RESULTS AND DISCUSSION

Determination of the chemical composition of fenugreek seeds :

The chemical properties of fenugreek seeds were determined and results obtained are shown in table (1).

TABLE (1)

The chemical properties of fenugreek seeds

Properties	Percentage
Moisture	8.50
Ash	3.22
Essential oil	2.60
Ether extract	8.41
Crude protein	17.50
Fibers	12.47
Total carbohydrate	47.30

The moisture content in fenugreek seeds was 8.50% which agree with the specifications of ISO (1982). However it was high than that reported by Kolousek (1955) and Hussein (1979) who mentioned 5.77 and 7.60%

respectively- Lopéz (1950) and Marsh (1977) gave a range of 8.84 to 10.30% moisture content.

Ash content reached 3,22% which agreed with Lopéz (1950) and ISO (1982) specifications. Nierle (19 7)gave lower percent 2.31- However Kolousek (1955), Elmadfa (1975), Marsh (1977) and Morsi (1967) reported 4.85 , 4.60, 3.40 and 3.40 percent respectively.

The essential oil was 2.60% which varied with that obtained by Hussein (1979) who mentioned only 1.05%.

The ether extract which reached 8.41% was higher than that mentioned by Lopéz (1950), Kolousek (1955), Morsi (1967), Naves (1974), Elmadfa (1976), Marsh (1977), Nierle (1977), Awadalla (1978), Hussein (1979) and Leung (1980) who reported arrange from 4.60 to 8.00%.

However it may agree with that obtained by Fleurent (1927) who mentioned 8.80%.

The crude protein was 17.50% which agreed with that reported by Lopéz (1950), Kolousek (1955), Morsi (1967) Elmadfa (1975), Marsh (1977), Nierle (1977), Hussein (1979), Awadalla (1980) and Leung (1980) who mentioned a range of 7.00 to 26.70%.

The fibers ranged to 12,47% which differed with that obtained by Lopéz (1950) and Kolousek (1955), they gave 18.38 and 15.20% respectively. While the obtained result increase than that obtained by Morsi (1967), Elmadfa (1975), Marsh (1977) and Hussein (1979), which were 9.7o, 10,40, 10.07 and 9.02 percent respectively.

Total carbohydrates which were 47.3% exceeded the percentages obtained by Lopéz (1950) who mentioned 36.72%. However they were lower than that obtained by Morsi (1967), Marsh (1977) and Hussein (1979) who reported 53.80, 58.35 and 49.72 percent erespectively.

Therefore fenugreek seeds could be considered a rich source of fat, carbhydrates and protein.

Meneral analysis of fenugreek (seeds gave 10.14 Iron , 3.8 Calcium, 114.5 Magnesium, 1.61 Copper, 107.3 Sodium 278,68 Potasium and 1.71 mg/100 g Zinc.

Yield of fenugreek seeds oleoresins

The extract yield of fenugreek seeds was determined using n-hexane, petroleum ether, acetone and pure ethyl alcohol. The obtained results are shown in the following table.

Table (2)

yield of fenugreek seeds extracts

Solvent	oleoresin %
n-hexane	7.25
petroleum ether of 45-60° (B.P)	8.41
acetone	10.02
ethyl alcohol	23.75

The oleoresin obtained by alcohol was viscous of greenish brown colour, while the other oleoresins were oily brownish yellow. The yield of oleoresins was ; 7.25, 8.41, 10.02 and 23.75% for; n-hexane, petroleum ether, acetone and ethyl alcohol respectively. As shown in table (2), n-hexane gave the lowest yield while ethyl alcohol gave the highest % of oleoresins.

It could be observed that the sort of solvent had

a considerable effect on the quality and yield of fenugreek seeds oleoresins which agreed with data mentioned by Leung (1980).

The result obtained for fenugreek oleoresin, extracted by petroleum ether was in agreement with that mentioned by Naves (1974) and Elmadfa (1975) who gave a yield of 4.90 and 8.50 % respectively. However Morsi (1967), Fazli et al (1971), Nierle et al.,(1977), Awadalla et al., (1978) and Hussein (1979) reported a range of 5.40 to 7.61%.

Oleoresins extracted by acetone and ethyl alcohol showed higher values than those stated by Wunschendorff (1914) who stated only 2.84 and 9.96% respectively.

Determination of the physical and chemical characteristics of fenugreek seeds oleoresins

The quality, consequently the value and application of oleoresins and volatile oils are highly correlated with their chemical composition. Such chemical composition affects the physicochemical characteristics of any such product. Therefore the physical and chemical characteristics of fenugreek seeds oleoresins were determined and results obtained are shown in table (3)

Table (3)

The physico-chemical properties of fenugreek seeds oleoresins

Characteristics	Solvent extraction		
	n-hexane	acetone	alcohol
Specific gravity at 20&20°C	0.9177	0.9316	-
Refractive index at 20°C	1.4768	1.4764	1.4795
Acid value	0.70	2.55	32.15
Acidity percent as oleic acid	0.35	1.28	17.17
Ester no.	185.58	201.58	172.11
Saponification value	186.28	204.13	204.26
Iodine no	145.53	139.00	71.36
Peroxide value	50.00	89.09	39.85
Unsaponifiable matter	5.36	-	-

Solubility in ethyl alcohol: The oleoresins of n-hexane and acetone were insoluble in 1 cc. of ethyl alcohol of 95% and more up to 10 cc, while that of alcohol was clearly soluble in 1 cc. of warm alcohol of 95% and more up to 10 cc. and separation was observed after 24 hours.

The specific gravity was 0.9177 and 0.9316 for n-hexane and acetone oleoresins. These values are less than those by Wunschendorff (1914), Fleurent (1927) and Flaschentragar (1958), who stated values between 0.9416 to 0.9740. The specific gravity of n-hexane oleoresin agreed with Shahat (1947) and Hussein (1979)who gave a range of 0.910 to 0.9142

The refractive index of n-hexane, acetone and ethyl alcohol oleoresins was; 1.4768, 1.4764 and 1.4795 respectively. The refractive index of n-hexane and acetone oleoresins was nearly inagreement with that reported by Wunschendorff (1919), Shahat (1947) and Hussein (1979), while that of ethyl alcohol showed a high value than mentioned.

The acid value of n-hexane, acetone and ethyl alcohol oleoresins was; 0.70, 2.55 and 32.15 respectively. The oleoresin of n-hexane and acetone had nearly an acid value similar to that reported by Shahat (1947)

and Hussein (1979). While that of ethyl alcohol oleoresin showed a higher value.

The ester no. of acetone oleoresins, showed a high value than the other oleoresins, while the saponification no. of n-hexane oleoresin showed the lowest value and was in agreement with that reported by Shahat (1947), Flaschentragar (1958) and Hussein (1979) who gave a range from 178.00 to 190.00

The iodine no. of n.hexane oleoresin was high, while that of ethyl alcohol was low as it was 145.53 and 71.36 respectively. The iodine value of acetone oleoresin was similar to that reported by Wunschendorff (1919) while that of alcohol was less than that mentioned by Shahat (1947) and Hussein (1979) who stated a range of 115.00 to 137.80.

The unsaponfiable matter of n-hexane oleoresin was 5.36 which was more than that obtained by Wunschendorff (1919), Shahat (1947), Flaschentrajar (1958) and Naves (1974), who reported 0.90, 3.90 to 4.00, 3.50 and 3.75 percent respectively. Several treatment were carried out to determine the unsaponifiable matters of acetone and ethyl alcohol oleoresins, but without success.

