Lipid, Protein, and Ash Contents, and Fatty Acid and Sterol Compositions of Peanut (*Arachis hypogaea* L.) Seeds from Ecuador

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ABSTRACT

Oil and protein percentages, ash, iodine value, fatty acid and sterol compositions were studied in 28 *Arachis hypogaea* L. cultivars originating from Ecuador. Results showed lower protein percentages in the varieties *hypogaea* (27.3%) and *hirsuta* (25.9%) than in the varieties *fastigiata* (29.4%), *peruviana* (29.4%), and *aequatoriana* (31.3%). The principal fatty acids were linoleic and oleic. The variety *hypogaea* exhibited higher concentrations of oleic acid (45.1%). The sterol composition showed higher concentration of β-sitosterol following by campesterol, stigmasterol, and Δ^5-avenasterol.

Key Words: Oil, protein, fatty acids, sterols, seeds, groundnut.

Numerous peanut cultivars and wild species exist and have been collected in South America. The probable centers of origin of *Arachis* species and *A. hypogaea* L. were in the Gran Pantanal (Mato Grosso, Brazil) and on the eastern slopes of the Andes in Bolivia, respectively (9, 15).

Many expeditions have been made in South America for the collection of different genotypes. Thousands of samples are maintained in germsplasm banks (2, 21)—for example, in the Instituto Nacional de Tecnología Agropecuaria (INTA) of Manfredi, Córdoba, Argentina; at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, A.P., India; and at Griffin, GA by the USDA (23).

Peanuts are grown worldwide in the tropics and temperate zones primarily as an oilseed crop (3). Peanut seeds make an important contribution to the human diet in many countries, and its widespread acceptability is attributed to its economic value to the industry and nutritional benefits to consumers. Peanut seeds are a good source of protein, lipid, and fatty acids for human nutrition (25). The fatty acid composition of the endogenous fats plays an important role in determining shelf-life, nutrition, and flavor of food products (8).

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The chemical composition of peanut seeds has been studied in relation to fatty acid composition (22, 26, 27), protein levels (29), and amino acid composition (18, 30). However, chemical studies of peanut cultivars originating from many parts of South America have been not undertaken. These materials contain new sources of germplasm that can be used to increase the variability in the genetic base of cultivated varieties (2, 19).

At present, fatty acids, sterols, and other chemical components have not been studied in Ecuadorian peanuts. The objective of this study was to characterize chemical properties of peanut seeds from Ecuador.

Materials and Methods

Plant Material. Sound and mature seeds of 28 different peanut cultivars from Ecuador were provided by INTA of Manfredi, Córdoba, Argentina (Table 1). A detailed description of the taxonomic classification of peanut was reported by Krapovickas and Gregory (16).

Oil, Protein, and Ash Contents. Three samples each containing five seeds from each cultivar were examined for oil, protein, and ash content. Seeds were milled and oil was extracted for 16 hr with petroleum ether (boiling range 30-60 C) in a Soxhlet apparatus. The extracted oils were dried over anhydrous sodium sulfate and the solvent removed under reduced pressure in a rotary film evaporator. Oil percentages was determined by weight difference.

Ash was determinated by incineration in a muffle furnace at 525 C (13). The nitrogen content estimated by the Kjeldahl method (13) and was converted to protein content by using the conversion factor 5.46 (29).

Fatty Acid Composition. Fatty acid methyl esters were prepared by transmethylation with a 3% solution of sulfuric acid in methanol (14). The fatty acid methyl esters of total lipids were analyzed on a Shimadzu GC-R1A gas chromatograph equipped with flame ionization detector (FID). An AT-WAX superox II capillary column (30 m x 0.25 mm inside diameter) was used. The column temperature was programmed from 180 C (held for 10 min) to 240 C (4 C/min) and the injector temperature was 250 C. The carrier (nitrogen) had a flow rate of 1 mL/min. A standard fatty acid methyl ester mixture (Sigma Chemical Co.) was run to use retention times for identifying sample peaks. Fatty acid levels were estimated on the basis of peak areas of known concentrations of the standards. Iodine values were calculated from fatty acid percentages (11) using the formula (% oleic x 0.8601) + (% linoleic x 1.7321) + (% eicosenoic x 0.7854).

