JOURNAL OF FOOD COMPOSITION AND ANALYSIS (2001) **14,** 585–590
doi:10.1006/jfca.2001.1020
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ORIGINAL ARTICLE

Compositional Studies of Seeds and Fruits from Two Varieties of *Geoffroea decorticans*

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Received September 8, 2000, and in revised form April 30, 2001

Chañar (*Geoffroea decorticans*) seeds and fruits constitute valuable foodstuff for humans and animals in many semiarid regions of South America. The purpose of this research was to determine the proximate composition and fatty acid pattern of seeds and fruits from two varieties of Chañar growing in Argentina. The chemical parameters evaluated varied very little among the two varieties. The most outstanding feature was the high average lipid content (about 47%) of seeds where oleic and linoleic acids accounted for 42 and 43%, respectively. The fruit composition showed similar protein and oil contents. Approximately 83% of the fatty acids were unsaturated with oleic and linoleic acids predominating. The oil yield of Chañar seeds, its physicochemical characteristics and the component fatty acids are found to be close to those reported for most commonly used edible oils. © 2001 Academic Press

Key Words: *Geoffroea decorticans*; seed; fruit; protein; oil; fatty acids.

INTRODUCTION

Chañar (*Geoffroea decorticans*), belonging to Leguminosae plant family, is a well-known and valuable tree in the semiarid regions of the Great Chaco vegetation (Lewis *et al*., 1990; Cabrera, 1994) from Paraguay, southern Peru and Bolivia, northern half of Chile, southern Uruguay and northern to central south-east (southern limit: Río Negro province) of Argentina (Tinto, 1977; Maranta, 1987; Delhey, 1991). The bark, flowers and leaves have various uses in popular medicine and the fruits provide a good food source for humans and their animals in rural communities since ancient times (Burkart, 1952). The seeds are also consumed, after roasting, as flavouring and nutritional sources because of their almond-like flavour and high oil content (Lamarque, personal communication).

Two varieties of Chañar have been described on the basis of morphological characters (Lillo, 1910; Burkart, 1949): *G. decorticans* var. *decorticans* which is largely distributed in Argentina, Chile, Peru, Bolivia, Uruguay and Paraguay; and *G. decorticans* var. *subtropicalis* which is confined to north-west of Argentina. Although a recent revision of Ireland and Pennington (1999) does not recognize the two varieties as

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separated entities, the characters used in the original description to define them (Lillo, 1910; Burkart, 1949) and confirmed later (Burkart, 1952; Fortunato, 1984; Ulibarri, 1994) are considered to be sufficient to maintain their different taxonomic levels.

Literature about chemical investigations is scarce and deals mainly with fruit composition of *G. decorticans* var. *decorticans* (Fischer de Riesnik, 1952; Tinto, 1977; Becker, 1983; Maranta, 1987; Delhey, 1991). Economical and efficient utilization of Chañar requires more scientific data and information on the characteristics and composition of seeds and fruits than is available.

This work aimed to provide basic information on seed and fruit chemical composition from the two varieties of Chañar mentioned above.

MATERIALS AND METHODS

Plant Material

Mature fruits of *G. decorticans* var. *decorticans* (Hook et Arn.) Burkart and *G. decorticans* var. *subtropicalis* (Lillo) Burkart were collected from San Juan and Tucumán provinces.

Three samples (consisting of 20 fruits each) were collected for each variety.

The pericarp (epicarp plus mesocarp) was separated from endocarp by hand with the aid of a scalpel. Twenty grams of pericarp from each sample were milled and oven-dried at 55°C. Endocarps (10 g) were crushed and seeds were recovered and ground in a mortar.

Triplicate analyses of each sample were performed for each chemical attribute.

Proximate Analysis

Fat, nitrogen, ash, total sugars and crude fibre contents were determined on a dry wt. basis according to the Association of Official Analytical Chemists (1990) methods. Protein content was calculated as $\%N \times 6.25$ (Balogun and Fetuga, 1986).

Oil Extraction and Fatty Acid Analysis

Fruits (pericarp) and seeds from each sample were extracted separately with n-hexane in a Soxhlet apparatus. The extracted lipids were dried over anhydrous sodium sulphate and the solvent was removed by vacuum distillation at 40°C. The fatty acid methyl esters (FAMEs) of oils were prepared and analysed by gas chromatography according to Maestri *et al.* (1998). The identification of the compounds was carried out by CG-MS (Lamarque *et al.*, 2000) and by comparison of the retention times with those of reference compounds. The oils and FAMEs were examined for the presence of hydroxy and epoxy fatty acids by IR. The IR spectra were obtained in KBr discs.

