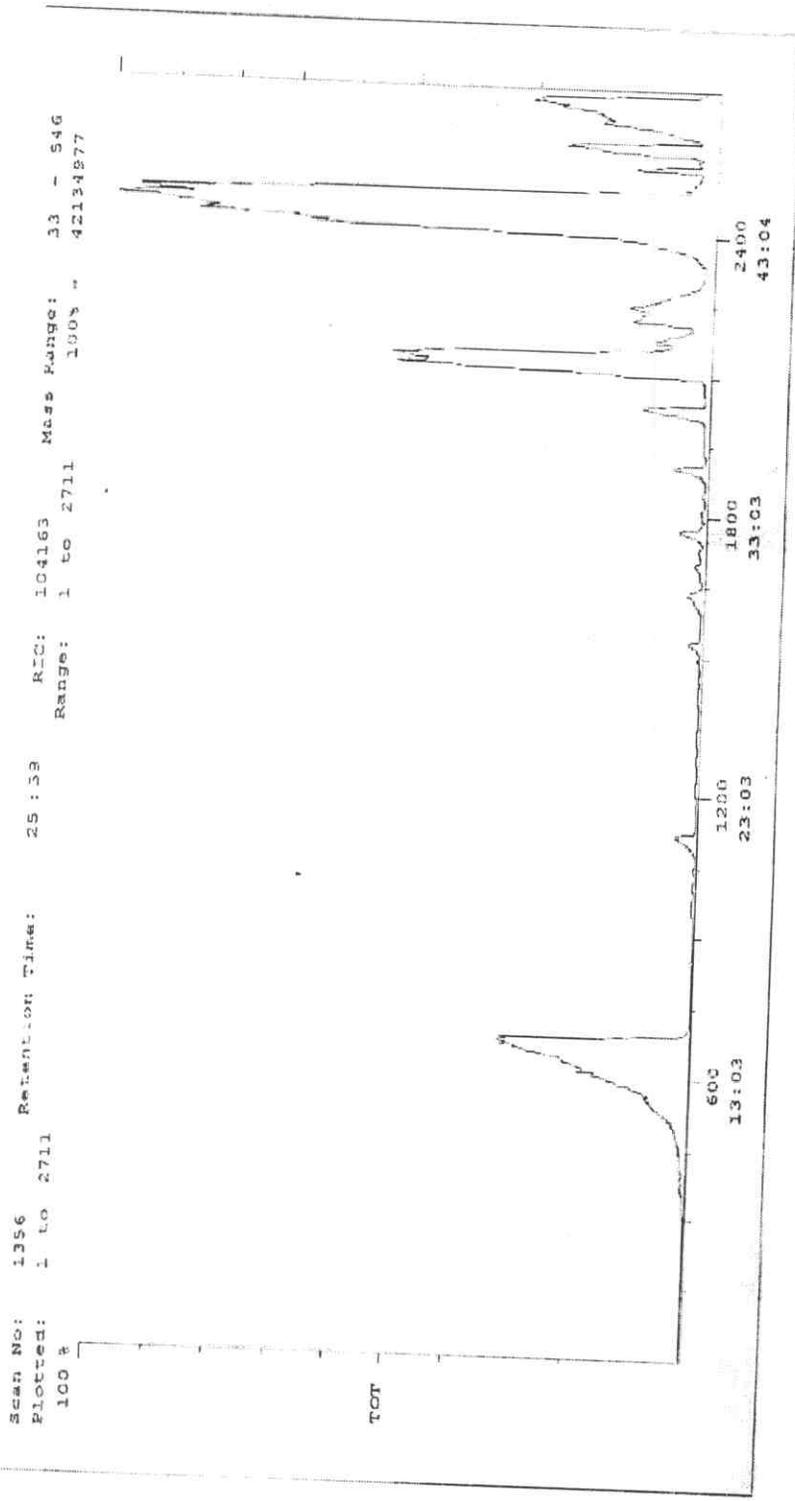


Fig. (1): GC -Mass spectra of identified components of cardamom

Scan No: 1356 Retention Time: 25:39 RIC: 2350569 Mass Range: 34 - 547
Plotted: 1 to 2711 Range: 1 to 2711 100% 39021898

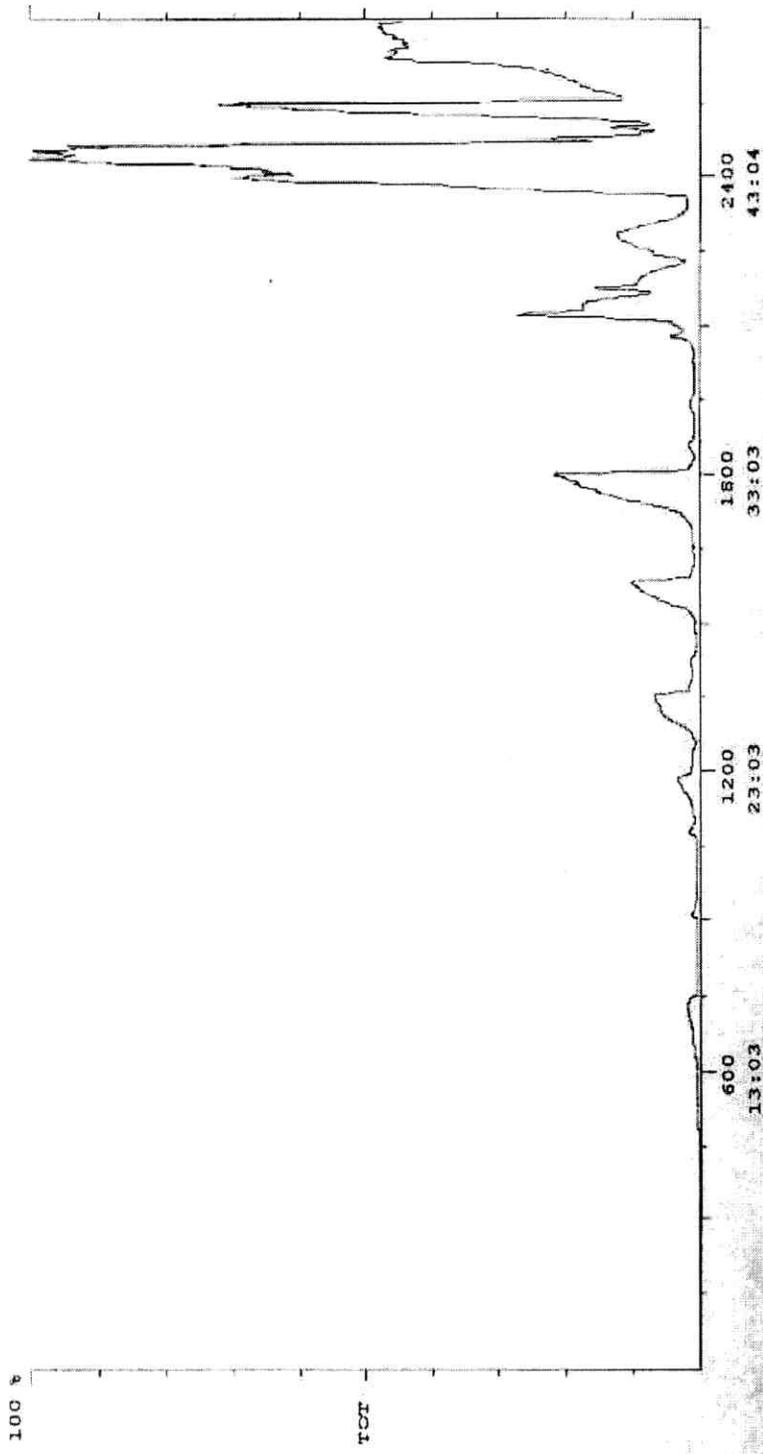


Fig. (4): GC -Mass spectra of identified components of thyme

Scan No: 471 Retention Time: 10:54 RIC: 595240 Mass Range: 21 - 397
Plotted: 1 to 942 Range: 1 to 942 100% = 80196788