Analysis of fenugreek seeds oleoresins

The fenugreek seeds oleoresins extracted by n-hexane acetone and ethyl alcohol were analysed and results obtained shown in table (4).

Table (4)

Analysis of fenugreek seeds oleoresins

Compounds %	Solvent extraction		
	n-hexane	acetone	ethyl alcohol
Sugar and related substances	0.60	0.40	15.20
Nigrogen	0.27	0.51	0.90
Fat content	97.70	96.26	79.12
Volatile matter	0.50	Traces	Traces

It could be noticed that fat content was the major constituent in oleoresins under investigation as it reached 97.70, 96.26 and 79.12 percent in n-hexane , acetone and alcohol oleoresins respectively.

On the other hand volatile matters were the lowest compounds as they were; 0.5% in hexane oleoresin and

traces in both acetone and alochol oleoresin.

Alcohol oleoresin gave the highest percent of Sugar and nitrogen while that of acetone gave the lowest value of sugar , however that of hexane gave the lowest percent of nitrogen. Therefore it could be mentioned that fenugreek oleoresins differ from solvent to another, which may be due to difference in solvent polarity or nature of substances extracted.

Effect of roasting temperature on the yield of fenugreek seeds oleoresins:

This experiment was carried out to determine the yield of fenugreek seeds oleoresins extracted by hexane, acetone and ethyl alcohol after roating at different temperatures. The sun dried fenugreek seeds were roasted at 125°, 150° and 175°C for one hour for every treatment then extracted. The results are shown in Table (5).

Table (5)

Effect of roasting temperature on the yield of fenugreek seeds oleoresins

Solvent	yield of fenugreek seeds oleoresins			
	Unroasted seeds	Roasted seeds at 125°C	150°C	175°C
n-hexane	7.25	8.29	8.27	7.22
acetone	10.02	10.59	9.27	9.03
ethyl alc.	23.75	24.37	25.48	26.71

Results obtained show that fenugreek seeds oleoresins extracted by n-hexane were; 7.25; 8.29, 8.27 and 7.22% for unroasted seeds, roasted seeds at 125 , 150 and 175°C respectively. Oleoresins extracted by acetone

showed high percentages. When seeds were roated at 125° , 150° and 175°C, as they reached; 10.02, 10.59, 9.27 and 9.03% respectively. However oleoresins extracted by ethyl alcohol were of higher values and increased by increasing roasting temperature as they reached; 23.75, 24.37, 25.48 and 26.71% for unroasted seeds, roasted seeds at 125°, 150° and 175°C respectively Therefore, it could be stated that extraction by ethyl alcohol revealed the highest percentages of oleoresins while those obtained by n-hexane were the lowest.

Effect of roasting temperature on the physical and chemical characteristics of fenugreek seeds oleoresins:

The physico-chemical properties of fenugreek seeds oleoresins extracted by n-hexane, acetone and ethyl alcohol after roasting at 125°C, 150°C and 175°C were studied and results obtained are reported in Table (6).

Table (6): The physico-chemical properties of roasted fenugreek seeds oleoresins

Characteristics	Hexane fenugreek seeds oleoresin				Acetone fenugreek seeds oleoresin				Alcohol fenugreek seeds oleoresin			
	unroasted seeds	Roasted seeds at at125°C	at150°C	at175°C	Unroasted seed	Roasted seeds at at125°C	at150°C	at175°C	Unroasted seeds	roasted seeds at at125°C	at150°C	at175°C
Specific gravity at 20°/20°C	0.9177	0.9237	0.9250	0.9280	0.9316	0.9339	0.9348	0.9399	-	-	-	-
Refractive index at 20°C	1.4768	1.4773	1.4790	1.4800	1.4764	1.4800	1.4779	1.4775	1.4793	1.4800	1.4801	1.4784
Solubility in ethyl alcohol 96 %	insol.	insol.	insol.	insol.	insol.	insol.	insol.	insol.	soluble in warm alcohol			
Acide value	0.70	1.08	1.91	1.27	2.55	3.99	4.00	4.04	32.15	38.70	40.00	48.43
Ester value	185.58	182.50	182.50	182.07	201.58	193.97	193.40	192.00	172.11	170.68	136.61	117.77
Iodine number	145.53	154.61	151,77	151.77	139.00	143.00	151.14	138.78	71.36	60.06	44.09	31.51
Peroxide value	50.00	48.09	56.92	56.79	89.09	75.00	62.00	53.00	39.85	48.81	65.59	68.42

Data presented in table (6) show that specific gravity of fenugreek seeds oleoresins extracted with hexane and acetone increased by increase of roasting temperature.

The refractive index of oleoresins extracted with hexane and acetone increased by roasting than that of unroasted seeds oleoresins. However oleoresins extracted with ethyl alcohol took another trend where the refractive index decreased when seeds were roasted at 175°C.

All oleoresins extracted with hexane and acetone were insoluble in 96% ethyl alcohol, while those extracted with alcohol were soluble in warm ethyl alcohol of 96%.

The acid value of all fenugreek seeds oleoresins increased by roasting. Such increase was gradual by increasing roasting temperatures. On the contrary the ester value took the opposite direction.

The iodine number of fenugreek seeds oleoresin extracted with hexane increased by increasing roasting temperature, while that of those extracted with ethyl alcohol took the other direction, however, the iodine no. fluctuated for oleoresins extracted with acetone.

The peroxide value of oleoresins extracted with acetone decreased gradually by increasing roasting temperature as it was; 89.09, 75.00, 62.00 and 53.00 for unroasted seeds, roasted seeds at 125, 150 and 175°C., while the peroxide value of those extracted with alcohol increased gradually as it was; 39.85, 48.51, 65.59 and 68.42 respectively. However, oleoresins extracted with hexane obtained less peroxide value of 48.09 when were roasted at 125°C and increased to 56.82 and 56.79 when seeds were roasted at 150° and 175°, respectively.

It could be concluded that roasting temperatures affected the physical and chemical properties of fenugreek seeds oleoresins extracted with the different solvents (hexane, acetone and alcohol) which agree with Leung , (1980).

The chemical composition of volatile matter of fenugreek seeds oleoresins:

Gas-liquid chromatography mass spectrum were used for qualitative and quantitative determination of the chemical constituents of volatile matter of fenugreek seeds oleoresin extracted by hexane and acetone. It was used also to study the effect of roasting temperatures, on their chemical composition.

Results obtained are shown in Table (7).

The major constituents of volatile matter of unroasted seeds oleoresins were Geranyl butyrate, citronellyl butyrate and neryl butyrate which represent 40.50, 21.00 and 17.50 per cent respectively. Other identified components were ethyl cinnamate, terpinyl butyrate , citronellyl iso butyrate and ethyl C-16 ester, which amounted to 6.50, 3.50, 2.00 and 1.00 percent respectively.

The previous identified components consisted of 92 percent of the chemical composition of volatile matter of fenugreek oleoresin. The rest which was 8 percent represented unknown compounds. Besides there were some components found in trace amounts in hexane oleoresin such as alcohol C-8, alcohol C-11, alcohol C-14 and leavo carvone.

