Characteristics and Fatty Acid Content of the Fat of Seeds of Nine Wild Mexican Plants

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The chemical composition of Mexican wild plants has been investigated from the nutritional point of view. The approach of this study was to select the samples with medium to high concentration of crude fat and determine the characteristics and fatty acid content of the fat. The range of the fat content in the seeds studied was 13.7–49.2%. Most of the fats isolated showed a high iodine number, except for two that belonged to the *Theobroma* genus. Linoleic acid was in high concentration in most of the seeds. Taking into consideration their characteristics and fatty acid content, these fats could be classified as edible fats for animal and human consumption. However, toxicological studies have to be done since these wild seeds have not been used as food before.

INTRODUCTION

The study of different Mexican wild plants from the nutritional point of view has interested the authors for the past 15 years, and at the present time more than 200 plants have been so far studied. Our interest has been mainly focused in the analysis and quality of the protein content present in these wild plants (Giral et al., 1978; Sotelo et al., 1980, 1986; De la Vega et al., 1981; De la Vega and Sotelo, 1986).

During the past 10 years there has been an important deficit of fat production in Mexico since it is mainly obtained from oily seed for both human and animal consumption. Consequently, significant amounts of oily seeds and fat have to be imported into the country (Banco de México, 1989).

As part of our interest in the search for new sources of fat, we have been interested in the study of those wild seeds that showed medium to high fat concentration in their chemical analysis; some seeds should be mainly used for animal consumption, although some of them could be used for human consumption as well.

The present study describes the lipid characteristics of the oil as well as the fatty acid composition of nine oily wild Mexican seeds which were found to have significant fat concentration by means of their chemical analysis.

MATERIAL AND METHODS

The seeds were collected from different areas of Mexico, and their botanical classification was made by experts at the Instituto de Biología, UNAM. Table I lists their scientific and common names as well as the place they were collected from.

After the seeds were cleaned, they were sun dried, and ground through a Model 4 Wiley mill, equipped with a 1-mm sieve, or through a Tecator cyclone mill. A portion of the ground seeds was used for the proximate analysis according to the AOAC methods including moisture, protein, fat, fiber, and ash, and by difference the carbohydrate content was then calculated (AOAC, 1984).

The crude fat was obtained by a Goldfisch extractor (Labconco) using diethyl ether as solvent, bp 32 °C. Afterward, the ether was removed by distillation and the crude fat dried in a vacuum oven at 40 °C and 80-mmHg pressure. Precautions were taken to avoid oxidation for the fats by placing them in the freezer in dark bottles with added nitrogen; the bottles were stoppered until the analysis were performed. The analytical study of the fat content in the extracts included the following.

(a) Physical and Chemical Characteristic Determinations: Melting point, saponification number, and iodine number were determined according to AOAC methods (AOAC, 1984).

(b) Fatty Acid Analysis. The fatty acids in the lipid were determined by gas chromatography after transesterification to their methyl ester by the boron trifluoride (Sigma) according to the technique described by Metcalfe et al. (1966). The esters were separated by using a CARLE 311 chromatograph equipped with a DEGS 6 ft × $^1/_8$ in. column. The column temperature was 180–190 °C. The carrier gas was nitrogen at a flow rate of 40–60 mL/min.

Compound retention times and areas were recorded by means of a Methrom Labograph E-478 recorder. Standard methyl ester fatty acid mixtures (Sigma) were separated under identical conditions to identify the compounds and to calculate the response factors of the acids. Each analysis was made in duplicate.

Table I. Nine Oily Wild Seeds Collected in Mexico

scientific name	common name	botanical family	state of origin
Caesalpinia crista	ojo de águila, jabilla, haba de San Antonio	Leguminosae	Oaxaca
Callophylum brasilensis		Guttiferae	Sinaloa
Castilla elastica	hule (rubber seed)	Monaceae	Chiapas
Guarea chichon	zapotillo	Meliaceae	Chiapas
Guarea excelsa		Meliaceae	Chiapas
Pithecellobium flexicaule	maguacata, ébano	Leguminosae	Tamaulipas
Theobroma angustifolium	castarrica	Sterculiaceae	Chiapas
Theobroma bicolor	pataste	Sterculiaceae	Chiapas
Trichilla hirta	napahuite	Meliaceae	Chiapas

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Table II. Chemical Composition of Selected Wild Seeds (Grams per 100 Grams of Sample)

sample	moisture	protein	fat	fiber	ash	carbohydrate
T. hirta	4.47	14.00	49.21	24.38	2.53	5.41
T. angustifolium	3.19	10.48	46.02	21.70	4.46	14.15
T. bicolor	5.33	19.25	34.23	23.16	3.95	13.88
C. elastica	9.87	12.81	30.47	18.03	2.87	30.95
C. crista	3.93	23.53	23.46	4.68	5.10	39.30
C. brasilensis	4.78	3.93	17.02	5.01	1.38	67.88
G. chichon	9.06	8.16	15.86	33.30	3.43	30.19
G. excelsa	8.68	9.46	14.54	19.77	3.41	44.14
P. flexicaule	8.29	28.93	13.71	13.45	3.16	30.46