Table 1. Collection data of *Arachis hypogaea* originating from Ecuador.

Classification	Cultivar[a]	RCM[a]	US[a]	Origin of sample
Subspecies *hypogaea*				
Var. *hypogaea*	1 Eh	86/2762	687(1)	Quito-Pichincha
	2 Eh	86/2744	693(6)	Pedro Carbó-Guayas
	3 Eh	86/2747	731(1)	Valencia-Los Ríos
	4 Eh	86/2756	686(1)	Quito-Pichincha
	5 Eh	86/2754	695(1)	Pedro Carbó-Guayas
	6 Eh	86/2764	694	Pedro Carbó-Guayas
	7 Eh	86/2763	690	EEA Boliche-Guayas
	8 Eh	86/2713	698(3)	Loma de Sargentillo-Guayas
Var. *hirsuta*	9 Ehi	86/2769	732	San Antonio-Pichincha
	10 Ehi	86/2770	733	Barrio Rumicucho-Pichincha
Subspecies *fastigiata*				
Var. *fastigiata*	11 Ef	86/2732	684	Quito-Pichincha
	12 Ef	86/2739	697(2)	Bachiller-Guayas
	13 Ef	86/2741	701(2)	Piñas-El Oro
	14 Ef	86/2706	711(1)	Zapotebamba-Loja
Var. *peruviana*	15 Ep	86/2714	717(2)	Catacocha-Loja
	16 Ep	86/2715	714(2)	Catacocha-Loja
	17 Ep	86/2667	688	Quito-Pichincha
	18 Ep	86/2678	698(3)	Loma de Sargentillo-Guayas
	19 Ep	86/2701	727	Macará-Loja
	20 Ep	86/2718	713	Catacocha-Loja
	21 Ep	86/2730	726	Macará-Loja
Var. *aequatoriana*	22 Ea	86/2535	683(3)	Quito-Pichincha
	23 Ea	86/2547	699(1)	Piñas-El Oro
	24 Ea	86/2587	711(1)	Loja-Loja
	25 Ea	86/2647	699(4)	Piñas-El Oro
	26 Ea	86/2654	719(3)	San Antonio-Loja
	27 Ea	86/2633	702(2)	Piñas-El Oro
	28 Ea	86/2645	729(2)	Chaguarpamba-Loja

[a]The cultivars were identified with a number and letters. The letters indicate the country of origin and variety. E = Ecuador, h = var. *hypogaea*, hi = var. *hirsuta*, f = var. *fastigiata*, p = var. *peruviana*, a = var. *aequatoriana*. RCM: Collection Registry Number of INTA of Manfredi, Córdoba, Argentina. US: Original number of collection.

Sterol Composition. Sterols of the unsaponifiable matter from 5 g of oil (after saponification with alcoholic 1*N* potassium hydroxide) were purified by preparative thin-layer chromatography (TLC). TLC was performed on silica gel 60 G (20 x 20 cm, 0.5-mm layer thickness) plates using chlroroform-diethyl ether (9:1 v/v) as the developing solvent. The aproximate relative R_f values of the 4-desmethylsterols fraction was 0.27. The unsaponifiable matter was dissolved in chloroform (5%) and 150 µL was deposited as a streak of 15 cm length on the plate. Cholesterol, used as standard, was spotted on the left and right hand sides of the plate. The corresponding band of 4-desmethylsterols was scraped off the plate and extracted with chloroform (8). Purified sterols were analyzed on a Shimadzu GC-R1A gas chromatograph equipped with FID. A Shimadzu CBP1 capillary column (25 m x 0.25 mm inside diameter) was used. Column temperature was programmed from 200 to 300 C (4 C/min) and the injector temperature was 320 C. The carrier (nitrogen) had a flow rate of 1 mL/min. Standard sterols (Sigma Chemical Co.) were run to use retention times in identifying sample peaks. Sterol levels were estimated on the basis of peak areas of known concentrations of the standards.

Statistical Analysis. The data of 28 peanut cultivars from Ecuador are mean values of triplicate analyses. Significant differences among mean values from varieties and subspecies of peanut were evaluated using a t-test (5). The variety *hirsuta* is not included in the statistical analysis because the mean values represent only two cultivars.