Roasting temperature affected the chemical composition of volatile components, hence the major constituents of volatile matter, which exceeded 90% in oleoresins of unroasted seeds disappeared by roasting either in hexane or acetone oleoresin as shown in table (7). C-16 ethyl ester, which was 1.00% in oleoresins of unroasted seeds increased to 1.87 and 1.03 % in hexane oleoresins of roasted seeds at 125° and 175°C respectively, while it decreased to 0.28% in oleoresin of seeds roasted at 150°C and 0.51% in acetone oleoresin of seeds roasted at 125°C. On the other hand some new constituents appeared when seeds were roasted at different temperatures. Oleoresins obtained by hexane extraction of roasted seeds at 125°C showed the following components ethyl butyrate 2.19, alcohol C12 2.55, alcohol C14 , 5.63, alkane C14 , 1.21, B-naphthyl ethyl ether 0.38, alcohol C16 , 12.12, alkane C 16 , 1.27 alcohol C18, 16.71 , alcohol C20, 16.32 and alcohol C22 , 9.25 percent.

When seeds were roasted at 150° the oleoresin contained the following components; ethyl butyrate 19.19, alcohol C-8, 0.40, alcohol C-10, 2.05, limonene 0.66 , alcohol C-12, 9.27, alkane C-12, 1.08, benzyl propionate 0.38, alkane C-13 , 0.95, vertenex 0.62, alcohol C-14 , 16.27, alkane C-14, 1.91, B-naphthyl ethyl ether 0.68 , alkane C-15 , 1.50, alcohol C-16, 15.90 alkane C-16, 1.52,

Table (7): Chemical composition of volatile matter of fenugreek seeds oleoresins by G.L.C.

Components	n-hexane oleoresin from unroasted seed	n-nexane oleoresin from seed roasted at			Acetone oleoresin from unroasted seed	Acetone oleoresin from roasted at 125°C
		125°C	150°C	175°C		
Ethyl cinnamate	6.50	-	-	-	6.50	-
Terpinyl butyrate	3.50	-	-	-	3.50	-
Citronellyl isobutyrate	2.00	-	-	-	2.00	-
Citronellyl butyrate	21.00	-	-	-	21.00	-
Neryl butyrate	17.50	-	-	-	17.50	-
Geranyl butyrate	40.50	-	-	-	40.50	-
C-16 Ethyl ester	1.00	1.87	0.28	1.03	1.00	0.51
Ethyl butyrate	-	2.19	19.19	-	-	-
Alcohol C-8	Traces	-	0.40	-	-	-
Alcohol C-10	-	-	2.05	-	-	6.44
Alcohol C-11	Traces	-	-	-	-	0.27
P-cymene	-	-	-	-	-	0.76
Limonene	-	-	0.66	-	-	2.04
Alcohol C-12	-	2.55	9.27	7.44	-	17.11
Alkane C-12	-	-	1.08	1.16	-	1.17
Benzyl propionate	-	-	0.38	0.36	-	1.45
Alkane C-13	-	-	0.95	0.72	-	-
Vertenex	-	-	0.62	0.64	-	0.64
Alcohol C-14	Traces	5.63	16.27	14.91	-	17.31
Alkane C-14	-	1.21	1.91	1.64	-	1.76
B-Naphthyl ethyl ether	-	0.38	0.68	1.38	-	0.61
Alkane C-15	-	-	1.50	1.78	-	-
Oranger crystals	-	-	-	1.22	-	-
Alcohol C-16	-	12.12	15.90	19.90	-	8.68
Alkane C-16	-	1.27	1.52	2.47	-	0.50
Alcohol C-18	-	16.71	7.72	13.28	-	6.61
Methyl C-16 ester	-	-	-	0.36	-	0.20
Alcohol C-20	-	16.32	3.23	5.93	-	4.28
Alcohol C-22	-	9.25	-	2.47	-	1.95
Laevo carvone	Traces	-	-	-	-	-

alcohol C-18 , 7.72 and alchol C-20 , 3.23 percent. While, the oleoresein obtained from roasted seeds at 175°C had the following; alcohol C-12, 7.44, alkane C-12, 1.16, benzyl propionate 0.36, alkane C-13, 0.72, vertenex 0.64, alcohol C-14, 14.91, alkane C-14, 1.64, B-naphthyl ethyl ether 1.38, alkane C-15, 1.78, oranger crystals 1.22, alcohol C-16, 19.90 alkane C-16, 2.47, alcohol C-18, 13.28, methyl C-16 ester 0.36, alcohol C-20, 5.93 and alcohol C-22, 2.47 percent.

When seeds were roasted at 125°C and extracted with acetone, the oleoresin contained the following new compositions; alcohol C-10 , 6.44, alcohol C-11,0.27, P-cymene 0.76, limonene 2.04, alcohol C-12, 17.11, alkane C-12, 1.17, benzyl propionate 1.45, vertenex 0.64,alcohol C-14, 17.31, alkane C-14, 1.76, B-naphthyl ethyl ether 0.61 alcohol C-16, 8.68, alkane C-16, 0.50, alcohol C-18 6.61, methyl C-16 ester 0.20, alcohol C-20 , 4.28 and alcohol C-22, 1.95 percent.

Fatty acids composition of fenugreek seeds oleoresins:

Gas liquid chromatography (G.L.C.) technique was employed to study the fatty acids composition of fenugreek seeds oleoresins extracted by hexane, acetone and alcohol before roasting and after roasting at 125°C ,150°C & 175°C. Results obtained are shown in table (8) and Figures (1,2,3,4,5,6).