Table III. Physical and Chemical Characteristics of the Fat of Wild Seeds

sample	mp, °C	iodine no., % absorbed iodine	saponification no., mg of KOH/g of sample
C. crista	-14.00	125.17	169.26
P. flexicaule	-4.0	99.69	186.36
G. excelsa	25.5	88.59	187.29
T. hirta	26.0	78.93	189.91
G. chichon	26.1	95.82	190.11
C. brasilensis	27.0	77.52	190.43
C. elastica	28.0	78.54	188.93
T. angustifolium	34.0	46.32	178.69
T. bicolor	36.0	40.72	180.94
cottonseed oil	-5.0	101–117	189–198
corn oil	-15.6	111–131	187–193
cocoa bean fat	29–35	33–46	190–200

RESULTS AND DISCUSSION

Table II shows the results of the chemical composition obtained for the nine wild Mexican seeds. The samples are given in a decreasing order according to fat content. The highest fat concentration (49.2%) was found in *Trichilla hirta*, while the lowest (13.7%) was found in *Pithecellobium flexicaule*, which had the highest protein content. The second and third seeds with the highest fat concentration were *Theobroma angustifolium* (46.0%) and *Theobroma bicolor* (34.2%), both of which belong to the same family of the cocoa bean.

The characteristics of the oil for each seed studied are shown in Table III, in which the samples are given in increasing order of melting point. Three edible fats are included in the table for comparison (Schmidt-Hebbel, 1966). According to the iodine and saponification numbers of the fats, they could be considered similar to edible fats. The two seeds with the highest melting point were *T. angustifolium* (34.0 °C) and *T. bicolor* (36.0 °C); these seeds had melting points as well as an iodine and saponification numbers very similar to those of the cocoa bean. On the other hand, *Caesalpinea crista* showed the lowest melting point (-14 °C), but the highest iodine number (125.1%), both values being very similar to those of corn oil.

In the Table IV is shown the fatty acid composition of the nine seeds studied.

Only in *T. hirta* was myristic acid detected (0.25%). The main differences between the cocoa bean and the two wild seeds of the same genus, *T. angustifolium* and *T. bicolor*, are the low concentration of palmitic acid in both wild seeds and the presence of arachidic and behenic acids, mainly in *T. angustifolium*. Also, the *T. bicolor* showed very high concentration of stearic acid (50%) in comparison to that found in cocoa bean (35%).

On the other hand, *C. crista* and *P. flexicaule* showed the highest percentage of unsaturated fatty acids, which is in accordance with the fact that they had the lowest melting points and the highest iodine numbers. Most of the seeds had a significant amount of oleic and linoleic acids. It is important to mention that *C. crista* showed the highest concentration of linoleic acid (a very important fatty acid from the nutritional point of view), 71.5% of the total fatty acid, and the unsaturated fatty acid amounted to 88.9%. However, in the review survey made by Badami and Patil (1981) on the structure and presence of fatty acids in plants, it is reported that in the oil of seeds of the Ulmaceae family was found the highest concentration of linoleic acid. In this revision some authors reported 85% of this fatty acid (probably the highest in a seed oil) in *Apanthe aspara*. The finding in *C. crista* is also very important because this high concentration of linoleic acid in the Leguminosae family is not common. As a matter of fact, this concentration is found in the safflower seed oil. The linoleic acid content is reported as 76–79% of the total fatty acid, and this concentration is lower in seeds that grow in the tropics (52–65%). Also, sunflower seeds under cool growing conditions yield oil with high linoleic acid content (Hilditch, 1956).

The fatty acid composition in *Callophylum brasilensis* is very similar to that of other seed oils of the *Callophylum* genus reported by other authors except the linoleic acid that was very low in the seeds presently studied. Another difference found between the revised literature and the results found in the present work was the linoleic and linolenic acids content in the rubber seed oil, 36% and 20%, respectively (Hilditch, 1956), as compared to 41% and 0.34% found in our laboratory.

Two of the samples, *Guarea excelsa* and *Guarea chichon*, which belong to the Meliaceae family, showed the highest amount of linolenic acid, which could indicate that these fats should be considered as drying oils; however, their concentration is similar to that present in soybean oil.

Table IV. Fatty Acid Composition of the Seeds of Nine Wild Mexican Plants

sample	fatty acid composition, % C16	C18	C20	C22	C18:1,Δ^{9}	C18:2,$\Delta^{9,12}$	C18:3,$\Delta^{9,12,15}$	not identified	unsaturated, %
C. crista	8.06	3.08			17.38	71.48			88.86
P. flexicaule	15.34	9.39	1.38	1.03	32.60	39.27		0.39	72.96
G. excelsa	26.13	6.79	1.43		42.11	12.85	6.97	3.72	65.47
T. hirta[a]	25.72	9.54			43.13	18.79	1.94	0.63	64.49
G. chichon	18.04	10.43			36.73	28.93	5.86		71.53
C. brasilensis	36.24	8.32			48.58	6.07	0.79		55.44
C. elastica	39.77	1.42			16.78	41.69	0.34		58.81
T. angustifolium	5.00	25.00	11.29	3.91	49.67	5.13			54.80
T. bicolor	6.11	50.44	1.26		39.38	2.81			42.19
cottonseed oil	24	3			18	53			72
corn oil	13	4			29	54			83
cocoa bean fat	24	35			39	2			41

[a] Only in this seed was myristic acid detected: 0.25%.

According to these results and on the basis of the physical and chemical characteristics and fatty acid composition, the fat of most of the wild seeds studied could be classified as edible fats.

Since these seeds have not been previously used as food, it is necessary to do the proper toxicological studies of the fats before they could be proposed for either animal or human consumption. The wild seeds studied represent a very small part of the Mexican wild flora which could be considered as a potential source of fat for human or animal feeding and also as substitutes of some fats used in the pharmaceutical and confectionary industries.

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