Physicochemical Characteristics of Seed Oils

Refractive indexes, unsaponifiable matter contents, saponification values and fat acidity were determined by the methods of AOAC (1990). Iodine values were calculated from fatty acid percentages (Carreras *et al.*, 1989). Peroxide values were determined according to thiocyanate method (Osawa and Namiki, 1981).

TABLE 1

Oil, protein, ash, total sugars and crude fibre contents (% of dry matter) of seeds and fruits from two varieties of *Geoffroea decorticans* (GD). Mean values ± standard deviations ($n = 3$)

	Fruit		Seed	
Parameter	GD decorticans	GD subtropicalis	GD decorticans	GD subtropicalis
Oil	6.3 ± 0.2	6.2 ± 0.05	48.8 ± 1.6	46 ± 0.4
Protein	6.5 ± 0.1	10 ± 0.5	21.6 ± 0.04	24.1 ± 0.2
Ash	3.1 ± 0.09	3.2 ± 0.07	2.9 ± 0.02	3.07 ± 0.06
Total sugars	25.7 ± 0.5	23.9 ± 0.4	—	—
Crude fibre	14.8 ± 0.2	15.5 ± 0.2	—	—

Mineral Composition

Mineral analysis was carried out by digestion of dry samples (2 g) in a mixture of 25 mL of 19% HCl and 5 mL of concentrated HNO_3. The mineral constituents were then determined by atomic absorption spectrophotometry (Balogun and Fetuga, 1986).

RESULTS AND DISCUSSION

The data on seed and fruit proximate composition are presented in Table 1. The seed oil content is similar in the two varieties studied (45.9–48.8%) and compares favourably with such commercial vegetable oils as peanut, sunflower and rapeseed (Padley *et al*., 1986; Grosso *et al*., 1997). Based on their oil content, Chañar seeds can be classified as high yielding and it is thus an indicator of a potential source of commercial vegetable oil.

Seeds contain 21.6–24% protein and 2.9–3.1% ash, i.e., slightly less protein and about the same content of ash as peanut seeds (Grosso *et al*., 1997).

Unlike seeds, the fruits from both varieties have reduced oil and protein quantities (6.2–6.3% and 6.5–10%, respectively). However, these values are higher than those reported by Becker (1983) in Chañar pericarp. On the other hand, oil contents are greater than the values found by Zolfaghari *et al*. (1986) and Harden and Zolfaghari (1988) in Mesquite (*Prosopis glandulosa*) pods; whereas protein contents are in the range of those found in *P. chilensis* pods (Corfo, 1985; Ibrahim, 1988). Ash contents are essentially the same in both, fruits and seeds, and they are indicative of fair sources of minerals. Total sugars constitute the preponderant fraction in fruits (23.9–25.7%). Like other Leguminosae (Zolfaghari *et al*., 1986), considerable amounts of crude fibre are present in fruits from the two varieties of Chañar (14.8–15.5%).

The purified lipids from seeds have the following physicochemical characteristics: refractive index, 1.466–1.469; unsaponifiable matter, 0.15–0.16% (w/w); saponification value, 175–178 mg KOH/g; fat acidity, 11.9–12.2 mg KOH/100 g seeds; iodine value, 115.3–116.3; peroxide value, 4.07–4.69 meq/kg (Table 2). The range of saponification values indicates the absence of lauric oils, while refractive and iodine indexes reflect high unsaturated fatty acid content. All the physicochemical data obtained fall within the range observed in some edible oils (Padley *et al*., 1986).

The FAME composition of seed and fruit lipids is shown in Table 3. Ten fatty acids are identified. Chañar seed oils are found to be highly unsaturated, exceptionally rich

TABLE 2

Physicochemical characteristics of seed oils from two varieties of *Geoffroea decorticans* (GD). Mean values ± standard deviations ($n = 3$)

Parameter	GD decorticans	GD subtropicalis
Refractive index (25°C)	1.466 ± 0.002	1.469 ± 0.001
Unsaponifiable matter (% w/w)	0.15 ± 0.01	0.16 ± 0.01
Saponification value (mg KOH/g)	175 ± 1.5	178 ± 1.4
Fat acidity (mg KOH/100 g seeds)	12.2 ± 0.2	11.9 ± 0.3
Iodine value	116.3 ± 1.1	115.3 ± 1.0
Peroxide value (meq/kg)	4.69 ± 0.5	4.07 ± 0.4