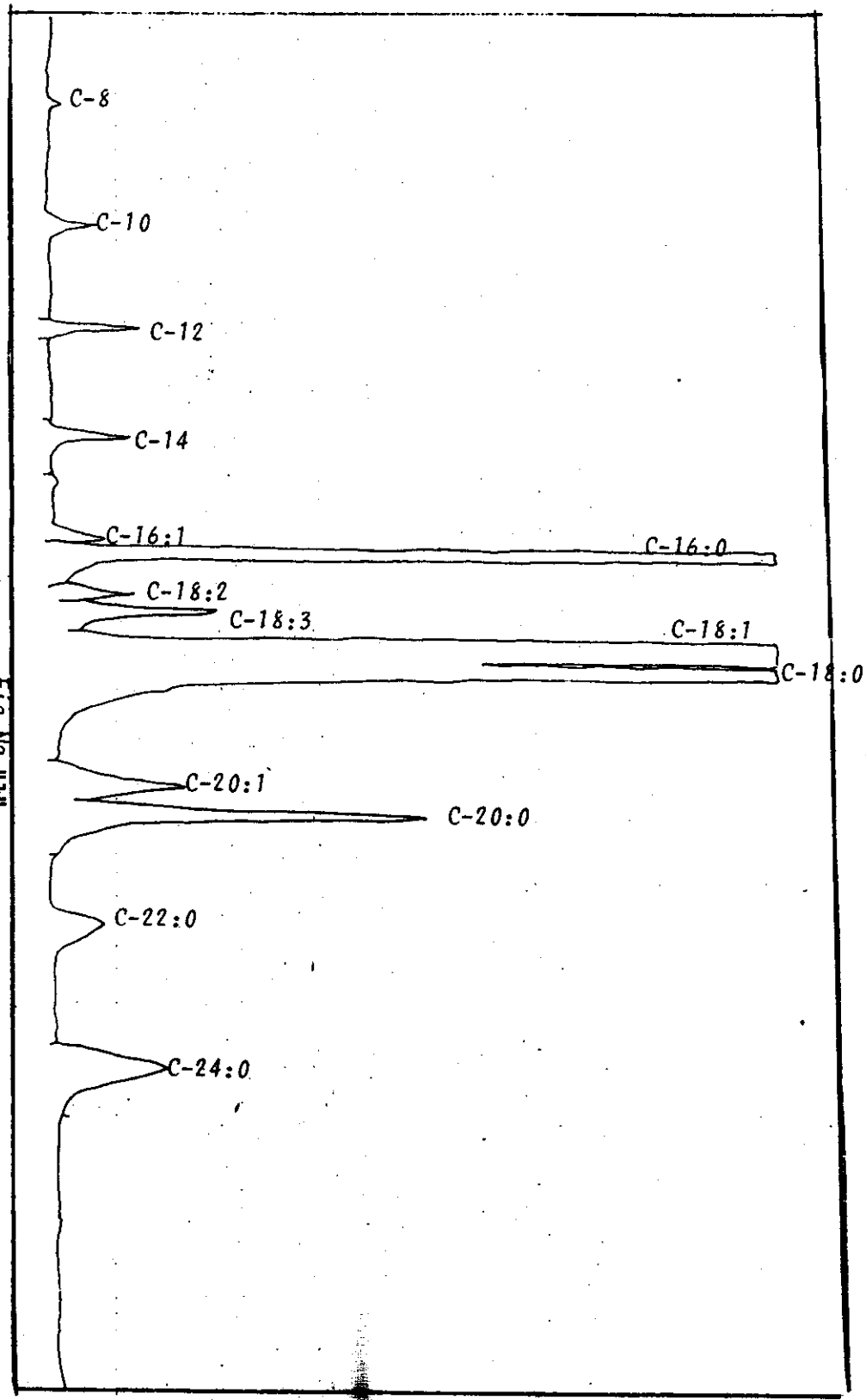

Fig No."1"

FATTY ACIDS OF UNROASTED FENUGREEK SEEDS OLEORESIN (HEXANE EXTRACTION)

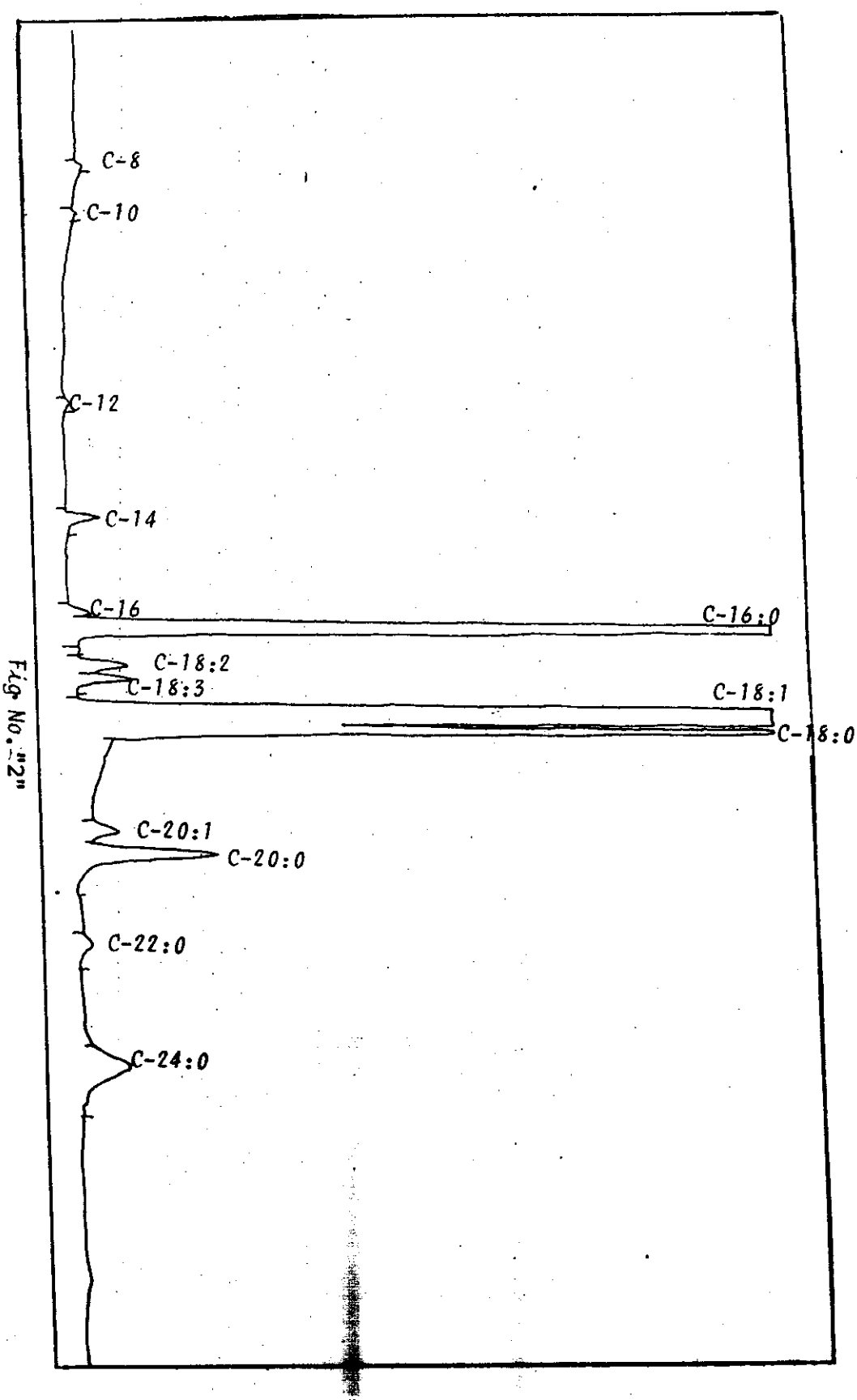

Fig. No. "2"

FATTY ACIDS OF OLEORESIN OF ROASTED FENUGREEK SEEDS AT 125°C (HEXANE EXTRACTION)