Results and Discussion

Oil content, protein level, ash, and iodine value are showed in Table 2. These results were similar to peanut cultivars reported by Ahmed and Young (1), except the iodine value was higher in this work. The variations of iodine values and oleic to linoleic ratios (O/L) could be due to differences in climatic conditions, soil moisture, and air temperature during maturation and temperatures during curing of peanut seed (12, 27). Peanuts are characterized by high oil and protein contents and low percentages of carbohydrates and ash. The knowledge of these components is important in the end products of the industry (1, 6). The variety *hypogaea* averaged lower iodine values than the other varieties; however, they were not significantly different from varieties *fastigiata* and *peruviana*.

Significant differences were found within the protein levels among varieties and subspecies of peanut (Tables 2 and 5). The cultivars of the varieties *hypogaea* and *hirsuta* (subspecies *hypogaea*) generally exhibited lower protein percentages than the varieties *fastigiata*, *peruviana*, and *aequatoriana* (subspecies *fastigiata*). The variety *hirsuta* showed higher oil content and lower protein level.

Palmitic (16:0), stearic (18:0), oleic (18:1), linoleic (18:2), arachidic (20:0), eicosenoic (20:1), behenic (22:0), and lignoceric (24:0) acids varied among genotypes (Table 3). The range of concentrations of the fatty acids was similar to the previously published peanut cultivars (1, 26). Significant differences were found in the fatty acid percentages (Tables 3 and 5).

Iodine value and oleic:linoleic ratio are both indicators of oil stability and shelf-life (1, 5). Traditionally in the U.S., runner market types have been predominantly utilized for the peanut butter trade, and oil composition (especially O/L ratio) likewise plays an important role in the manufacturing of this end-use product (5). Previous fatty acid composition studies with the cultivated run-

Table 2. Oil, protein, and ash percentages, and iodine value of peanut cultivars from Ecuador.

Cultivar	Oil[a]	Protein[a]	Ash[a]	Iodine value
	---------- % ----------			
Var. *hypogaea* (M)[b]	46.66a	27.37b	2.61a	102.1a
SD (n = 8)	±3.58	±1.04	±0.08	±1.88
1 Eh	50.4	27.6	2.6	99
2 Eh	47.2	27.8	2.7	100
3 Eh	52.7	27.2	2.7	102
4 Eh	43.2	29.2	2.5	103
5 Eh	43.1	27.3	2.7	105
6 Eh	46.6	27.4	2.5	103
7 Eh	47.2	25.4	2.6	102
8 Eh	42.9	27.1	2.6	103
Var. *hirsuta* (M)	53.05	25.90	2.70	109.5
SD (n = 2)	±1.63	±0.42	±0.28	±0.70
9 Ehi	51.9	26.2	2.5	110
10 Ehi	54.2	25.6	2.9	109
Var. *fastigiata* (M)	46.57a	29.45a	2.67a	103.2a
SD (n = 4)	±1.34	±1.87	±0.15	±2.22
11 Ef	44.7	28.7	2.8	106
12 Ef	47.6	28.0	2.5	104
13 Ef	47.5	32.2	2.8	102
14 Ef	46.5	28.9	2.6	101
Var. *peruviana* (M)	48.43a	29.47a	2.46b	106.0a
SD (n = 7)	±3.49	±1.82	±0.19	±6.68
15 Ep	47.3	31.7	2.5	102
16 Ep	43.0	28.3	2.6	101
17 Ep	49.7	28.1	2.4	102
18 Ep	52.9	29.3	2.3	103
19 Ep	50.1	28.5	2.3	103
20 Ep	49.3	32.4	2.3	113
21 Ep	45.7	28.0	2.8	118
Var. *aequatoriana* (M)	49.16a	31.36d	2.44b	113.1b
SD (n = 7)	±3.37	±1.03	±0.10	±2.91
22 Ea	44.9	32.3	2.4	110
23 Ea	43.9	31.3	2.4	113
24 Ea	52.3	31.3	2.4	117
25 Ea	49.4	31.2	2.3	115
26 Ea	51.1	32.4	2.5	116
27 Ea	51.0	29.3	2.6	111
28 Ea	51.5	31.7	2.5	110

[a]Expressed as pecentages (g/100 g of seeds) on dry matter basis.
[b]Mean values (M) and standard deviations (S.D.) for each variety. Means followed by the same letter within each column are not significantly different at P = 0.05.

ner-type peanut from Córdoba (Argentina) showed a low O/L ratio (approximatly 1.20) (10). The Argentinean industry prefers a high level of O/L ratio. The variety *hypogaea* cultivars from Ecuador (except 8 Eh) exhibited high oleic acid contents and correspondingly high O/L ratios. These cultivars could be useful for the development of new cultivars with improved stability characteristic and more desirable fatty acid composition.