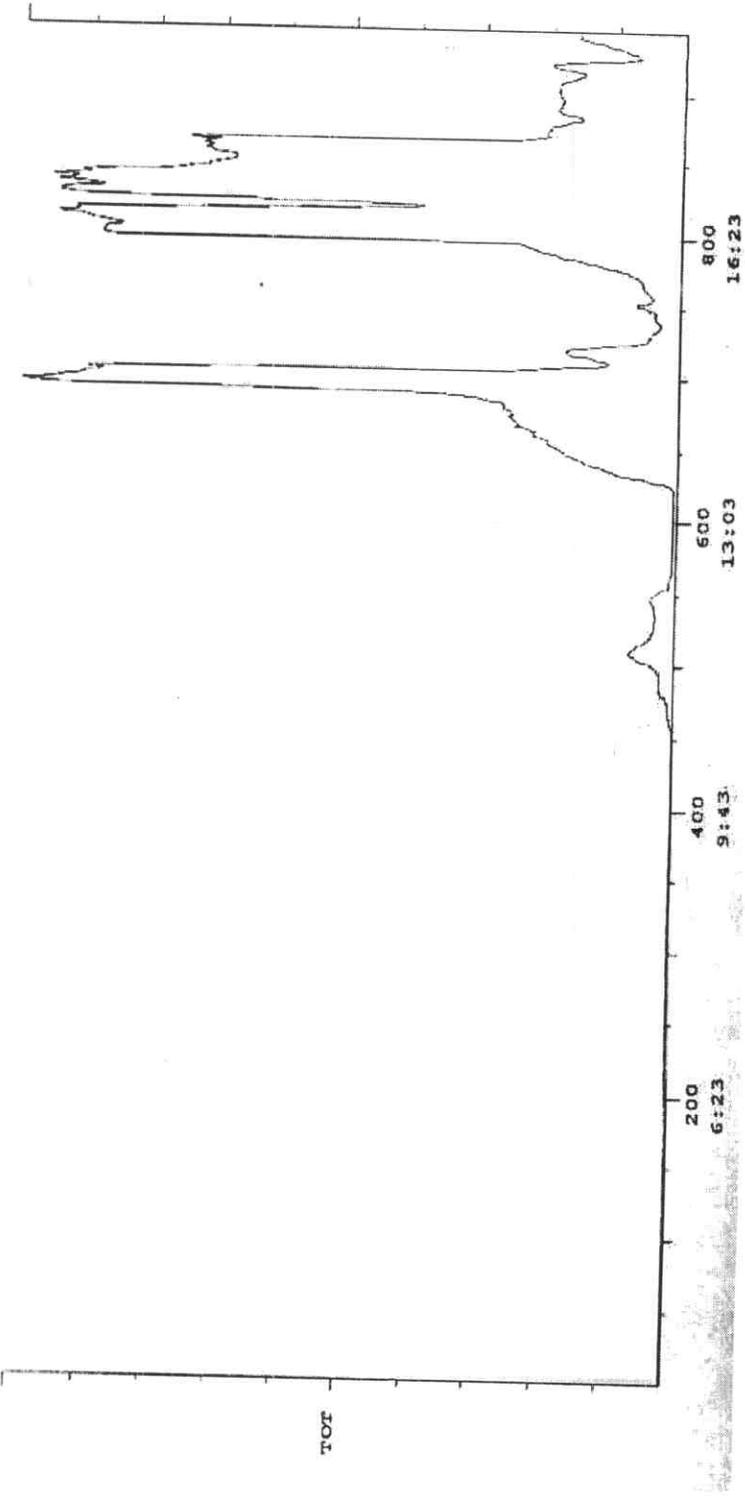


Fig. (5): GC -Mass spectra of identified components of marjoram

Scan No: 1547 Retention Time: 28 :50 RIC: 966910 Mass Range: 34 - 549
Plotted: 1 to 3093 Range: 1 to 3093 100% 93716252

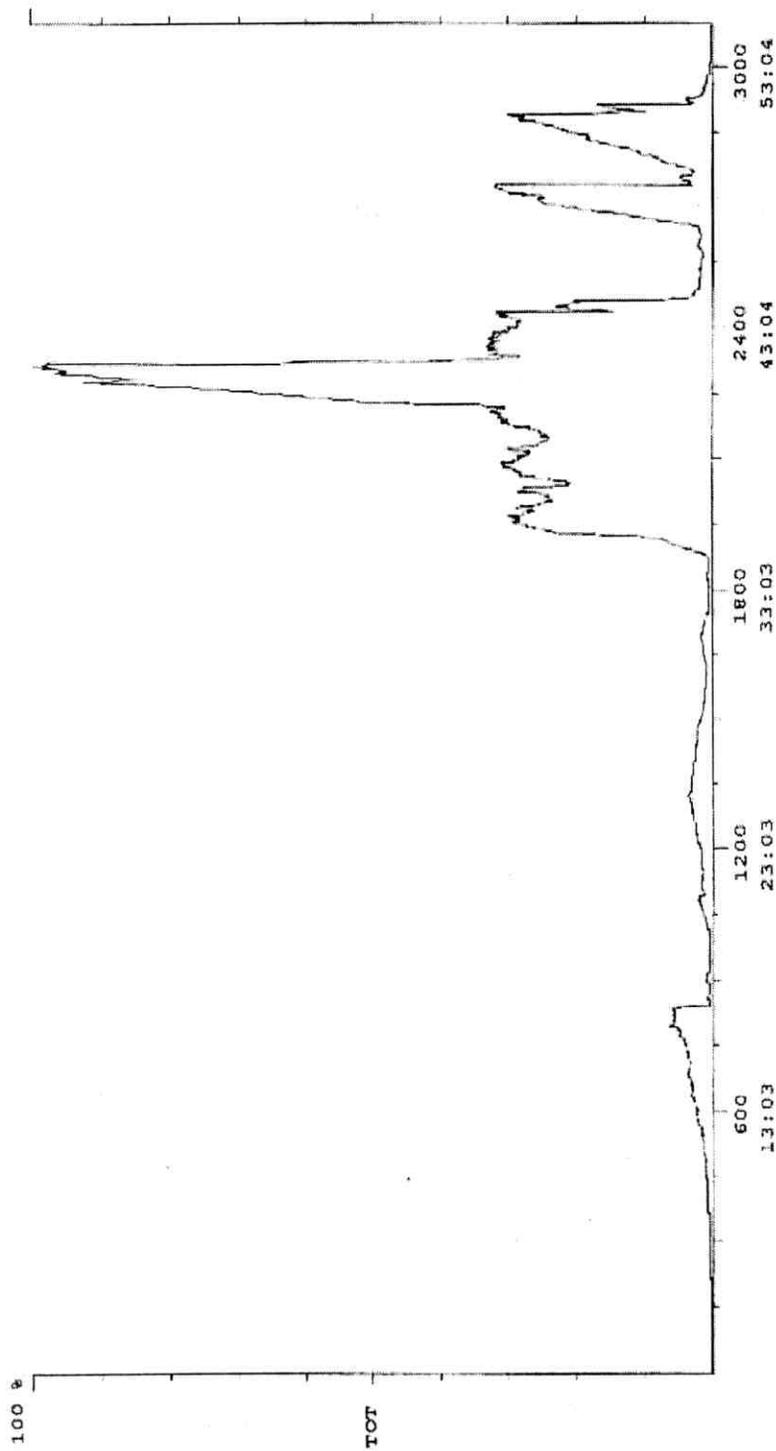


Fig. (6): GC -Mass spectra of identified components of rosemary

The sixth chemical group found in cardamom volatile oil was sesquiterpene alcohols. Two compounds were found belonged to this up namely, trans-nerolidol (33.2%) and cis-nerolidol (0.65%). These pounds were represented (2.98%).

These compounds were reported previously as constituents of cardamom volatile oil by **Masada (1980) and Gurudutt *et al.* (1996)**.

In general, the flavor components of cardamom volatile oil could be classified in to the following groups: Major compounds (>10%): represented 68.23% of cardamom volatile oil, composed of two major compounds namely, 1, 8 cineol (34.5%), terpinyl acetate (33.73%), minor compounds (<10-1%) represented 18.21% of cardamom volatile oil, composed of nine compounds namely, α -pinene (1.72%), sabinene (2.15%), linalool (2.41%), linalyl acetate (1.91%), geranyl acetate (3.77%), α -copane (1.36%), γ -elemene (1.06%), Allo-Aromodrene (1.5%) and trans-nerolidol (2.33%) and traces compounds (less than 1%)represented (12.91%) composed of 100 compounds.

4.5. Chemical composition of cinnamon volatile oil:

The chemical constituents of cinnamon volatile oil were fractionated and identified by using Gas Liquid Chromatography-Mass Spectrometry technique. The obtained data are tabulated in Table (3) and Fig. (2). from these results, it could be indicated that, 41 Components were isolated from cinnamon essential oil.

Nineteen components were identified and classified into 9 chemical categories namely; monocyclic terpenes (2.42%), bicyclic terpenes (0.51%), aromatic hydrocarbons (0.86%), aromatic aldehydes (64.6%), alcohols (14.35%), phenol and phenol ethers (2.86%), terpene esters (1.29%), aromatic alcohols (3.44%) and aromatic esters (1.02%). These identified compounds accounted for 91.35% of the Composition of cinnamon essential oil. 24 unknown constituents representing 8.65%.

The first chemical group in Table (3) cinnamon essential oil was monocyclic terpenes which consisted of one compound namely; Limonene (2.42%).

The second recorded chemical group was bicyclic terpenes which consisted of 2 compounds namely; α -pinene (0.34%) and camphene (0.17%). These components were reported as constituents of cinnamon essential oil by **Burdock (1995)**.

The third identified chemical group was aromatic hydrocarbons which consisted of one compound namely; P-cymene (0.86%). This compound was reported as constituent of cinnamon essential oil by **Masada(1980)**.

The fourth chemical group was aromatic aldehydes which consisted of 4 compounds namely; benzaldehyde (0.45%), 2-methoxy benzaldehyde (0.55%), cinnamic aldehyde (57.76%) and 2-propenal 1,3 (2-methoxy phenyl) (5.74%). This compound was reported as the major constituent of Cinnamon essential oil by **Lawiess (1992) and Burdock (1995)** who reported that

cinnamon bark essential oil contained much higher amount of cinnamon- aldehyde arrived to about 40-85% on the average.

The fifth chemical group recorded and identified in cinnamon essential oil was alcohols, 5 compounds was found in it namely; linalool (7.02%), terpene-4-ol (0.68%), α -terpineol (3.01%), phenyl ethyl alcohol (1.12%) and 2-propene-1-ol-3-phenyl (2.52%). This compound was reported by **Burdock (1995)**.

The sixth chemical group fractionated and identified in cinnamon essential oil was phenol and phenol ethers which contains one compound namely; eugenol (2.86%). These findings were comply with those obtained by **Lawiess (1992)** and **Burdock (1995)**, who reported that phenol content (as eugenol) represents from 4% to 10% from cinnamon bark essential oil. The seventh chemical group was terpenes esters which consisted of one compound namely; linalyl acetate (1.29%). The eighth chemical group was aromatic alcohols which consisted of 3 compounds namely: phenyl ethyl formate (0.47%) phenyl ethyl acetate (0.82%), 2-propen-1-ol, 3 phenyl acetate (2.15%). The ninth chemical group was aromatic esters which consisted of one compound namely; benzy benzoate (1.02%).

4.6. Chemical composition of clove essential oil:

The chemical constituents of clove essential oil were fractionated and identified using Gas liquid chromatography - Mass Spectrometry technique. The obtained results are tabulated

4.8. Chemical composition of marjoram essential oil:

The chemical constituents of marjoram essential oil were fractionated and identified using Gas liquid chromatography - Mass Spectrometry technique. Chemical compositions of essential oils are shown in Table (3) and Fig. (5). From these results, 28 compounds were identified by means of gas liquid chromatography and GC-MS analysis. The most prominent component was terpinen-4-ol (23.11%), linalool (17.89%), Thymol (12.95%), β -pinene (7.99%), α -terpinene (7.8%), Bicylogermacene (4.53%), β -caryophyllene (3.71%) and Camphor (2.88%).