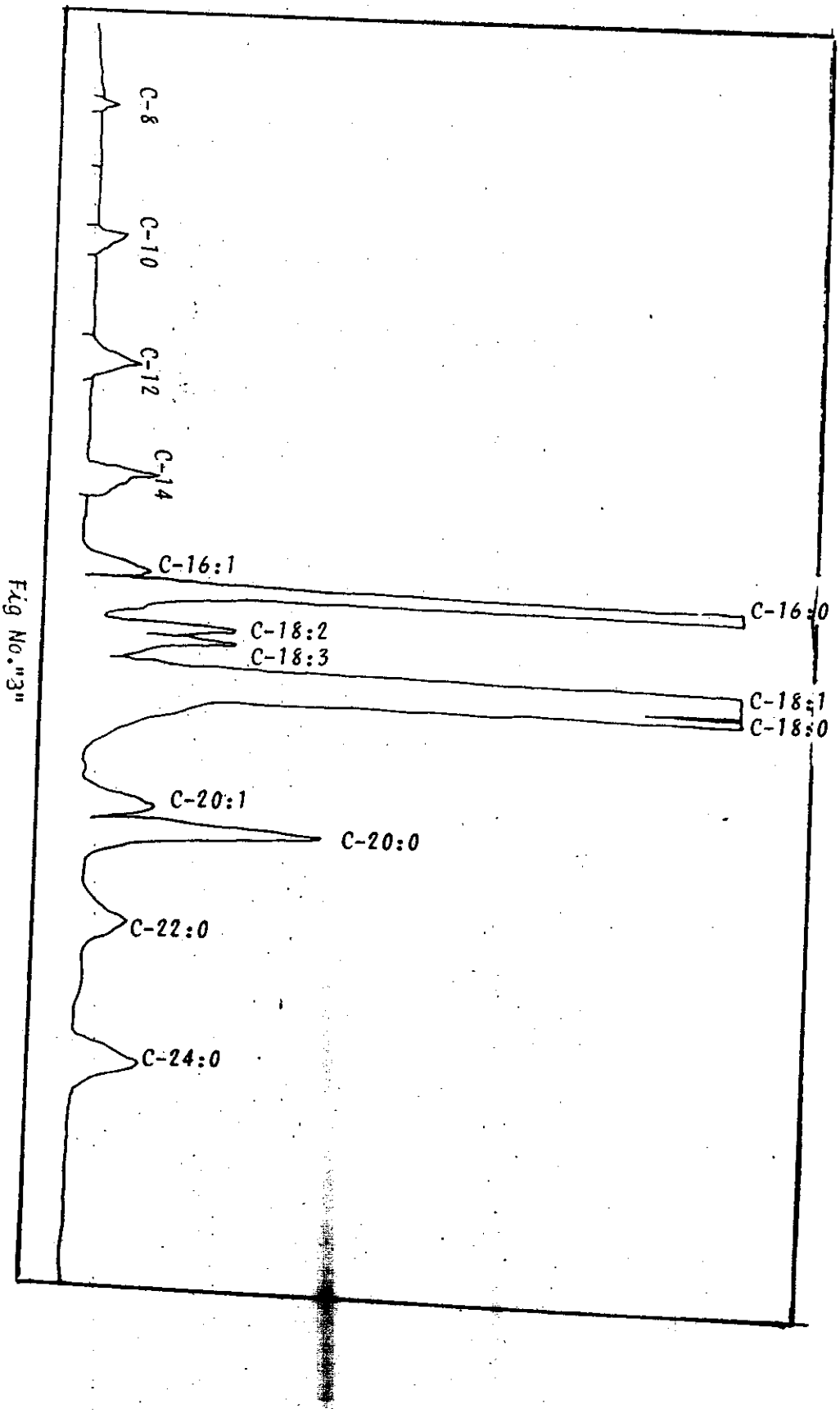

Fig No."3"

FATTY ACIDS OF OLEORESIN OF ROASTED FENUGREEK SEEDS AT 150°C (HEXANE EXTRACTION)

FATTY ACIDS OF OLEORESIN OF ROASTED FENUGREEK SEEDS AT 175°C (HEXANE EXTRACTION)

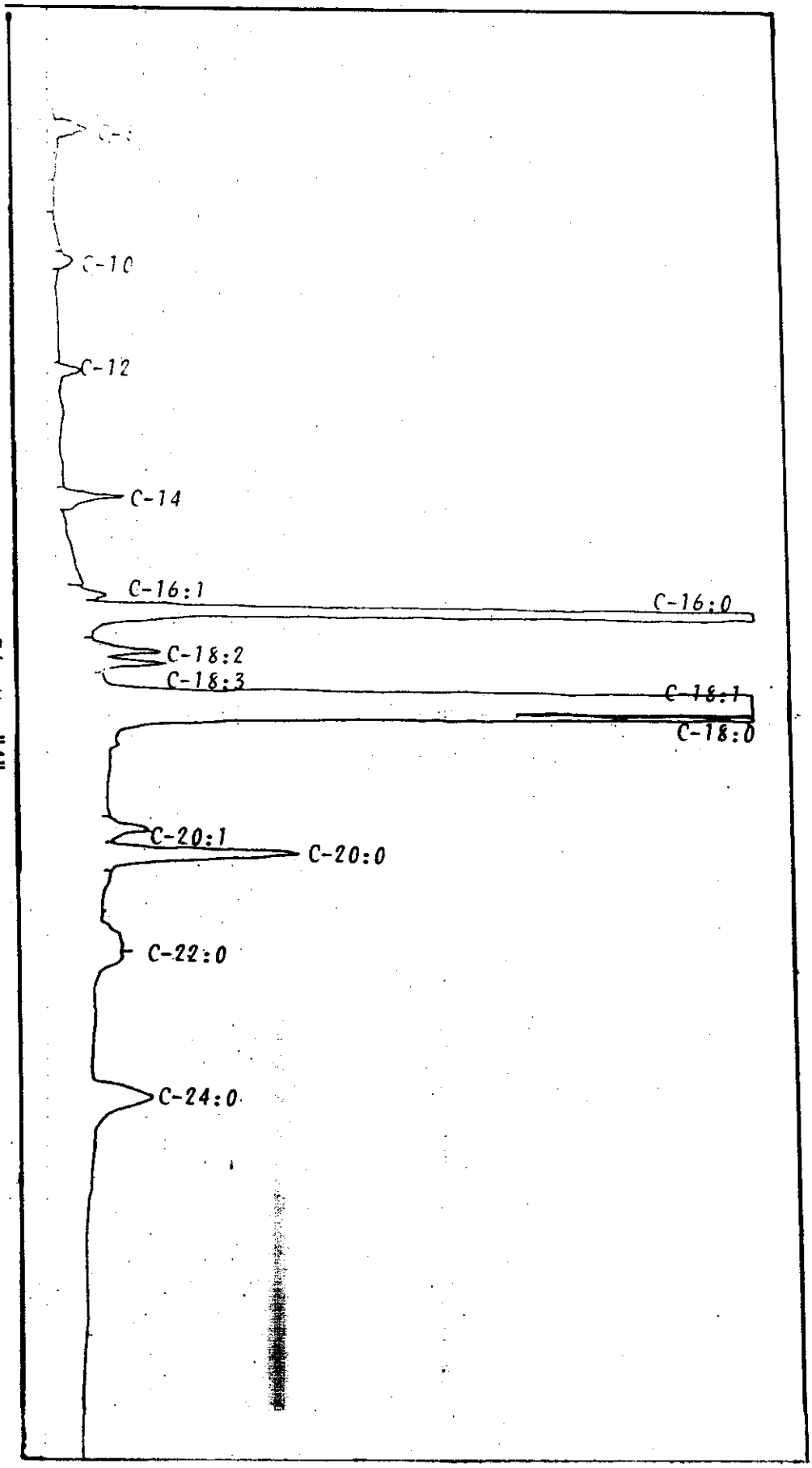

Fig No. "4"

