THE FATTY ACIDS OF INDIGENOUS RESOURCES FOR POSSIBLE INDUSTRIAL APPLICATIONS

Part I.—Investigation of the Species of Urticaceae and Rosaceae Families

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Some of the locally available varieties of *Morus alba* and *Morus nigra* (N.O. Urticaceae) and *Rosa macrophylla*, *R. moschata* and *R. webbiana* (N.O. Rosaceae) have been studied with respect to the chemical composition of their seeds and seed oils. Linoleic acid is the predominant component of the *M. alba* and Rosa species. Whereas palmitic acid constitutes the major component of the *M. nigra* seed oil, it is present, alongwith oleic, linoleic and linolenic acids in minor amounts in the Rosa varieties.

Introduction

By far the most important raw materials that have direct bearing upon many vital industries are vegetable and animal fats. Unfortunately, however, there is a considerable shortage of the fats in Pakistan. In order, therefore, to meet the situation arising out of this deficit, an investigation of the many hitherto neglected sources including the indigenous flora is urgently called for.

The present investigations suggest that the seeds of the mulberry trees [1,2] (*Morus alba* and *M. nigra*—N.O. Urticaceae) locally known as 'tut' and 'shahtut' respectively, are an important but so far neglected source of an oil (30-33%). The seeds are available to the extent of 10,000 maunds a year from the Changa Manga (District Lahore) plantation alone.

Similarly, the seeds of *Rosa macrophylla*, *R. moschata* and *R. webbiana* can be exploited for the recovery of an unsaturated oil. In an earlier communication[3] the potential of these wild roses as a possible source of vitamin C has already been pointed out. The hips of these roses contain up to 80% of seeds. Unless used suitably the seeds will go waste and thus affect the economics of the production of the vitamin from this important source. The rose-hip seeds have, therefore, also been analysed and found to contain 6%, 9% and 4% oil for *R. macrophylla*, *R. moschata* and *R. webbiana* respectively. Apparently these oil contents are low but they assume significance in view of the fact that even in other countries low oil-bearing seeds like grape-seeds are being exploited for their oil.

There are many garden varieties of the mulberry trees and in this investigation the seeds as well as the oils of all the available varieties were studied for their chemical composition. The seeds of the short varieties (black, white and yellow) of *M. alba* and those of the large variety, *M. nigra* (black) were procured from the Changa Manga plantation. The mulberry seeds were separated in each case, from the fruits by maceration, washed with water and then dried at room temperature (25°C).

The seeds of the Rosa species were obtained from the hips as collected and studied previously.[3]

Experimental

Analysis of the Seeds.—The seeds were analysed for their protein, oil, carbohydrates, moisture and fibre contents according to the standard methods[4] and the results are recorded in Table 1.

Examination of the Oils.—The seed was crushed in an iron pestle and mortar and then extracted with petroleum ether (40-60°) by the Swedish steel tube method.[5] The extract was dried over anhydrous sodium sulphate and the solvent removed by a stream of carbon dioxide. The amount of oil in the seed and its important physical and chemical values as determined by the standard methods[6,7] are recorded in Table 2.

Analysis of the Constituent Fatty Acids of the Oils.—The oil was saponified with 0.5N alcoholic potassium hydroxide under reflux in an atmosphere of nitrogen for six hours. The solution of the soap was shaken in a separatory funnel with ethyl ether to remove the unsaponifiable material. The residual soap solution was acidified with 4N sulphuric acid and the liberated fatty acids were extracted with ethyl ether, dried over anhydrous sodium sulphate and the solvent removed by a stream of nitrogen.

The fatty acids were then converted into their methyl esters by diazomethane in ethereal solution at low temperature. The esters were analysed by the gas-liquid phase chromatography usinga Radium Ionization Detector unit on a SEG column (13% diethylene glycol succinate on chrom[8] P w/w)

TABLE 1.—CHEMICAL COMPOSITION OF THE SEEDS OF THE SPECIES OF URTICACEAE AND ROSACEAE FAMILIES.

Components	*Morus alba* varieties			*Morus nigra* black long	*Rosa Macro-phylla*	*Rosa moschata*	*Rosa webbiana*
	White short	Black short	Yellow short				
Oil	33.00	32.50	30.00	8.00	6.00	9.00	4.00
Proteins	18.10	17.10	21.14	10.30	11.40	4.55	3.80
Fibre	9.85	9.15	9.75	28.15	43.90	40.20	58.46
Moisture	6.38	5.86	5.67	7.80	9.70	9.48	10.32
Mineral matter (including sand)	3.78	5.66	4.40	5.89	3.19	2.90	2.16
Carbohydrates (by difference)	28.89	29.73	29.04	39.86	25.81	33.87	21.26

TABLE 2.—PHYSICO-CHEMICAL CHARACTERISTS OF THE SEED OILS OF THE SPECICS OF URTICACEAE AND ROSACEA FAMILIES.