This results were in agreement with **Abd El-Lateef *et al.* (2001)** reported that marjoram oil contained 40.12% monoterpinoid alcohols (linalool, 19.59% and terterpinen 4-ol, 20.53%), 15.38% monoterpinenes (α -terpinene, 7.14% and β -pinene 8.24%) and 12.19% phenols as thymol as the major constituents.

4.9. Chemical composition of rosemary essential oil:

The chemical constituents of rosemary essential oil were fractionated and identified using Gas liquid chromatography-Mass Spectrometry technique. Chemical compositions of essential oils are shown in Table (3) and Fig. (6).

From these results, 36 compounds were identified by means of gas liquid chromatography and GC-MS analysis. The major component was β -pinene (2.75%), α -pinene (36.42%) and camphor (7.75%), 1, 8-cineole (3.98%), verbenone (2.45%) and

borneol (21.27%), thymol (1.81%), α -terpinene (6.62%), this results were in agreement with **Elena *et al.* (1999)**

4.10. Sensory evaluation of different prepared cake:

Cinnamon bark and clove buds, cardamom fruits, thyme, rosemary and marjoram were added separately to wheat flour at four different concentrations (0.5, 1.0, 1.5, and 2.0%) for cake manufacture, while, the volatile oils of previous spices were added separately to cake batter at creaming stage at four different level 0.05, 0.075, 0.1 and 0.15% and the obtained products were sensory evaluated. The samples were evaluated by ten panelists for their cells, grains, texture, crumb color and flavor. The mean values were statistically analyzed using analysis of variance and least significant difference (LSD) as shown in Tables (4 and 5). The results indicated that additions of different levels of spices or their essential oils caused a significant difference in cake properties.

The results in Table (4) showed that, for texture and grain, there were significant differences between each adding level of spices were used. For grain and texture of samples prepared at adding levels 1% by using cardamom or cinnamon has the highest score (20.0) of the other spices, the most values were significantly different. Crumb color was also significantly reduced by increasing the spices level.

Flavor (taste and odor) is one of the most important quality attributes of different bakery products. There were significant differences in flavor (taste and odor) of spices cakes

Table (4): Effect of adding different levels of spices powders (cardamom, thyme, marjoram, rosemary, cinnamon, and clove) on sensory characteristics of cakes.

Spices	adding levels %	Crust color	Crumb color	Flavor		Texture	Grain	Overall acceptability
				Odor	Taste			
		10	20	15	15	20	20	100
Control	0	9.5 ^a	19.3 ^{ab}	14.0 ^{ab}	14.0 ^{abc}	19.0 ^a	18.5 ^{ab}	94.3 ^{ab}
Sodium propionate	0.03	9.0 ^{ab}	19.5 ^a	13.5 ^{bc}	14.5 ^{ab}	19.0 ^a	18.0 ^{ab}	93.5 ^{ab}
Cardamom	0.5	8.5 ^{abc}	17.5 ^{abc}	15.0 ^a	14.5 ^{ab}	20.0 ^a	19.0 ^{ab}	94.5 ^{ab}
	1.0	9.0 ^{ab}	17.6 ^{abc}	15.0 ^a	15.0 ^a	20.0 ^a	20.0 ^a	96.6 ^a
	1.5	8.0 ^{bcd}	17.0 ^{abc}	15.0 ^a	14.0 ^{abc}	19.0 ^a	18.0 ^{abc}	91.0 ^{abc}
	2.0	8.8 ^{ab}	16.5 ^{abc}	12.1 ^{de}	13.4 ^{abc}	16.9 ^{bc}	18.2 ^{ab}	85.9 ^{de}
Thyme	0.5	8.5 ^{ab}	18.0 ^{abc}	13.0 ^{bc}	13.0 ^{bcd}	17.0 ^{bc}	16.0 ^{cde}	85.5 ^{de}
	1.0	8.2 ^{abc}	16.5 ^{abc}	12.7 ^{cd}	13.0 ^{bcd}	14.9 ^{de}	15.0 ^{ef}	80.3 ^{ef}
	1.5	6.8 ^d	14.8 ^{de}	12.4 ^{de}	11.2 ^e	12.4 ^{fgh}	15.9 ^{def}	73.5 ^g
	2.0	7.0 ^d	13.6 ^{de}	11.3 ^e	11.2 ^e	12.7 ^{fgh}	15.5 ^{ef}	71.3 ^{gh}
Marjoram	0.5	9.0 ^{ab}	17.0 ^{abc}	13.5 ^{bc}	13.5 ^{abc}	20.0 ^a	19.0 ^{ab}	92.5 ^{abc}
	1.0	9.0 ^{ab}	17.0 ^{abc}	14.5 ^a	13.0 ^{bcd}	18.5 ^{ab}	17.0 ^{bc}	89.0 ^{bcd}
	1.5	8.8 ^{ab}	17.0 ^{abc}	14.3 ^{ab}	13.0 ^{bcd}	13.4 ^{efg}	18.1 ^{abc}	84.6 ^{de}
	2.0	8.8 ^{ab}	16.9 ^{abc}	13.0 ^{bc}	12.7 ^{cd}	13.4 ^{efg}	16.6 ^{cde}	81.4 ^{ef}
Rosemary	0.5	9.2 ^{ab}	18.4 ^{abc}	14.1 ^{abc}	12.8 ^{cde}	14.2 ^{def}	19.1 ^{ab}	87.8 ^{cd}
	1.0	8.8 ^{ab}	17.3 ^{abc}	13.4 ^{bc}	13.2 ^{bcd}	14.1 ^{ef}	17.8 ^{bcd}	84.6 ^{de}
	1.5	8.2 ^{abc}	16.3 ^{bcd}	13.1 ^{bc}	12.0 ^{de}	13.0 ^{efg}	17.0 ^{bcd}	80.5 ^{ef}
	2.0	7.3 ^{cd}	16.1 ^{cde}	13.4 ^{bc}	11.5 ^e	12.7 ^{fgh}	16.8 ^{cde}	77.8 ^f
Cinnamon	0.5	9.5 ^a	19.3 ^{ab}	15.0 ^a	14.5 ^{ab}	19.0 ^a	18.0 ^{abc}	95.3 ^a
	1.0	9.0 ^{ab}	19.5 ^a	15.0 ^a	15.0 ^a	20.0 ^a	20.0 ^a	96.5 ^a
	1.5	8.9 ^{ab}	18.5 ^{abc}	13.9 ^{abc}	13.6 ^{abc}	16.1 ^{cd}	16.5 ^{cde}	87.5 ^{cd}
	2.0	8.6 ^{abc}	16.3 ^{bcd}	13.8 ^{abc}	12.7 ^{cd}	14.1 ^{ef}	17.9 ^{abc}	83.4 ^{def}
Clove	0.5	8.0 ^{bcd}	16.0 ^{cde}	12.4 ^{de}	12.0 ^{de}	13.3 ^{efg}	17.9 ^{abc}	79.6 ^{ef}
	1.0	7.3 ^{cd}	12.9 ^{def}	11.4 ^e	8.4 ^f	12.3 ^{efgh}	15.2 ^{ef}	67.5 ^h
	1.5	6.0 ^{de}	10.0 ^{fg}	10.2 ^f	5.9 ^g	12.0 ^{gh}	15.0 ^{ef}	59.1 ⁱ
	2.0	5.0 ^e	8.0 ^g	7.0 ^g	2.0 ^h	11.0 ^h	14.0 ^f	47.0 ^j
L.S.D	-	1.34	3.16	1.40	1.68	1.93	2.12	5.73

Table (5): Effect of adding different levels of spices essential oils (cardamom, thyme, marjoram, rosemary, cinnamon, and clove) on the sensory characteristics of cakes.

Spices	adding levels %	Crust color	Crumb color	Flavor		Texture	Grain	Overall acceptability
				Odor	Taste			
				10	20			
Control	0	9.5ab	19.3 ab	14.0 abc	15.0 a	18.0 bc	18.5 bc	94.3 a
Sodium propionate	0.03	9.0bc	19.5 ab	13.5 bc	14.5a b	19.0 ab	17.0 de	92.5 ef
Cardamom	0.050	9.5ab	19.0 ab	14.0 ^{ab} _c	13.5 cd	19.0 ab	20.0 a	95.0 bcde
	0.075	10.0a	20.0a	15.0a	15.0a	19.5a	19.0ab	98.5a
	0.100	9.5ab	19.5ab	14.6a	14.0bc	19.5a	19.5a	96.6abc
	0.150	8.5cd	18.0abc	13.0cd	13.5cd	20.0a	19.0ab	93.0def
Thyme	0.050	9.0bc	17.0bcd	13.0cd	12.0e	16.0de	16.0ef	83.5h
	0.075	8.5cd	16.0cde	12.0de	10.0f	15.0e	15.5fg	76.0k
	0.100	8.0d	16.0cde	9.5f	7.0i	12.5f	13.0hi	67.0m
	0.150	7.0e	14.0ef	4.0i	2.5 m	12.5f	13.0hi	53.0o
Marjoram	0.050	9.5ab	19.5ab	13.5bc	13.5cd	19.0ab	19.0ab	94.5cde
	0.075	9.0bc	18.5abc	12.0de	12.0e	18.0bc	18.0bcd	87.5g
	0.100	8.5cd	18.0abc	12.0de	10.0f	18.0bc	16.0ef	82.5hi
	0.150	8.0d	17.5abc	11.0e	9.0g	18.0bc	15.5fg	79.0jk
Rosemary	0.050	9.0bc	18.5abc	13.0cd	13.0d	20.0a	17.5cd	91.0f
	0.075	9.0bc	18.0abc	11.5e	9.0g	19.0d	17.0de	83.5h
	0.100	8.5cd	18.0abc	9.0f	7.0i	15.0e	14.5g	72.0l
	0.150	8.0d	17.0bcd	7.5g	5.0k	13.5f	13.0hi	64.0m
Cinnamon	0.050	9.0bc	19.0ab	15.0a	14.0bc	19.0ab	18.0bcd	94.0cdef
	0.075	10.0a	19.0ab	15.0a	15.0 a	19.0ab	20.0a	98.0ab
	0.100	10.0a	20.0a	14.5ab	13.5cd	19.0ab	19.0ab	96.0abc
	0.150	8.5cd	19.0ab	12.0de	12.0 e	19.5a	20.0a	92.0ef
Clove	0.050	9.0bc	18.0abc	11.0e	10.0f	17.0cd	15.0fg	80.0ij
	0.075	8.0d	16.0cde	9.0f	8.0h	16.0de	14.5g	71.5l
	0.100	7.0e	14.5def	6.0h	6.0 j	15.0e	14.2gh	62.7n
	0.150	5.0f	12.0f	5.0hi	4.0 l	13.0f	12.0i	51.0o
L.S.D	-	0.92	2.55	1.01	0.92	1.42	1.46	3.27

samples than control sample, and also between each spices level and the other.