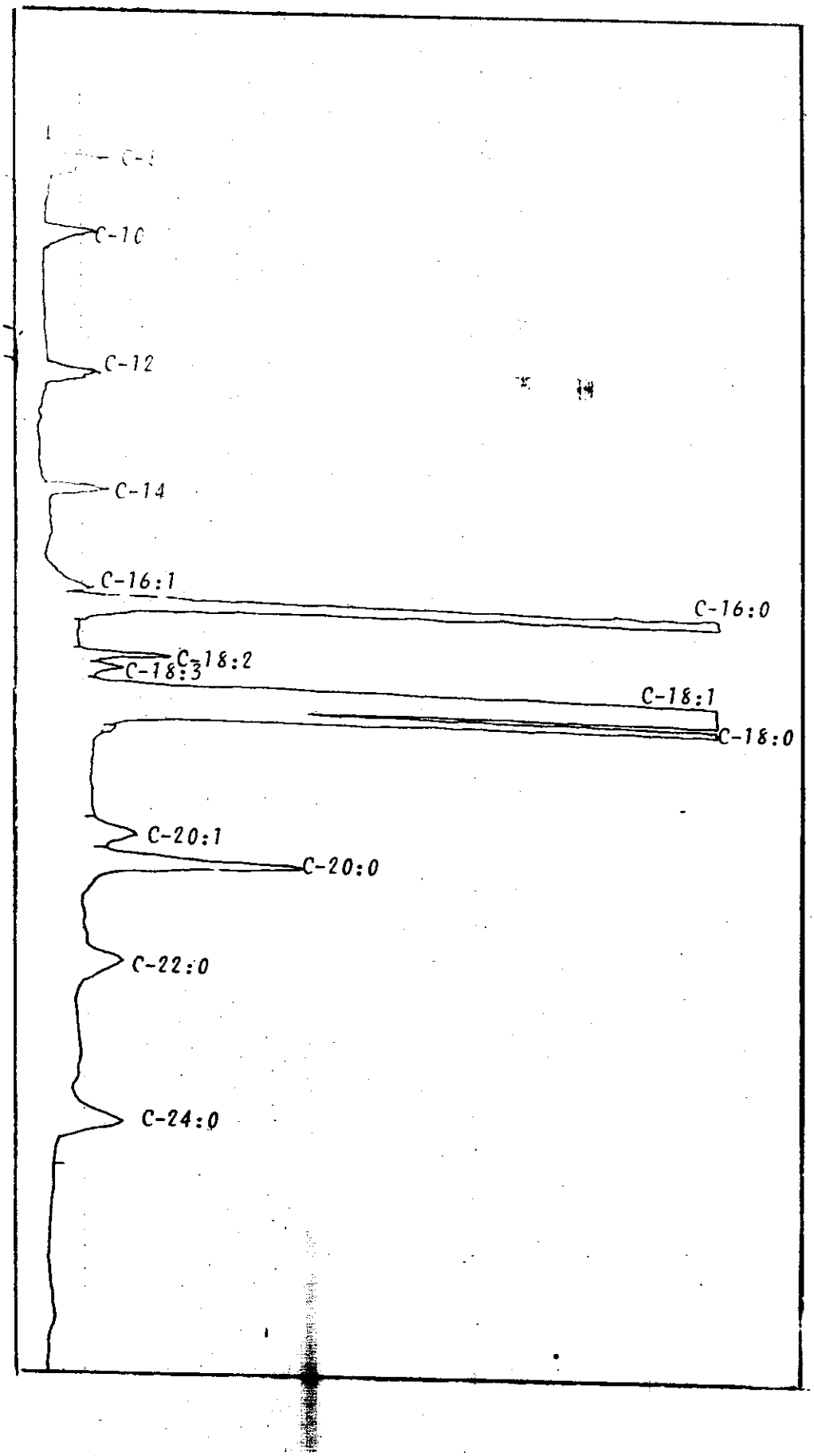

FIG NO. "5"
FATTY ACIDS OF UNROASTED FENUGREEK SEEDS OLEORESIN (ACETONE EXTRACTION)

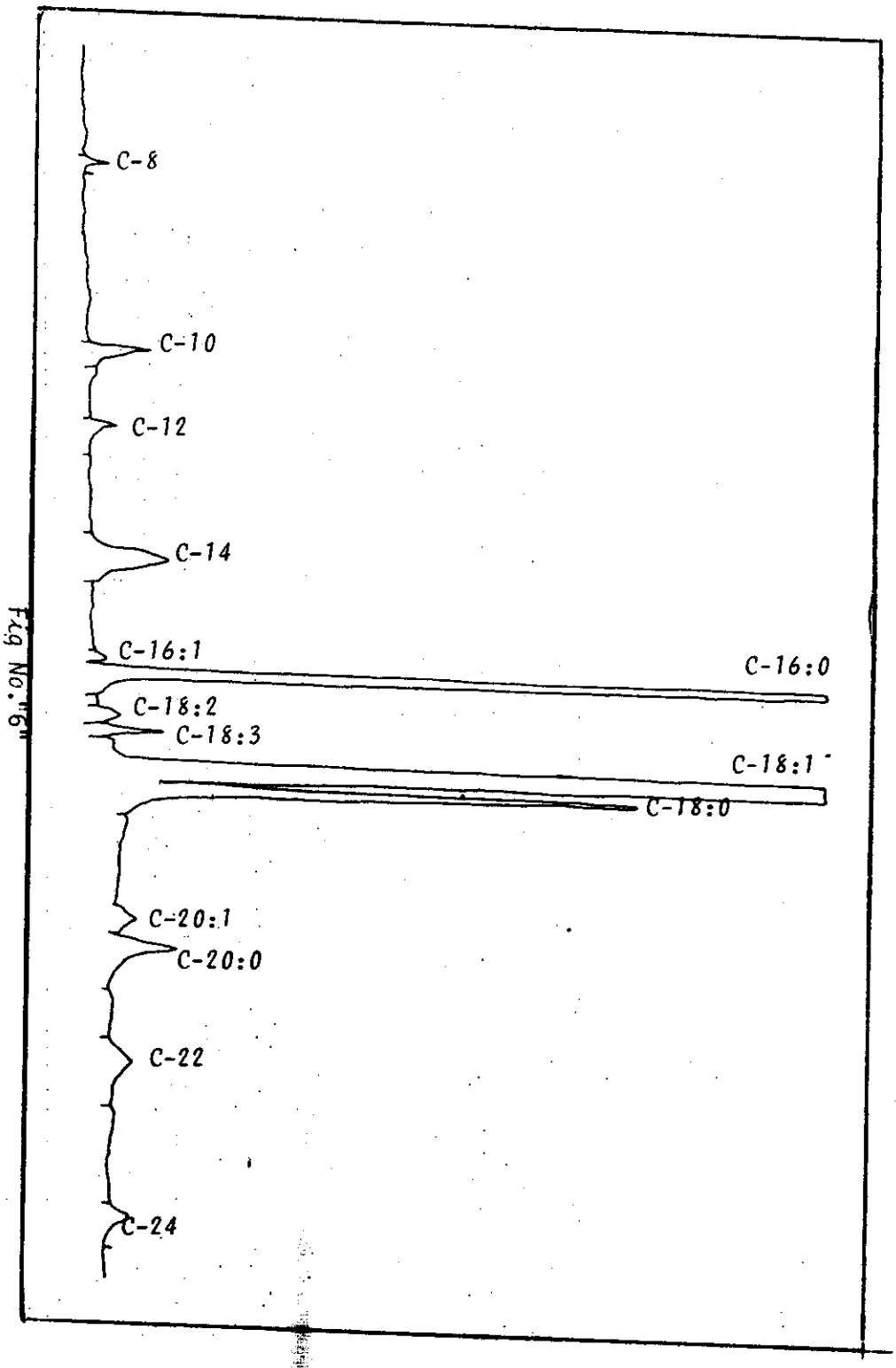

Fig No."6"

FATTY ACIDS OF UNROASTED FENUGREEK SEEDS OLEORESIN (ALCOHOL EXTRACTION)

Table (8): Fatty acids composition of Fenugreek seeds oleoresins.