Value	*Morus alba* varieties			*Morus nigra* black long	*Rosa mac-rophylla*	*Rosa moschata*	*Rosa webbiana*
	White, short	Black, short	Yellow, short				
Refractive index at 30° ..	1.476	1.475	1.4808	—	1.473	1.480	1.479
Specific gravity at 30° ..	0.946	0.949	0.957	—	0.947	0.946	0.956
Colour (Lovibond) ..	2.4Y, .1R	3.4Y, .2R	2.8Y, .3R	1.6Y, .2R	29.8Y, 6.1R	20.0Y, 9.9R	27.1Y, 6.0R
Infra red bands or groups ..	Usual	Usual	Usual	Usual	Usual	Usual	Usual
Acid value ..	15.85	27.00	13.10	4.50	3.47	4.67	7.48
Iodine value ..	—	—	—	—	154.00	161.80	156.74
Saponification value ..	179.70	179.10	179.30	205.70	190.40	190.10	190.23
Non-saponifiable matter% ..	0.892	0.780	0.810	1.180	10.00	13.00	11.00

at 190°. The carrier gas used was Argon (flow rate 50 ml./min.) and the chart speed was maintained at 20 inches/hour.

The identity and the percentage composition of the component fatty acids in each oil were determined from the retention times and the peak areas of the methyl esters respectively. (Table 3).

Discussion

The determination of the constituent fatty acids reveals that the oils of *M. alba* and Rosa varieties are a rich source of linoleic acid while palmitic acid is the major constituent of *M. nigra* oil. The presence of myristic, palmitoleic and arachidic acids in traces and of stearic and oleic acids in minor amounts was also indicated in *Morus alba* and *M. nigra* varieties. The Rosa varieties contained stearic acid in traces and palmitic acid in minor amounts. The high percentage of unsaturated acids in the *M. alba* and Rosa varieties and of saturated acids in the *M. nigra* was further confirmed by resolving their total fatty acids into liquid and solid acids by Twitchell's Lead-salt-alcohol method as adopted by Hilditch.[9] The absence of linolenic acid in all the oils of the mulberry varieties was confirmed by the failure of the liquid acids to afford any hexabromide on bromination, whereas the oils of Rosa varieties yielded hexabromostearic acid. The di- and tetra-bromostearic acids[10] were afforded by *M. alba* and Rosa varieties. The absence of hydroxyl groups and the conjugated double bonds in the fatty acids was inferred from infra-red and ultra-violet analysis.

In view of the fact that linoleic acid is the predo-

TABLE 3.—G.L.C. ANALYSIS OF THE SPECIES OF URTICACEAE AND ROSACEAE FAMILIES.

Component Acid %	*Morus alba* varieties			*Morus nigra* black long	*Rosa macrophylla*	*Rosa moschata*	*Rosa webbiana*
	White, short	Black, short	Yellow, short				
14:0	trace	0.39	trace	trace	—	—	—
16:0	11.02	13.01	10.33	81.40	3.82	3.04	4.77
16:1	trace	trace	trace	trace	—	—	—
18:0	1.09	1.57	1.84	trace	trace	trace	trace
18:1	3.82	3.40	2.75	4.92	25.10	6.80	17.68
18.2	84.06	81.63	85.05	13.68	60.10	81.03	60.32
18:3	—	—	—	—	10.89	9.13	17.17
20:0	trace	trace	trace	trace	—	—	—

minant constituent of the oils of *M. alba* varieties and that these varieties containing upto 33 percent oil are available in large quantities, we, therefore, have got in these seeds an excellent source of a drying oil. The value of this source can further be realised from the consideration that these oils do not contain any linolenic acid in them. The linolenic acid rich oils, like linseed oil, are now giving way to linoleic acid predominant oils such as sunflower oil for the paint and varnish industries. Mulberry seed oil, particularly that of *M. alba*, therefore, is important from the industrial point of view.

The rose hip seeds also constitute a valuable source of a drying oil and hence these can be regarded yet another possible industrial commodity. The *R. moschata* seed oil merits consideration in greater detail. Whereas the seeds as well as the hips of *R. macrophylla* and *R. webbiana* may not be available in large quantity, the seed of *R. moschata* can be collected in large quantity, because of the abundance of this rose in the hilly areas of West Pakistan. The oil contents of this variety are also higher than those of the others. In the commercial exploitation of the rose hips for their high vitamin C contents the utilization of their waste—the seeds—can be given a serious consideration.

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References

1. I.H. Burkill, *A Working List of the Flowering Plants of Baluchistan* (The Pakistan Press, Quetta, 1956), p. 93.
2. R.N. Parker, *A Forest Flora of the Punjab with Hazara and Delhi* (Government Printing Press, West Pakistan, 1956), p. 472.
3. A.I. Ajmal, M.A. Chattha, M.I. Qureshi, M.K. Bhatty and Karimullah, Pakistan J. Sci. Ind. Res., **8**, 261 (1965).
4. V.C. Mehlendbacker and T.H. Hopper, *Official and Tentative Methods of the American Oil Chemists Society* (A.O.C.S. Official Method), second edition.
5. S. Troeing, J. Am. Oil Chemists' Soc., **32**, 124 (1955).
6. K.A. Williams, *Oils, Fats and Fatty Foods* (J & A Churchill Ltd. London, 1950), third edition, pp. 97-133, 515.
7. J. Devine and P.N. William, *The Chemistry and Technology of Edible Oils and Fats* (Pregman Press London, 1961), 1st edition, p. 145.
8. D. Glick, *Method of Bio-chemical Analysis*, (Inter Science Publishers, N.Y., London 1962), vol. 11, pp. 79-80.
9. T.P. Hilditch, *The Chemical Constitution of Natural Fats* (Chapman and Hall Ltd., 1956), third edition, p. 574.
10. W.F. Baughman and G.S. Jamieson, J. Am. Chem. Soc., pp. 119, 154 (1920).