The obtained data showed that cinnamon, cardamom spices powder addition at levels 1.0 and 1.5% enhanced the cake flavor (taste and odor) comparison with control cake sample, thus, the over all acceptability were increased. A positive relationship was found between spices addition levels and flavor (taste and odor) of cakes until 1.5% of all spices except thyme and clove. That was probably due to good flavor these spices. The results indicated that the high levels addition of spices caused a significant deterioration in cake properties such as color of crust and crumb, flavor, texture, grain and over all acceptability. Thyme and clove addition had unacceptable taste, while, clove deteriorated the cake color values.

The obtained data from Table (5) showed that, there were no high change between control cake and all different cake volatile oils treatments in crust and crumb color except cinnamon and clove increasing adding volatile oils lead to an increase in color change. Also the result showed that, the high adding levels of marjoram and rosemary had unacceptable taste and odor. There were apposite relationship between adding levels of cardamom and cinnamon and overall acceptability until 1.5% level then the overall acceptability of cakes was decreased. Adding cinnamon and cardamom enhanced the cake taste, odor and overall acceptability, thus, the overall acceptability of 0.075 and 0.1 % adding level was better than control. The overall acceptability in control was 94.3%, while it was 98.0% and 100% of cardamom at 0.075 % and 0.1% respectively adding

levels also it was 98% and 96% in the same cinnamon adding level but the enhancing in overall acceptability stopped at 0.15% adding level.

4.11. Effect of adding 0.5, 1.0, 1.5 and 2.0% cinnamon, clove, cardamom, thyme, rosemary and marjoram powders and 0.05, 0.075, 0.1 and 0.15% of their essential oils on physical properties on cakes.

The results in Tables (6 and 7), shows the effect of adding 0.5, 1.0, 1.5 and 2.0% cinnamon, clove, cardamom, thyme, rosemary and marjoram powders and 0.05, 0.075, 0.1 and 0.15% of their essential oils on physical properties on cakes.

It could be observed that all cardamom, thyme, marjoram and clove powder treatments gave higher value in weight volume and specific volume for cakes. While all rosemary and cinnamon powder treatments gave lower values in volume and specific volume for cakes. This may be noticed that any addition of cardamom and clove powder increased physical properties and gave high value. Also, addition 0.03% Sodium propionate increased the volume and specific volume high increased than the control while it was lower than all cardamom, thyme, marjoram and clove powder treatments, this increase was simple and near the control. And it could be observed also all cardamom, thyme, and marjoram essential oils treatments gave higher value in weight volume and specific volume for cakes while all rosemary, cinnamon and clove essential oils treatments gave lower values.

Table (6): Physical properties of cakes produced from different levels of cinnamon, clove, cardamom, thyme, rosemary and marjoram powders treatments

Treatments	Weight (g)	Volume (cm ³)	Specific volume (cm ³ /g)
Control	38.05	57	1.498
Sodium propionate 0.03%	38.10	58	1.522
Cardamom 0.5%	34.29	58	1.691
Cardamom 1.0%	37.40	62	1.657
Cardamom 1.5%	35.02	62	1.770
Cardamom 2.0%	41.85	88	2.102
Thyme 0.5%	39.57	80	2.021
Thyme 1.0%	38.48	74	1.923
Thyme 1.5%	33.86	60	1.772
Thyme 2.0%	35.29	53	1.503
Rosemary 0.5%	38.59	39	1.010
Rosemary 1.0%	37.16	44	1.184
Rosemary 1.5%	36.24	38	1.048
Rosemary 2.0%	43.66	57	1.302
Marjoram 0.5%	38.55	68	1.763
Marjoram 1.0%	38.35	70	1.825
Marjoram 1.5%	39.49	71	1.797
Marjoram 2.0%	41.46	73	1.760
Cinnamon 0.5%	35.15	24	0.682
Cinnamon 1.0%	41.23	40	0.970
Cinnamon 1.5%	40.25	41	1.018
Cinnamon 2.0%	41.49	56	1.349
Clove 0.5%	39.29	66	1.679
Clove 1.0%	37.44	68	1.816
Clove 1.5%	36.89	67	1.816
Clove 2.0%	41.54	80	1.925

Table (7): Physical properties of cakes produced from different levels of cinnamon, clove, cardamom, thyme, rosemary and marjoram oils treatments.

Treatments	Weight (g)	Volume (cm)	Specific volume (cm ³ /g)
Control	38.05	57	1.498
Sodium propionate 0.03%	38.10	58	1.522
Cardamom 0.05%	35.52	56	1.576
Cardamom 0.075%	36.85	62	1.682
Cardamom 0.1%	38.64	74	1.915
Cardamom 0.15%	39.07	74	1.894
Thyme 0.05%	33.82	64	1.893
Thyme 0.075%	38.55	74	1.919
Thyme 0.1%	38.80	59	1.520
Thyme 0.15%	35.92	60	1.670
Rosemary 0.05%	33.03	35	1.059
Rosemary 0.075%	34.89	25	0.716
Rosemary 0.1%	37.29	33	0.884
Rosemary 0.15%	40.35	41	1.016
Marjoram 0.05%	40.21	67	1.667
Marjoram 0.075%	38.19	66	1.728
Marjoram 0.1%	36.51	63	1.725
Marjoram 0.15%	34.71	53	1.526
Cinnamon 0.05%	39.41	48	1.217
Cinnamon 0.075%	39.41	48	1.217
Cinnamon 0.1%	32.86	38	1.156
Cinnamon 0.15%	34.00	40	1.176
Clove 0.05%	38.28	44	1.149
Clove 0.075%	37.05	42	1.133
Clove 0.1%	41.26	50	1.218
Clove 0.15%	42.67	58	1.359

4.12. Chemical composition of different prepared cake:

The Chemical composition and total calories of prepared cake were determined on dry weight basis (Tables 8 and 9).

Results in table indicated that; the prepared cakes give 20.1%, 30.18% of energy and protein, respectively of Recommended Daily Dietary Allowances (**R.D.D.A., 1989**) for children 7-10 years, 28 Kg weight and 132 cm height.

Also, this result agreed with **Doweidar (2001)**, who found the cake give 438.52kcal, and cake contained 8.44% Protein, 10.6% Fat, 2.88%ash, 0.74% fiber and 77.34% carbohydrate. And also agreed with **Mahfouz *et al.* (2007)**.who found cake give 418 kcal, and cake contained 7.12% Protein, 22.1% Fat, 1.56% ash, 0.34% fiber and 68.88% carbohydrate.

Result in Table (8) showed there is no high change in protein, fat, carbohydrate, moisture and energy between different adding (0.5, 1.0, 1.5 and 2.0%) cinnamon, clove, cardamom, thyme, rosemary and marjoram powders, thus the different in protein contain of the samples ranged between 0.23% to 0.35% from the control, and Protein was 8.45 in control sample, the highest Protein value was 8.48 in cinnamon, cardamom, marjoram and thyme at adding level 2.0% and cinnamon 1.5% the and lowest value in rosemary at addition levels (1.0, 1.5 and 2.0%) and clove at 2% addition level. Also, the different in fat contain of the samples ranged between -0.1% to -0.70% from the control, and fat control was 28.73, the highest fat value was 28.73% in control followed by marjoram and rosemary at adding level 0.5% and the lowest value in cardamom addition

Table (8): Chemical composition of cake produced from wheat flour (WF) 72% extraction, cinnamon, clove, cardamom, thyme, rosemary and marjoram powders

Sample No.	Blends	Moisture %	As a dry basis					Energy Cal./100 g cake
			Protein %	Fat %	Fiber %	Ash %	Total carbohydrate %	
Recommended Daily Dietary Allowances for children 7-10 years (1989)		-	28 g	-	-	-	-	2000
Control		24.92	8.45	28.73	0.29	1.66	60.87	402
1	Cardamom 0.5%	24.85	8.46	28.70	0.34	1.68	60.82	402
2	Cardamom 1.0%	24.86	8.47	28.65	0.37	1.71	60.80	402
3	Cardamom 1.5%	24.84	8.47	28.60	0.42	1.76	60.75	402
4	Cardamom 2.0%	24.82	8.48	28.53	0.45	1.76	60.78	401
5	Thyme 0.5%	24.88	8.46	28.70	0.34	1.68	60.82	402
6	Thyme 1.0%	24.85	8.46	28.65	0.38	1.70	60.90	402
7	Thyme 1.5%	24.82	8.47	28.60	0.41	1.72	60.80	402
8	Thyme 2.0%	24.79	8.48	28.58	0.43	1.75	60.76	402
9	Rosemary 0.5%	24.87	8.44	28.72	0.33	1.68	60.83	402
10	Rosemary 1.0%	24.84	8.43	28.68	0.36	1.67	60.86	402
11	Rosemary 1.5%	24.82	8.43	28.65	0.41	1.68	60.89	402
12	Rosemary 2.0%	24.79	8.43	28.63	0.43	1.69	60.82	402
13	Marjoram 0.5%	24.87	8.45	28.72	0.32	1.69	60.82	402
14	Marjoram 1.0%	24.85	8.46	28.66	0.35	1.72	60.85	402
15	Marjoram 1.5%	24.82	8.47	28.62	0.39	1.75	60.77	402
16	Marjoram 2.0%	24.76	8.48	28.58	0.42	1.78	60.74	402
17	Cinnamon 0.5%	24.88	8.45	28.70	0.33	1.65	60.87	402
18	Cinnamon 1.0%	24.86	8.46	28.65	0.39	1.67	60.83	402
19	Cinnamon 1.5%	24.83	8.48	28.60	0.42	1.67	60.83	402
20	Cinnamon 2.0%	24.81	8.48	28.55	0.49	1.68	60.80	402
21	Clove 0.5%	24.87	8.45	28.70	0.30	1.68	60.87	402
22	Clove 1.0%	24.85	8.44	28.66	0.32	1.70	60.88	402
23	Clove 1.5%	24.83	8.44	28.62	0.33	1.72	60.89	402
24	Clove 2.0%	24.81	8.43	28.59	0.34	1.73	60.91	402

* Food Nutrition Board, National Academy of Sciences-National Research Council Recommended Daily Dietary Allowances (1989).