Component	hexane unroasted seeds oleoresins	Hexane oleoresin from seeds roasted at			Acetone oleoresin of unroasted seed	Alcohol oleoresin of unroasted seeds
		125°C	150°C	175°C		
Caprylic C 8:0	0.050	0.024	0.052	0.052	0.231	0.150
Capric C 10:0	0.171	0.014	0.101	0.011	0.367	0.586
Lauric C 12:0	0.215	0.013	0.165	0.058	0.337	0.159
Myristic C 14:0	0.173	0.189	0.461	0.211	0.226	1.733
Palmitoleic C16:1	0.109	0.106	0.126	0.151	0.209	0.111
Palmatic C 16:0	10:395	12.539	16.863	11.285	17.739	15.975
Stearic C 18:0	8.048	5.541	6.715	4.996	8.423	6.798
Oleic C 18:1	77.623	77.674	70.180	78.964	65.974	69.914
Linoleic C 18:2	0.234	0.384	1.179	0.537	0.773	0.333
Linolenic C 18:3	0.616	0.355	0.756	0.459	0.621	0.598
Arachidic C 20:0	1.259	1.613	1.887	1.726	2.643	1.651
Cadoleic C 20:1	0.479	0.455	0.281	0.714	0.576	0.850
Behenic C 22:0	0.106	0.111	0.337	0.213	0.791	0.553
Legnoceric C 24:0	0.522	0.982	0.897	0.623	1.090	0.589
Unsaturated fatty acids	79.061	78.974	72.522	80.825	68.153	71.806
Saturated fatty acids	20.939	21.026	27.478	19.175	31.847	28.194

Palmatic (C-16:0), Oleic (C-18:1), stearic (C-18:0) and arachidic (C-20:0) occured as the major fatty acids which amounted to 10.395, 77.623, 8.048, and 1.259 percent respectively in hexane fenugreek seeds oleoresins m Meanwhile caprylic (C-8:0), capric (C-10:0), lauric (C-12:0), myristic (C-14:0), palmatic (C-16:1) Linoleic (C-18:2), linolenic (C-18:3) Cadoleic (C-20:1), behenic (C-22:0) and legnoceric (C-24:0) were the minor components of less than one percent each. The unsaturated fatty acids were higher than saturated ones as they were 79.061 and 20.939 percent respectively.

Palmatic (C-16:0), oleic (C-18:1) stearic (C-18:0) arachidic (C-20:0), legnoceric (C-24:0) were the major fatty acids as they were 17.739, 65.974, 8.423, 2.643 and 1.090 respectively in acetone oleoresins , while caprylic (C-8:0), capric (C-10:0) lauric (C-12:0), myristic (C-14:0), palmitoleic (C-16:1), Linoleic (C-18:2), Linolenic (C-18:3), cadoleic (C-20:1) and behenic (C-22:0) were the minor ones not greater than each. The unsaturated fatty acids were higher than saturated ones as they were 68.153 and 31.847 percent respectively.

Palmatic (C-16:0), oleic (C-18:1) stearic (C-18:0) and arachidic (C-10:0) obtained the highest percent of

fatty acids in alcohol fenugreek seeds oleoresin as they reached 15.975, 69.914, 6.798 and 1.651 percent respectively. While caprylic, capric (C-10:0), lauric (C-12:0), palmitoleic (C-16:1), linoleic (C-18:2) , linolenic (C-18:3), cadoleic (C-20:1), behenic (C-22:0) and legnoceric (C-24:0) had lowest percent. The unsaturated fatty acids were higher than saturated ones as they were 71.806 and 28.194 percent respectively.

The percentages of fatty acids; myristic (C-14:0) palmatic (C-16:0), stearic (C-18:0), arachidic (C-20:0) and legnoceric (C-24:0) in acetone oleoresin exceeded their percentages in either hexane or alcohol oleoresins; while oleic (C-18:1) in hexane oleoresin reached the highest percent among acetone and alcohol oleoresin as it was; 77.623, 65.974 and 69.914 respectively.

The unsaturated fatty acids percentage in hexane oleoresin was higher than that of alcohol and acetone oleoresins as it was 79.061, 71.806 and 68.153 percent respectively, while the saturated fatty acids percent in hexane oleoresin was lower than that of alcohol and acetone oleoresin as it was 20.939, 28.194 and 31.847 percent respectively.

The percentages obtained of palmatic and stearic

fatty acids were higher than those stated by Schvette (1940) and Shahat (1947), who mentioned 7.3:9.68 and 2.4:4.92 percent respectively.

The percentages obtained for arachidic and behenic fatty acids in all fenugreek seeds oleoresins were nearly within the range reported by Schvette (1940) and Shahat (1947). While oleic percentage was higher than that given by the same authors. Lenoleic and lenolenic acids were of less percentages than those mentioned by the same authors.

As mentioned before roasting fenugreek seeds affected the fatty acids percentages in all oleoresins obtained palmatic, arachidic and behenic fatty acids in hexane oleorresin increased by increasing roasting temperature, where the highest percent was achieved at 150°C Roasting seeds at 175°C gave the lowest percent of palmatic while roasting them at 125°C gave the lowest percentage of arachidic and behenic. Stearic acid percent decreasedby roasting fenugreek seeds as it was 8.048 in hexane oleoresin of unroasted seeds and became 5.541, 6.715 and 4.996% after roasting seeds at 125°, 150 and 175°C respectively.

Roasting fenugreek seeds at 150°C gave the highest percent of linoleic and linolenic acids in hexane oleoresin

Roasting seeds at 175°C gave the highest percent of oleic.

It could be concluded that, oleic, palmatic , stearic and arachidic were the major fatty acids of fenugreek seeds oleoresins.

Also the fatty acids per-centages differed by different solvents and roasting temperature.

The Infrared Absorption properties of fenugreek seeds oleoresins;

This work was carried out to study the infrared spectra of fenugreek seeds hexane oleoresins as (finger-prints) of such oil treatments. These spectra indicate the following properties:

- The frequencies as wave number CM^{-1} of different infrared absorption bands. The obtained results are shown in Table (9) deduced from figures 7 and 8 respectively.
- The effect of roasting temperature on the infrared absorption properties was also studied.

Table (9)

The infrared absorption properties of hexane fenugreek seeds olearesins

Band No.	Frequencies as wave number Cm^{-1}	Fenugreek seeds oleoresins of unroasted seeds	Roasted seeds at 125°C	150°C	175°C
1	632	-	+	+	+
2	800	+	+	+	+
3	930	-	+	+	+
4	1005	-	+	+	+
5	1069	+	+	+	+
6	1102	+	+	+	+
7	1160	+	+	+	+
8	1220	-	+	+	+
9	1245	+	+	+	+
10	1380	+	+	+	+
11	1420	-	+	+	+
12	1465	+	+	+	+
13	1550	+	+	+	+
14	1655	-	+	+	+
15	1748	+	+	+	+
16	2860	+	+	+	+
17	2925	+	+	+	+
18	3015	+	+	+	+