TABLE 3

Fatty acid composition (% of total fatty acids) of seeds and fruits from two varieties of *Geoffroea decorticans* (GD). Mean values ± standard deviations ($n = 3$)

	Seed		Fruit	
Parameter	GD decorticans	GD subtropicalis	GD decorticans	GD subtropicalis
C 16:0	8.8 ± 0.4	7.7 ± 0.04	11.1 ± 0.1	12.4 ± 0.5
C 16:1	—	—	1.1 ± 0.1	1.0 ± 0.03
C 18:0	3.4 ± 0.06	3.8 ± 0.02	2.9 ± 0.06	3.0 ± 0.05
C 18:1	41.4 ± 0.5	42.8 ± 0.3	35.3 ± 0.6	35.3 ± 0.3
C 18:2	43.4 ± 1.1	42.6 ± 0.8	44.7 ± 0.6	40.0 ± 0.7
C 18:3	—	—	1.17 ± 0.1	5.98 ± 0.2
C 20:0	0.8 ± 0.01	0.9 ± 0.05	0.8 ± 0.05	0.7 ± 0.03
C 20:1	0.7 ± 0.01	0.7 ± 0.04	0.6 ± 0.04	0.6 ± 0.1
C 22:0	1 ± 0.07	1.3 ± 0.12	1.2 ± 0.25	0.3 ± 0.2
C 24:0	0.6 ± 0.2	0.4 ± 0.03	1.1 ± 0.06	0.7 ± 0.01
Total saturates	15 ± 0.2	14 ± 0.1	17 ± 0.1	17 ± 0.2
Total unsaturates	85 ± 0.3	86 ± 0.3	83 ± 0.2	83 ± 0.3
C 18:1/C 18:2	1.0 ± 0.03	1.0 ± 0.02	0.8 ± 0.02	0.9 ± 0.01

in 9-octadecenoic (oleic, 18:1) and 9, 12-octadecadienoic (linoleic, 18:2) acids. The oleic to linoleic (O/L) ratio is about 0.98 in both varieties. Saturated acids are mainly composed of hexadecanoic (palmitic, 16:0) and octadecanoic (stearic, 18:0) acids. Besides these constituents, eicosanoic (arachidic, 20:0), eicosenoic (gadoleic, 20:1), docosanoic (behenic, 22:0) and tetracosanoic (lignoceric, 24:0) acids are detected in small quantities. There are no unusual fatty acids. The IR spectra of oils and FAMEs from both varieties do not show characteristic bands at 840–820/cm and 3450/cm for epoxy and hydroxy functional groups, respectively (Daulatabad and Hosamani, 1991).

The fruit fatty acid pattern differs qualitatively and quantitatively from that of the seeds. The fruit lipids present the fatty acids found in the seeds, plus hexadecenoic (palmitoleic, 16:1) and octadecatrienoic (linoleic, 18:3) acids. Furthermore, the O/L ratio in fruit lipids is lower than that of seed lipids.

The mineral composition from fruits of the two varieties of *G. decorticans* is listed in Table 4. Potassium is the most abundant mineral, followed by magnesium and calcium. Composition of the microminerals shows similar levels of copper, zinc and iron, and minor values of manganese.

From the results of the present investigation and other related studies (Tinto, 1977; Becker, 1983; Maranta, 1987; Delhey, 1991), it appears that the fruits and mainly the

TABLE 4

Mineral composition (mg/g of dry matter) of fruits from two varieties of *Geoffroea decorticans* (GD). Mean values ± standard deviations ($n = 3$)

Minerals	GD decorticans	GD subtropicalis
Calcium	0.55 ± 0.02	0.50 ± 0.01
Magnesium	0.75 ± 0.04	0.55 ± 0.03
Sodium	0.23 ± 0.01	0.47 ± 0.02
Potassium	13.3 ± 0.3	11.7 ± 0.2
Manganese	< 0.005	< 0.005
Copper	0.015 ± 0.002	0.015 ± 0.003
Zinc	0.015 ± 0.002	0.010 ± 0.001
Iron	0.015 ± 0.003	0.020 ± 0.003

seeds from the two varieties of *G. decorticans* studied are a valuable source of oil and protein, comparable in quality to those of some oily plant species. On average, oil and protein together constitute about 70% of dry seed. The fatty acid composition is similar to that of any other edible oil, such as sunflower, rapeseed and peanut oil (Padley *et al*., 1986; Grosso *et al*., 1997). Therefore, Chañar oil may be a good source of essential unsaturated fatty acids.

The findings shown in this work raise the nutritional value of these underexploited leguminous plants, especially in semiarid regions of Argentina, where conventional crops are difficult.

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