Table (9): Chemical composition of cake produced from wheat flour (WF) 72% extraction, cinnamon, clove, cardamom, thyme, rosemary and marjoram volatile oils

Sample No.	Blends	Moisture %	As a dry basis					Energy Cal./100 g cake
			Protein %	Fat %	Fiber %	Ash %	Total carbohydrate %	
Recommended Daily Dietary Allowances for children 7-10 years (1989)		-	28 g	-	-	-	-	2000
Control		24.92	8.45	28.73	0.29	1.66	60.87	402
1	Cardamom 0.05%	24.95	8.44	28.76	0.29	1.66	60.85	403
2	Cardamom 0.075%	24.90	8.44	28.76	0.27	1.67	60.86	402
3	Cardamom 0.1%	24.91	8.43	28.77	0.28	1.66	60.86	402
4	Cardamom 0.15%	24.94	8.44	28.79	0.29	1.65	60.83	402
5	Thyme 0.05%	24.88	8.45	28.76	0.29	1.67	60.83	403
6	Thyme 0.075%	24.90	8.46	28.77	0.28	1.66	60.83	403
7	Thyme 0.1%	24.95	8.45	28.77	0.30	1.65	60.83	402
8	Thyme 0.15%	24.95	8.46	28.79	0.28	1.67	60.80	402
9	Rosemary 0.05%	24.93	8.45	28.76	0.29	1.66	60.84	402
10	Rosemary 0.075%	24.96	8.46	28.77	0.28	1.67	60.82	402
11	Rosemary 0.1%	24.94	8.45	28.77	0.29	1.66	60.83	402
12	Rosemary 0.15%	24.95	8.44	28.79	0.30	1.68	60.79	402
13	Marjoram 0.05%	24.92	8.46	28.76	0.29	1.66	60.83	402
14	Marjoram 0.075%	24.90	8.45	28.77	0.29	1.67	60.82	402
15	Marjoram 0.1%	24.93	8.45	28.78	0.28	1.66	60.83	402
16	Marjoram 0.15%	24.94	8.44	28.90	0.29	1.66	60.71	403
17	Cinnamon 0.05%	24.95	8.46	28.76	0.27	1.67	60.82	402
18	Cinnamon 0.075%	24.94	8.45	28.77	0.28	1.67	60.83	402
19	Cinnamon 0.1%	24.93	8.44	28.77	0.29	1.66	60.84	402
20	Cinnamon 0.15%	24.93	8.44	28.85	0.29	1.67	60.75	403
21	Clove 0.05%	24.96	8.45	28.76	0.28	1.66	60.85	402
22	Clove 0.075%	24.95	8.45	28.77	0.28	1.66	60.84	402
23	Clove 0.1%	24.94	8.44	28.77	0.29	1.67	60.83	402
24	Clove 0.15%	24.93	8.44	28.81	0.30	1.66	60.79	402

* Food Nutrition Board, National Academy of Sciences-National Research Council Recommended Daily Dietary Allowances (1989).

level 2.0%. Also, the different in carbohydrate contain of the samples ranged between -0.21% to 0.04% from the control, and fat control was 60.87, the highest carbohydrate value was 60.91% in clove at adding level 2.0% followed by thyme at adding level 1.0% and the lowest carbohydrate value in marjoram addition level 2.0%. And the different in moisture contain of the samples ranged between -0.16% to- 0.64% from the control, the highest moisture value was 24.92% in control and the lowest moisture value in thyme addition level 2.0%.

Also from Table (9) there were change in fiber contain, the fiber in control sample was 0.29 and the highest fiber value was 0.49 at 2.00% level from cinnamon and followed by cardamom at the same addition level, while the lowest fiber value was 0.29 in control sample, the different in fiber contain of the samples ranged between 3.45% to 68.9% from the control.

Result in Table (9) showed there is no high change in protein, fat, carbohydrate, moisture and energy between different adding (0.05, 0.075, 0.1 and 0.15%) cinnamon, clove, cardamom, thyme, rosemary and marjoram essential oils, and also no high change in fiber.

Result show the fiber range at different adding level only was (0.27 to 0.30%) the highest value 0.30% was adding clove and rosemary at level 0.15 followed by thyme 0.1% the lowest value in cinnamon 0.05% and cardamom 0.075% adding level.

4.13. Effect of addition cinnamon, clove, cardamom, thyme, rosemary and marjoram powders or their essential oils on the shelf life of the cake:

Since the microbial carries (bacterial, mold and yeast) of any food product is correlated directly with the sanitary conditions of processing, handling and storage, the fungal growth of different cake under investigation were followed up directly after preparation and during the storage time to assess one of the most important factors in evaluation of cake safety and quality.

This section was planned to study the possibility of adding of cinnamon, clove, cardamom, thyme, rosemary and marjoram as a natural preservatives, at different levels 0.5, 1.0, 1.5 and 2.0% spices powder and 0.05, 0.075, 0.1 and 0.15% their essential oils in cake formula to retard the deterioration of growth microorganisms in cake and consequently to extend its shelf life. Cake (24.76 to 24.96% moisture ranges) were packaged with polyethylene and stored for different periods (0, 3, 6, 9, 12, 15, 18, 21, 24, 27 and 30 days) at 25°C. The results were presented in Tables (10 and 11)

The results showed that the addition of the spices powder or their essential oils at any adding level increased the storage period than the control, which, showed the lowest storage period (6 days). The effect of addition of cinnamon, clove, cardamom, thyme, rosemary and marjoram powder or their essential oils on the shelf life of the cake increased by increasing their

Table (10) Effect of addition cinnamon, clove, cardamom, thyme, rosemary and marjoram powders on visual growth of fungal and the shelf life of the cake

Treatments	Storage time (days) at 25°C										
	0	3	6	9	12	15	18	21	24	27	30
Control	-	-	-	+	++	++	+++	+++	++++	++++	VS
Sodium propionate 0.03%	-	-	-	-	-	-	-	+	+	++	++
Cardamom 0.5%	-	-	-	-	-	-	++	++	+++	+++	++++
Cardamom 1.0%	-	-	-	-	-	-	++	++	++	+++	+++
Cardamom 1.5%	-	-	-	-	-	-	-	+	+	++	++
Cardamom 2.0%	-	-	-	-	-	-	-	-	+	++	+++
Thyme 0.5%	-	-	-	-	-	-	+	+	++	++	+++
Thyme 1.0%	-	-	-	-	-	-	-	+	+	+	++
Thyme 1.5%	-	-	-	-	-	-	-	-	+	+	++
Thyme 2.0%	-	-	-	-	-	-	-	-	-	-	+
Rosemary 0.5%	-	-	-	-	-	-	+	++	+++	+++	++++
Rosemary 1.0%	-	-	-	-	-	+	+	++	++	+++	+++
Rosemary 1.5%	-	-	-	-	-	-	+	++	++	++	+++
Rosemary 2.0%	-	-	-	-	-	-	-	+	+	++	++
Marjoram 0.5%	-	-	-	-	-	+	++	++	+++	+++	++++
Marjoram 1.0%	-	-	-	-	-	-	+	++	++	+++	+++
Marjoram 1.5%	-	-	-	-	-	-	-	+	++	++	++
Marjoram 2.0%	-	-	-	-	-	-	-	+	+	++	++
Cinnamon 0.5%	-	-	-	-	-	++	++	++	+++	++++	VS
Cinnamon 1.0%	-	-	-	-	-	-	+	++	++	+++	++++
Cinnamon 1.5%	-	-	-	-	-	-	-	+	++	+++	++++
Cinnamon 2.0%	-	-	-	-	-	-	-	-	+	++	+++
Clove 0.5%	-	-	-	-	-	++	++	+++	+++	++++	++++
Clove 1.0%	-	-	-	-	-	+	+	++	++	+++	+++
Clove 1.5%	-	-	-	-	-	-	-	+	+	++	+++
Clove 2.0%	-	-	-	-	-	-	-	-	-	++	++

(-) = No growth

(++) = High growth

(+) = Start growth

(++++) = Highest growth

(++) = Moderate growth

(VS) = Very large spread

Table (11): Effect of addition cinnamon, clove, cardamom, thyme, rosemary and marjoram essential oils on visual growth of fungal and the shelf life of the cake