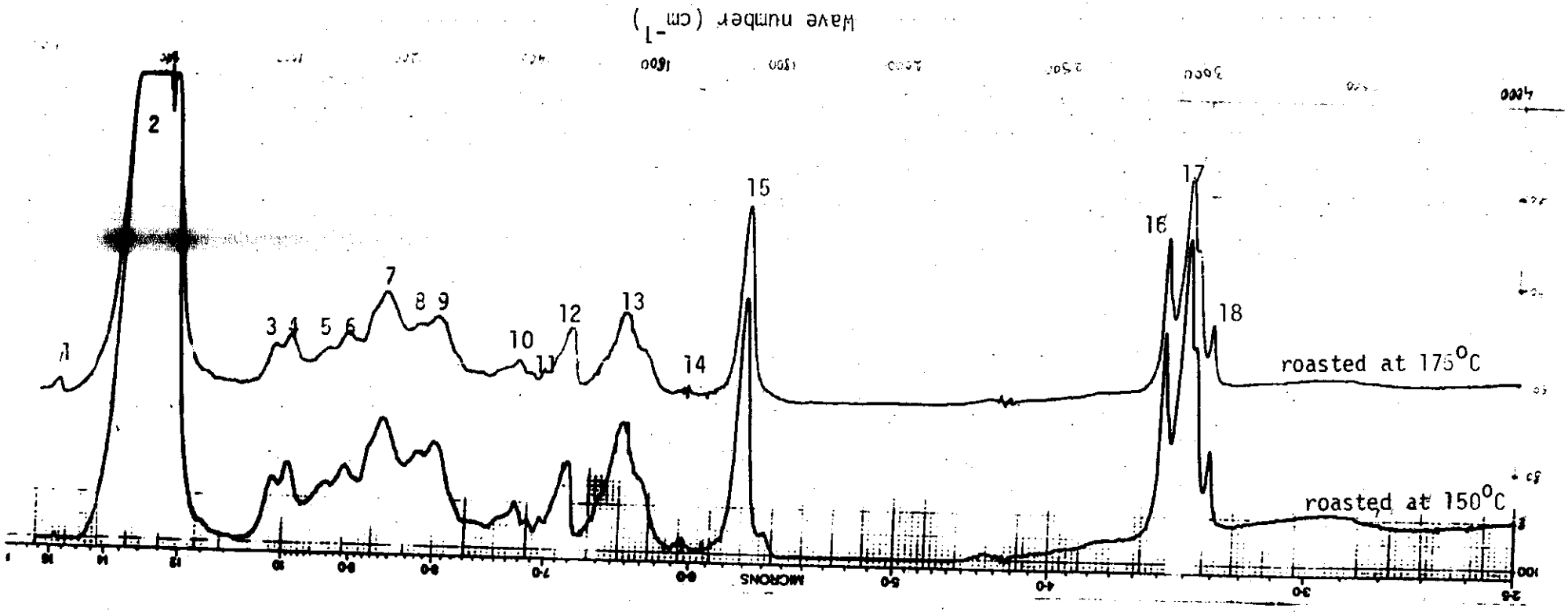

Fig. (7): The Infrared spectrum of roasted fenugreek seeds oleoresins at 150°C and 175°C.

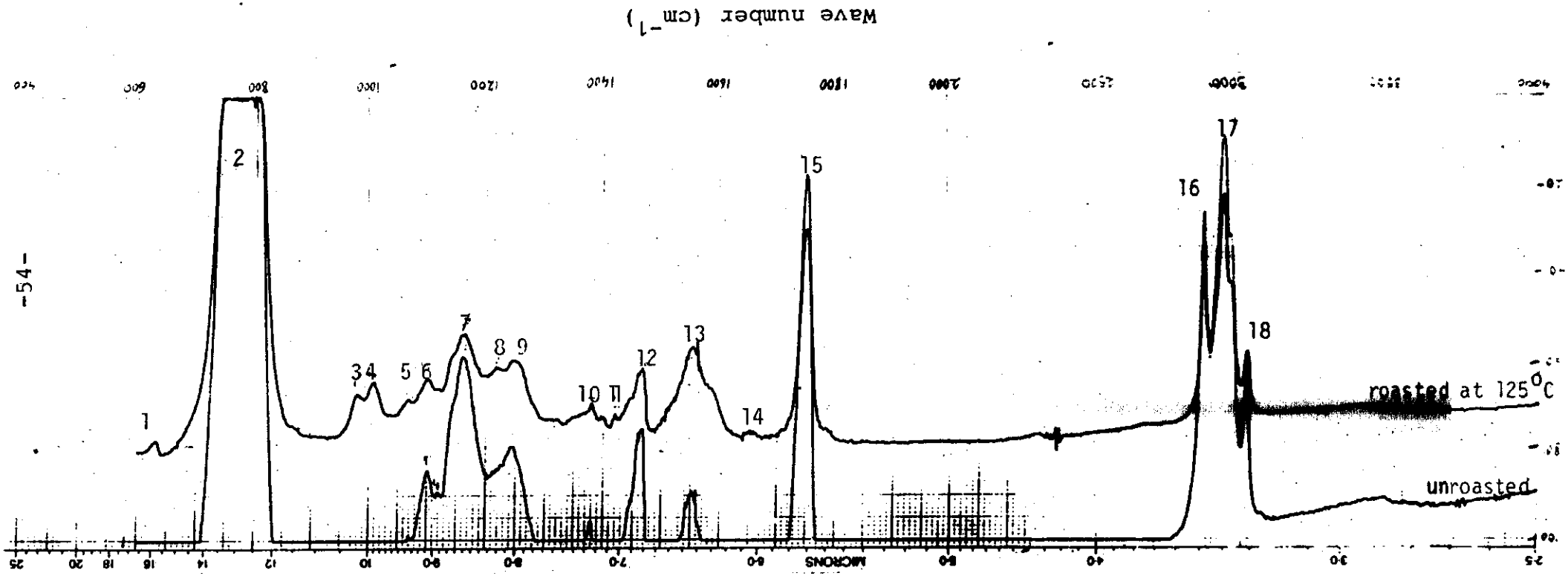

Fig. (8): The Infrared spectrum of unroasted and roasted fenugreek seeds at 125°C oleoresins.

From the obtained results it could be noticed that roasting fenugreek seeds at 125, 150 and 175°C affected the oleoresins infrared absorption properties, as the absorption bands increased from 12 to 18. The absorbance wavenumber of these bands varied from 632 CM^{-1} to 3015 CM^{-1} for roasted seeds, while in unroasted seeds oleoresins it varied from 800 to 3015 CM^{-1}. There were 12 bands identical in their positions in both oleoresins (from unroasted seeds and seeds roasted at 125, 150 and 175°C), These bands were present at wavenumbers 800 , 1069, 1160, 1245, 1380, 1465, 1550, 1748, 2860, 2925 and 3015 CM^{-1} respectively.

While the absorption bands at wavenumber 632 , 930, 1005, 1220, 1420 and 1655 CM^{-1} appeared in oleoresins of roasted seeds at 125, 150 and 175°C.

Generally, some functional groups might be suggested qualitatively in these oleoresins as their main characteristic absorption bands.

The characteristic band at wavenumber 1005 was in the limits of the characteristics bands of the cyclopropane derivatives as mentioned by Bellamy (1958) and Alpert (1970). The characteristic bands at 1069, 1102 , 1160 and 1220 CM^{-1} in the infrared spectra of fenugreek seeds hexane oleoresins was suggested for the nitrogen

containing compound as mentioned by Alpert et al.(1970).

The characteristic band at wavenumber 1245CM^{-1} was suggested for branched chain hydrocarbons as mentioned by Alpert et al (1970).

The three characteristic bands at 1280 CM^{-1} , 1420 CM^{-1} and 1465 CM^{-1} might prove the presence of a methyl group as mentioned by Nakanishi (1964).

The characteristic band at 1448 CM^{-1} in the infrared spectrum of fenugreek seeds hexane oleoresins was suggested for C=O group as mentioned by Bellamy,(1962).

In addition the presence of an absorpance 1860 CM^{-1} , 2925 CM^{-1} and 3015 CM^{-1} in the infrared spectra suggested for the presence of the "OH" group (bonded) in this oleoresins as mentioned by Carroli and Prive (1964), Bellamy (1962), Bhati (1968) and Alpert (1970).

Therefore it could be concluded that the infrared spectroscopy might be used as a guide for qualitative analysis of fenugreek seeds oleoresins. Also it proved that there were a difference between the oleoresins obtained from unroasted seeds and roasted seeds at 125, 150 and 175°C.