Treatments	Storage time (days) at 25°C									
	0	3	6	9	12	15	18	21	24	27
Control	-	-	-	+	++	++	+++	+++	++++	++++
Sodium propionate 0.03%	-	-	-	-	-	-	-	+	+	++
Cardamom 0.05%	-	-	-	-	-	-	++	++	++	+++
Cardamom 0.075%	-	-	-	-	-	-	+	+	+	++
Cardamom 0.1%	-	-	-	-	-	-	-	+	+	++
Cardamom 0.15%	-	-	-	-	-	-	-	-	+	++
Thyme 0.05%	-	-	-	-	-	-	+	+	++	++
Thyme 0.075%	-	-	-	-	-	-	+	+	+	+
Thyme 0.1%	-	-	-	-	-	-	-	-	+	++
Thyme 0.15%	-	-	-	-	-	-	-	-	-	+
Rosemary 0.05%	-	-	-	-	-	+	+	++	+++	+++
Rosemary 0.075%	-	-	-	-	-	-	+	++	++	+++
Rosemary 0.1%	-	-	-	-	-	-	+	++	++	++
Rosemary 0.15%	-	-	-	-	-	-	-	+	+	++
Marjoram 0.05%	-	-	-	-	-	+	++	++	+++	+++
Marjoram 0.075%	-	-	-	-	-	-	+	++	++	+++
Marjoram 0.1%	-	-	-	-	-	-	-	+	++	++
Marjoram 0.15%	-	-	-	-	-	-	-	+	+	++
Cinnamon 0.05%	-	-	-	-	-	++	++	++	+++	++++
Cinnamon 0.075%	-	-	-	-	-	-	+	++	++	+++
Cinnamon 0.1%	-	-	-	-	-	-	-	+	++	+++
Cinnamon 0.15%	-	-	-	-	-	-	-	-	+	++
Clove 0.05%	-	-	-	-	-	-	++	++	+++	+++
Clove 0.075%	-	-	-	-	-	-	+	+	++	+++
Clove 0.1%	-	-	-	-	-	-	-	+	+	++
Clove 0.15%	-	-	-	-	-	-	-	-	+	++

(-) = No growth
(+++)= High growth

(+) = Start growth
(++++)= Highest growth

(++) = Moderate growth
(VS) = Very large

concentrations. Also the high addition of thyme powder (2 g/100 g) or its essential oil (0.15 g/100 g) had the highest effect on retarding the growth of all microorganisms in the stored cake till (27 days) for powder and (24 days) for essential oil, followed by the addition of cinnamon, clove and cardamom powder (2 g/100 g) and thyme powder at level (1.5 g/100 g) or their essential oils (0.15 g/100 g) or (0.1 g/100 g) for thyme essential oil, (21 days). The addition of marjoram and rosemary powder at level 2.0 g/100 g, the addition of cardamom, cinnamon or clove powder at level 1.5 g/100 g and the addition 1.0 g/100 g of thyme had the same effect of adding 0.03% of sodium propionate (18 days). While the spoilage of cake treated by marjoram, cinnamon or clove powder at level 0.5 g/100 g flour or rosemary or clove at level 1 g/100 g flour was detected only after (12 days).

The results of the additions of essential oils were extremely had the same effect of additions of the spices powders. This result was agreed with **Mohamed (1999)** who reported that, the addition cardamom, cinnamon and clove powders or their volatile oils, had a distinctive effect in extending shelf life of cookies by suppressing growth of microorganisms. And he reported also the inhibitory effect of oils can be ranked as follows: clove volatile oil > cinnamon volatile oil > cardamom volatile oil. and results was agreed also with **Hassanen (2005)** that reported, the inhibitory effect of oils can be ranked as follows: clove essential oil > cinnamon essential oil and reported also the inhibitory effect of clove, cinnamon and ginger essential oils increased with increasing their concentrations.

4.14. Identify the type of microbial growth on the cake samples produce with different addition level of spices.

The results in Tables (12 and 13) show the microbial types growth on cake in different treatments on cakes. From results in Table (12) the result showed there were no growth on every different spices powders treatments at the first week, and in second week the fungal growth noticed in control and some treatments such as marjoram, cinnamon and clove spices powders treatments at adding level 0.5% also at clove powder treatment at adding level 1.0 % and rosemary powder treatment at the same adding level. And when identified the type of fungal growth found that, the growth in control, rosemary and cinnamon treatments was *Penicillum* sp, while the growth in marjoram and clove treatments was *Aspergillus* sp.

And the results showed on third week on third week the every powder treatments had fungal growth, and identified both *Penicillum* and *Aspergillus* sp in control, cardamom, marjoram, and cinnamon 0.5%, thyme and clove 0.5, 1.0 and 1.5 % adding powders level, and also identified *Rhizopus* sp in thyme 0.5% treatments, but the growth in sodium propionate 0.03%, cardamom 1.0, 1.5 and 2.0%, rosemary 1.5 and 2.0% powders treatments was *Penicillum*, while it was *Aspergillus* sp at marjoram 1.0, 1.5 and 2.0% , cinnamon 1.0 and 1.5% and clove 2.0%.

And identified both *Penicillum* and *Aspergillus* sp growth in every treatments on fourth week except thyme and cinnamon 2.0% adding powder level was *Aspergillus* only but noticed also *Fusarium* sp at control, sodium propionate 0.03%, thyme 0.5 and

Table (12): The type of microbial growth of different treatments (spices powders adding) on cakes powder

Treatments	Storage period (week)				
	Zero	First	Second	Third	Fourth
Control	-	-	P	P+A	P+A+R+F
Sodium propionate 0.03%	-	-	-	P	P+A+F
Cardamom 0.5%	-	-	-	P+A	P+A+R
Cardamom 1.0%	-	-	-	P	P+A
Cardamom 1.5%	-	-	-	P	P+A
Cardamom 2.0%	-	-	-	P	P+A
Thyme 0.5%	-	-	-	A+P+R	A+P+R+F
Thyme 1.0%	-	-	-	P+A	P+A+R+F
Thyme 1.5%	-	-	-	P+A	A+P+R
Thyme 2.0%	-	-	-	A	A
Rosemary 0.5%	-	-	-	P+A	P+A
Rosemary 1.0%	-	-	P	P+A	P+A
Rosemary 1.5%	-	-	-	P	P+A
Rosemary 2.0%	-	-	-	P	P+A
Marjoram 0.5%	-	-	A	A+P	A+F+R
Marjoram 1.0%	-	-	-	A	A+P+R
Marjoram 1.5%	-	-	-	A	A+R
Marjoram 2.0%	-	-	-	A	A+P
Cinnamom 0.5%	-	-	P	P+A	A+P
Cinnamom 1.0%	-	-	-	A	A+P
Cinnamom 1.5%	-	-	-	A	A+P
Cinnamom 2.0%	-	-	-	P	A
Clove 0.5%	-	-	A	A+P	A+P+F+R
Clove 1.0%	-	-	A	A+P	A+P+F+R
Clove 1.5%	-	-	-	A+P	A+P+R
Clove 2.0%	-	-	-	A	A+P

- = No growth

P= penicillum sp

A = *Aspergillus* sp

R=*Rhizopus* sp

F= *Fusarium* Sp

Table (13): The type of microbial growth of different treatments (spices Volatile oils adding) on cakes

Treatments	Storage period (week)				
	Zero	First	Second	Third	Fourth
Control	-	-	P	P+A	P+A+R+F
Sodium propionate 0.03%	-	-	-	P	P+A+F
Cardamom 0.05%	-	-	-	P+A	P+A+R
Cardamom 0.075%	-	-	-	P+A	P+A
Cardamom 0.1%	-	-	-	P	P+A
Cardamom 0.15%	-	-	-	P	P+A
Thyme 0.05%	-	-	-	A+P	A+P+R
Thyme 0.075%	-	-	-	P+A	P+A+F
Thyme 0.1%	-	-	-	P+A	A
Thyme 0.15%	-	-	-	A	A
Rosemary 0.05%	-	-	P	P+A	P+A+F
Rosemary 0.075%	-	-	-	P+A	P+A
Rosemary 0.1%	-	-	-	P	P+A
Rosemary 0.15%	-	-	-	P	P+A
Marjoram 0.05%	-	-	A	A+P	A+F+R
Marjoram 0.075%	-	-	-	A+p	A+P+R+
Marjoram 0.1%	-	-	-	A	A+R
Marjoram 0.15%	-	-	-	A	A+P
Cinnamon 0.05%	-	-	P	P+A	A+P+R
Cinnamon 0.075%	-	-	-	A+p	A+P
Cinnamon 0.1%	-	-	-	A	A+P
Cinnamon 0.15%	-	-	-	P	A
Clove 0.05%	-	-	A+P	A+P+F	A+P+F+R
Clove 0.075%	-	-	A	A+P	A+P+F+R
Clove 0.1%	-	-	-	A+P	A+P+R
Clove 0.15%	-	-	-	A	A+P

- = No growth

P= penicillium sp

A = *Aspergillus* sp

R=*Rhizopus* sp

F= *Fusarium* Sp

1.0%, marjoram 0.5% and clove 0.5 and 1.0% adding level and identified *Rhizopus* sp at cardamom 0.5%, thyme 0.5, 1.0 and 1.5%, marjoram 1.0 and 1.5% and clove 0.5, 1.0 and 1.5% adding level spices powders treatments.

4.15. Antimicrobial activity of cinnamon, cardamom, rosemary and marjoram

4.15.1. Effect of cinnamon, cardamom, rosemary and marjoram essential oils on fungal growth and inhibition rate

The effect of some spices essential oils on fungal growth and inhibition rate were studied and the obtained results are shown in Tables (14 to 16) and illustrated in Fig (7).

From the results presented in Table (14) and illustrated in Fig (7) it could be noticed that addition of cinnamon, cardamom, rosemary and marjoram essential oils to the media (PDA) at levels (0.075, 0.1 and 0.15) increased the diameter of zone inhibition of *Penicillium chrysogenum*, increase in zone inhibition at 0.15% level in cinnamon, cardamom, rosemary and marjoram were 191.66, 200, 125 and 255%. Also, increase in zone inhibition at 0.1% level in cinnamon, cardamom, rosemary and marjoram were 141.66, 181.60 and 171%. Also, increase in zone inhibition at 0.075% level in cinnamon, cardamom, rosemary and marjoram were 66.67, 115, 35 and 130%.

From the results presented in Table (14) and illustrated in Fig (7) it could be noticed that addition of cinnamon, cardamom,

Table (14): Effect of cinnamon, cardamom, rosemary and marjoram essential oils on growth and inhibition rate of *Penicillium chrysogenum* (incubation period 120 hrs)

Treatments	Diameter of zone inhabitation (cm)	Increase in zone inhabitation (%)
Control	0.50	0.0
Rosemary 0.075%	0.68	35
Rosemary 0.1%	0.80	60
Rosemary 0.15%	1.13	125
Marjoram 0.075%	1.15	130
Marjoram 0.1%	1.35	170
Marjoram 0.15%	1.77	255
Cinnamon 0.075%	0.83	66.67
Cinnamon 0.1%	1.46	141.66
Cinnamon 0.15%	1.20	191.66
Cardamom 0.075%	1.08	115
Cardamom 0.1%	1.40	180
Cardamom 0.15%	1.50	200

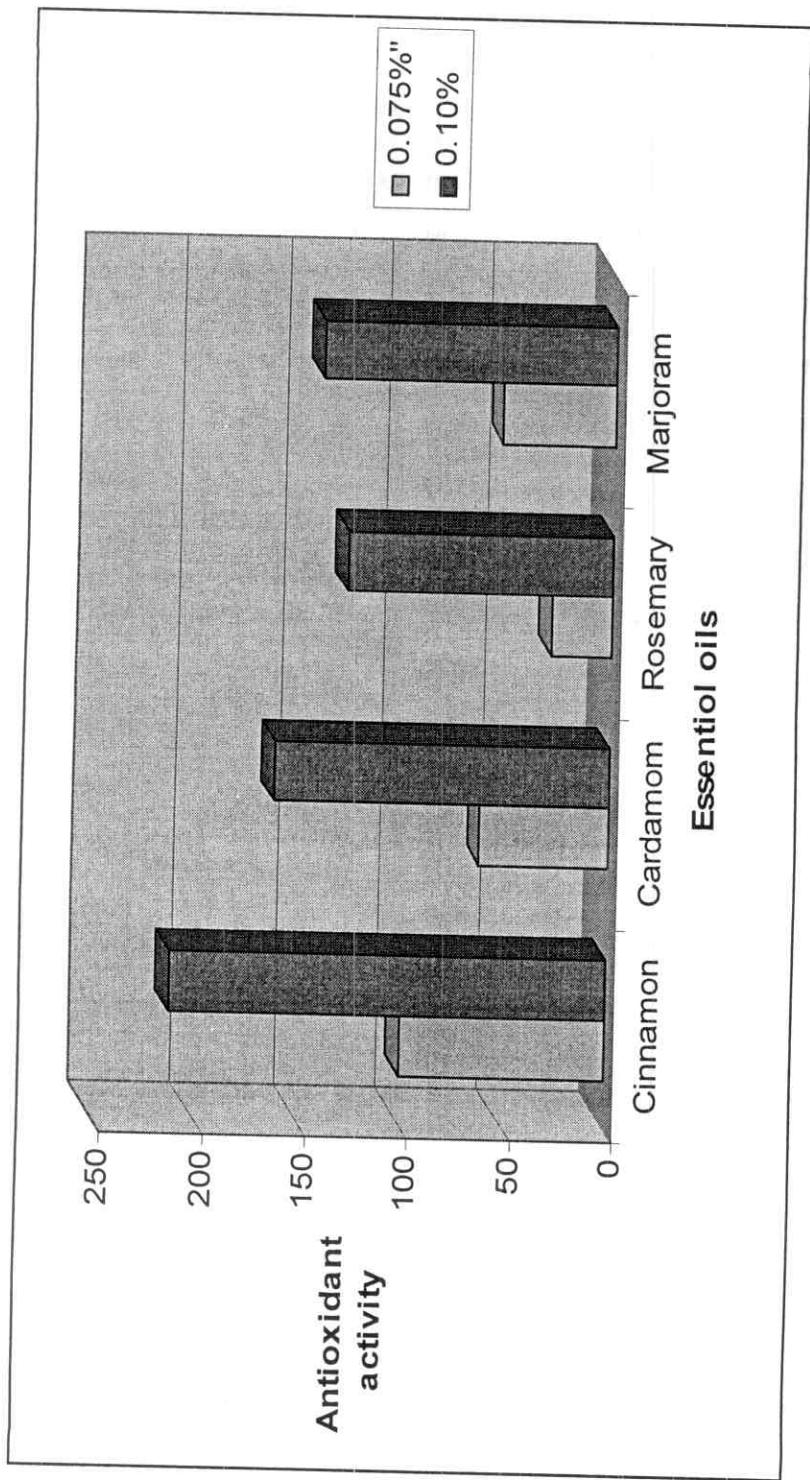


Fig. (7): Antioxidant activity (AA) of cinnamon, cardamom, rosemary and marjoram essential oils

rosemary and marjoram essential oils to the media (PDA) at levels (0.075, 0.1 and 0.15) increased the diameter of zone inhibition of *Aspergillus flaus*, increase in zone inhibition at 0.15% level in cinnamon, cardamom, rosemary and marjoram were 177.27, 279.10, 142.30 and 279.1%. Also, increase in zone inhibition at 0.1% level in cinnamon, cardamom, rosemary and marjoram were 113.63, 187.50, 84.61 and 107.14%. Also, increase in zone inhibition at 0.075% level in cinnamon, cardamom, rosemary and marjoram were 72.72, 125, 30.77 and 32.14%.

From the results presented in Table (15) illustrated in Fig (8) it could be noticed that addition of cinnamon, cardamom, rosemary and marjoram essential oils to the media (PDA) at levels (0.075, 0.1 and 0.15) increased the diameter of zone inhibition of *Fusarium oxysporium*, increase in zone inhibition at 0.15% level in cinnamon, cardamom, rosemary and marjoram were 172.73, 171.4, 142.3 and 92.30%. Also, increase in zone inhibition at 0.1% level in cinnamon, cardamom, rosemary and marjoram were 136.36, 150, 69.23 and 84.61%. Also, increase in zone inhibition at 0.075% level in cinnamon, cardamom, rosemary and marjoram were 72.73, 114.23, 53.85 and 76.92%.

The increasing in diameter of zone inhabitation indicate to increasing in zone inhabitation which referring to increasing in anti-fungal effect.

In general inhibited the growth increased by increasing essential oils levels and adding level at 0.15 had strongest inhibited the growth against organisms. Every treatments had stronger inhibited the growth of the organisms than control. The

Table (15): Effect of cinnamon, cardamom, rosemary and marjoram essential oils on growth and inhibition rate of *Aspergillus flavus* (incubation period 120 hrs)

Treatments	Diameter of zone inhabitation (cm)	Increase in zone inhabitation (%)
Control	0.5	0.0
Rosemary 0.075%	0.65	30.77
Rosemary 0.1%	0.92	84.61
Rosemary 0.15%	1.21	142.3
Marjoram 0.075%	1.15	32.14
Marjoram 0.1%	3.0	107.14
Marjoram 0.15%	1.5	279.1
Cinnamon 0.075%	0.86	72.72
Cinnamon 0.1%	1.067	113.63
Cinnamon 0.15%	1.39	177.27
Cardamom 0.075%	1.13	125
Cardamom 0.1%	1.44	187.5
Cardamom 0.15%	1.90	279.1

cardamom at level 0.15 had a strongly inhibited the growth against *Aspergillus flaus* and *Fusarium oxysporium*, also cinnamon at level 0.15 had a strongly inhibited the growth against *Aspergillus flaus* and *Fusarium oxysporium*, while marjoram at level 0.15 had a strongly inhibited the growth against *Penicillium chrysogenum*. Also, The cinnamon and cardamom had effects varied between from moderate to high against the activity of the three test fungus at levels (0.075% 0.1% and 0.15%), while The rosemary and marjoram had effects varied between from low to moderate against the activity of the three test fungus at levels (0.075, 0.10 and 0.15%) except marjoram had high inhabiting effect against *Penicillium chrysogenum*

Finally the results lead the cardamom, cinnamon, marjoram and rosemary were highly inhibitive to growth so prefer to use with bakery product to increase shelf life especially in cake and croissant pastry which are considered a high-fat, high moisture bakery product.

4.16. Antioxidant activity of the essential oils:

The antioxidant activities of the essential oils extracted from the cinnamon bark, cardamom, rosemary and marjoram powders were assessed by the Rancimat instrument. The Rancimat test was applied in our investigation because this technique allows the automatic determination of the oxidative stability of oils and fats without the need for expensive and environmentally hazardous chemicals. The Rancimat test is

Table (17): Effect of addition of cinnamon, cardamom, rosemary and marjoram essential oils on antioxidant activity percentage (AA)% in corn oil:

Sample		(AA)% *
Control (0.0%)		0.00
Cinnamon	0.075%	100.60
	0.1%	212.94
Cardamom	0.075%	62.48
	0.1%	163.79
Rosemary	0.075%	29.39
	0.1%	129.69
Marjoram	0.075%	54.46
	0.1%	142.73

*The antioxidant activity percentage (AA) was calculated from the following equation:

$$AA\% = \frac{\text{Induction period (IP) of sample} - \text{Induction period (IP) of control}}{\text{Induction period (IP) of control}} \times 100$$

Table (19): Effect of addition of cinnamon, cardamom, rosemary and marjoram essential oils on relative stability % in corn oil:

Sample		Relative stability % *
Control (0.0%)		100
Cinnamon	0.075%	49.85
	0.1%	31.95
Cardamom	0.075%	61.54
	0.1%	37.90
Rosemary	0.075%	79.13
	0.1%	43..53
Marjoram	0.075%	64.74
	0.1%	41.19

* Relative stability % was calculated from the following equation:

$$\text{Relative stability \%} = \frac{\text{Induction period (IP) of sample}}{\text{Induction period (IP) of control}} \times 100$$

The antioxidants properties of cinnamon, cardamom, rosemary and marjoram at 0.075 and 0.10% adding level on corn oil were determined and the obtained results are recorded in Tables (18-19) and illustrated in Figs. (7 and 8).

The results illustrated that all studied essential oils at various concentrations exhibited antioxidant activity.

Moreover, the induction periods for all studied systems were greater than that of control corn oil free from additives). This means that all the added essential oils possessed antioxidant effect.

Concerning cinnamon essential oil, from the results presented in table 10 it exhibited lower relative stability than that of cardamom, rosemary and marjoram essential oils. These results were agreed with the results reported by **Mohammed (1999)** who reported that, the addition cardamom, cinnamon and clove to palm oil caused indication period increased, and results were agreed also with **Hassanen (2005)**

The results also shows 0.1% adding level exhibited lower relative stability than 0.075% adding level of cinnamon, cardamom, rosemary and marjoram essential oils These results were agreed with the results reported by **Mohammed (1999)** who reported also that antioxidant efficiency of clove, cinnamon and cardamom essential oils increased by increasing their concentrations.

These structural requirements are supported by the powerful antioxidant activities of the natural antioxidant thymol (**Farag et al., 1989a; and Pizzale et al., 2002**). In general, the

phenolic OH has to be in the free form and if these groups are attached to other groups it would prevent their antioxidant power due to the lack of hydrogen atom donates to a fatty acid radical (Asakura *et al.*, 1989).

4.17. Sensory evaluation of different prepared croissant pastry:

Data in Table (20) represent the mean scores and their statistical indications for crust appearance, layer formation, texture, color, taste, odor and acceptability for prepared croissant pastry manufactured with different adding levels of cardamom, cinnamon, rosemary and marjoram powders (1.0 and 1.5%) or their volatile oils (0.1 and 0.075) and the obtained products were sensory evaluated. The samples were evaluated by ten panelists for their crust appearance, layer formation, texture, color, taste, odor and acceptability. The mean values were statistically analyzed using analysis of variance and least significant difference (LSD) as shown in Tables (20). The results indicated that additions of different levels of spices or their essential oils caused a significant difference in croissant properties.

Data in Table (20) showed that, for layer formation there were significant differences between each adding level of spices were used, adding levels 1.0 and 1.5% by using cardamom or cinnamon powder and adding levels 0.1 and 0.075% by using cardamom or cinnamon essential oils has the highest score (20.0) of the other spices. The most values were significantly different.

Table (20): Effect of adding different levels of spices powder and their essential oils (cardamom, marjoram, rosemary, and cinnamon) on sensory characteristics of croissant pastry produced from commercial flour.

Spices	Adding levels %	Sensory characteristics						Overall accept-Ability (100)	
		Crust appearance (15)	Layer formation (20)	Crumb color (10)	Texture (15)	Taste (20)	Odor (20)		
Control	000	15.0a	19.0ab	9.0b	15.0a	19.5ab	19.0abc	96.5b	
Sodium propionate	0.03	15.0a	19.0ab	9.0b	15.0a	19.0abc	18.5bcd	95.5b	
Cardamom	Powder	1.00	14.0b	20.0a	9.0b	14.0a	20.0a	20.0a	97.0ab
		1.50	14.0b	20.0a	9.0b	14.0a	20.0a	20.0a	97.0ab
	Essential oils	0.075	14.0b	20.0a	10.0a	14.0a	20.0a	20.0a	98.0ab
		0.100	15.0a	20.0a	10.0a	15.0a	20.0a	20.0a	100.0a
Marjoram	Powder	1.00	14.5ab	18.0b	10.0a	13.5ab	18.0cde	18.0cde	92.0c
		1.50	14.5ab	18.0b	10.0a	12b	17.5de	17.5de	89.5c
	Essential oils	0.075	15.0a	15.0c	10.0a	15.0a	15.5f	15.5f	86.0d
		0.100	15.0a	15.0c	10.0a	15.0a	15.0fg	15.0f	85.0d
Rosemary	Powder	1.00	14.5ab	18.0b	10.0a	13.5ab	17.5de	17.5de	91.0c
		1.50	14.5ab	18.0b	10.0a	12.0b	17.0e	17.0e	88.5a
	Essential oils	0.075	15.0a	15.0c	10.0a	15.0a	15.0fg	15.0f	85.0d
		0.100	15.0a	15.0c	10.0a	15.0a	15.5f	14.5f	85.0d
Cinnamon	Powder	1.00	14.0b	20.0a	9.5ab	15.0a	18.5bcd	18.5bcd	95.5b
		1.50	14.5ab	20.0a	9.0a	15.0a	18.5bcd	19.0abc	96.0b
	Essential oils	0.075	15.0a	20.0a	9.5ab	15.0a	18.5bcd	19.0abc	97.0ab
		0.100	15.0a	20.0a	10.0a	15.0a	19.0abc	19.5ab	98.5ab
L.S.D		0.92	1.52	0.7	1.64	1.28	1.13	3.32	

* Properties with the same letter not differed significantly

Table (22): Chemical composition of croissant produced from wheat flour (WF) 72% ext., cinnamon, clove, cardamom, thyme, rosemary and marjoram volatile oils

Sample No.	Blends	Energy Cal./ 100 gm cake	Moisture %	As a dry basis				
				Protein %	Fat %	Fiber %	Ash %	Total carbohydrate %
	Recommended Daily Dietary Allowances for children 7-10 years (1989)	2000	-	28 gm	-	-	-	-
Control		384	31.82	8.13	33.2	0.48	2.32	55.87
1	Cardamom0.1%	334	31.70	8.11	33.2	0.48	2.34	55.87
2	Cardamom0.075%	384	31.61	8.12	33.2	0.47	2.34	55.87
3	Rosemary0.1%	384	31.65	8.12	33.1	0.48	2.32	55.98
4	Rosemary0.075%	385	31.65	8.13	33.2	0.46	2.33	55.88
5	Marjoram0.1%	384	31.68	8.11	33.2	0.48	2.33	55.88
6	Marjoram0.075%	385	31.69	8.12	33.3	0.49	2.32	55.77
7	Cinnamon0.1%	384	31.71	8.11	33.2	0.47	2.33	55.89
8	Cinnamon0.75%	385	31.72	8.12	33.3	0.48	2.34	55.76

The result show there is no significant change in protein, fat, ash, carbohydrate and energy, while there is significant change in fiber.

The moisture range 31.52 to 31.82%, the control had the highest value it was 31.82% followed by marjoram at 0.1% adding level and cinnamon at adding level 1.5 had lowest value .and the protein range 8.05 to 8.16%, marjoram at 0.1% adding level had the highest value it was 8.16% and rosemary at adding level 1.5% had lowest value. And the fat range between 32.71 to 33.20% the control had the highest value it was 33.2% followed by marjoram at 0.1% adding level and the lowest value was 32.71% at cinnamon 1.5% adding level, while fiber range was from 0.48 to 0.71 the highest value in cinnamon 1.5% it was 0.71 but the lowest result show in control sample.

From Table (22) found there is no significant change in protein, fat, ash, carbohydrate and energy, and also there is no significant change in fiber in different croissant produced from adding cinnamon, clove, cardamom, thyme, rosemary and marjoram volatile oil.

4.19. Effect of addition cinnamon, clove, cardamom, thyme, rosemary and marjoram powders or their essential oils on the shelf life of the croissant pastry:

This section was planned to study the possibility of adding different levels of cinnamon, cardamom, rosemary and marjoram as a natural preservatives, at different levels 1.0 and

1.5% spices powder and 0.075 and 0.1% their essential oils in croissant formula to retard the deterioration of growth microorganisms in croissant and consequently to extend its shelf life. Croissant pastry were packaged with polyethylene and stored for different periods (0, 2, 4, 6, 8, 10, 12 and 14 days) at 25°C. The results were presented in Tables (23 and 24).

The results showed that the addition of any type of spices powder or their essential oils at any adding level Increased the storage period, the control show the lowest storage period (4 days).

The results showed also that the effect of addition of cinnamon, clove, cardamom, thyme, rosemary and marjoram powder or their essential oils on the shelf life of the croissant increased by increasing their concentrations. The results were presented in Tables (23 and 24)

The results showed that the addition of the spices powder or their essential oils at any adding level Increased the storage period than the control, which, showed the lowest storage period (4 days). The effect of addition of cinnamon, cardamom, rosemary and marjoram powder or their essential oils on the shelf life of the croissant increased by increasing their concentrations. Also the high addition of cinnamon, marjoram and cardamom essential oil (0.1 g/100 g) and high addition of cinnamon (1.5 g/100 g) had the highest effect on retarding the growth of all microorganisms in the stored croissant till (12 days). While the spoilage of croissant treated by rosemary essential oil at level 0.1 g/100g flour was detected only after (8 days). Rosemary powder at level 1.0 g/100g flour was detected only after (6 days).

Table (23): Effect of addition cinnamon, cardamom, rosemary and marjoram powders on visual growth of fungal and the shelf-life of the croissant pastry.

Treatments	Storage time (days) at 25°C							
	0	2	4	6	8	10	12	14
Control	-	-	-	+	++	++	+++	+++
Sodium propionate 0.03%	-	-	-	-	-	+	++	++
Cardamom 1.0%	-	-	-	-	-	++	++	++
Cardamom 1.5%	-	-	-	-	-	-	+	+
Rosemary 1.0%	-	-	-	-	+	+	++	++
Rosemary 1.5%	-	-	-	-	-	+	++	++
Marjoram 1.0%	-	-	-	-	-	+	++	++
Marjoram 1.5%	-	-	-	-	-	-	+	++
Cinnamon 1.0%	-	-	-	-	-	-	+	++
Cinnamon 1.5%	-	-	-	-	-	-	-	+

(-) = No growth
(++) = Moderate growth

(+) = Start growth
(+++)= High growth

Table (24): Effect of addition cinnamon, cardamom, rosemary and marjoram essential oils on visual growth of fungal and the shelf life of the croissant pastry

Treatments	Storage time (days) at 25C							
	0	2	4	6	8	10	12	14
Control	-	-	-	+	++	++	+++	+++
Sodium propionate 0.03%	-	-	-	-	-	+	++	++
Cardamom 1.0%	-	-	-	-	-	-	+	+
Cardamom 1.5%	-	-	-	-	-	-	-	+
Rosemary 1.0%	-	-	-	-	-	+	+	++
Rosemary 1.5%	-	-	-	-	-	-	+	++
Marjoram 1.0%	-	-	-	-	-	-	+	++
Marjoram 1.5%	-	-	-	-	-	-	-	+
Cinnamon 1.0%	-	-	-	-	-	-	+	++
Cinnamon 1.5%	-	-	-	-	-	-	-	+

(-) = No growth
(++) = Moderate growth

(+) = Start growth
(+++)= High growth