The peanut oil is unique among vegetable oils in that it contains long chain saturated fatty acids (20-24 carbons) (26). In previous studies, these fatty acids have been shown to comprise 4-9% of total composition (28). The long chain saturated fatty acids of the 28 cultivars of Ecuadorian peanuts varied within this range (Table 3).

Disregarding a few exceptions, vegetable oils contain an average of 0.2-1.5% unsaponifiable compounds. The sterols are components of unsaponifiable lipids and are important to identify blends of fats and oils (4, 17). Tocopherols and sterols are also of interest because of their antioxidant activity (7). The following sterols were

Table 3. Fatty acid composition (relative percentages) of peanut cultivars from Ecuador.

Cultivar	Fatty acids								O/L
	16:0	18:0	18:1	18:2	20:0	20:1	22:0	24:0	
Var. *hypogaea* (M)[a]	10.67b	2.22ab	45.16b	36.01b	1.24a	1.72a	1.72a	1.14a	1.26b
SD (n = 8)	±0.69	±0.97	±3.06	±2.13	±0.20	±0.37	±0.35	±0.15	±0.15
1 Eh	10.2	3.9	47.0	33.8	1.5	1.1	1.5	1.0	1.39
2 Eh	10.7	2.5	47.2	34.0	1.2	1.7	1.7	1.0	1.39
3 Eh	9.9	2.4	46.6	35.0	1.3	1.5	1.9	1.2	1.33
4 Eh	10.9	1.1	45.2	36.2	1.2	2.1	1.9	1.3	1.25
5 Eh	10.2	1.6	46.8	36.1	0.9	2.3	1.1	1.0	1.30
6 Eh	11.4	1.1	44.8	36.8	1.1	1.8	1.5	1.3	1.21
7 Eh	10.2	2.1	45.8	35.6	1.2	1.7	2.0	1.3	1.29
8 Eh	11.9	3.1	37.9	40.6	1.5	1.6	2.2	1.0	0.93
Var. *hirsuta* (M)	12.15	1.25	35.25	45.10	1.15	1.50	2.20	3.25	0.78
SD (n = 2)	±0.21	±0.07	±0.35	±0.42	±0.07	±0.14	±0.00	±0.07	±0.01
9 Ehi	12.0	1.2	35.0	45.4	1.2	1.6	2.2	1.3	0.77
10 Ehi	12.3	1.3	35.5	44.8	1.1	1.4	2.2	1.2	0.79
Var. *fastigiata* (M)	12.60a	1.90ab	37.32a	40.20a	1.62b	2.02ab	2.77b	1.50b	0.93a
SD (n = 4)	±0.75	±0.82	±1.17	±1.89	±0.21	±0.75	±0.49	±0.08	±0.06
11 Ef	12.8	1.1	35.8	42.7	1.5	2.0	2.7	1.4	0.84
12 Ef	13.4	1.3	38.6	40.1	1.4	1.5	2.2	1.5	0.96
13 Ef	11.6	2.5	37.7	39.9	1.8	1.5	3.4	1.6	0.96
14 Ef	12.6	2.7	37.2	38.1	1.8	3.1	2.8	1.5	0.98
Var. *peruviana* (M)	11.90a	1.96a	36.19a	42.09a	1.61b	2.30b	2.63b	1.21ab	0.88a
SD (n = 7)	±0.66	±0.42	±2.68	±5.24	±0.43	±0.63	±0.78	±0.32	±0.15
15 Ep	12.4	2.4	37.6	39.3	1.6	2.7	2.7	1.3	0.96
16 Ep	11.6	2.6	37.2	38.6	1.8	2.7	3.6	1.8	0.96
17 Ep	12.8	2.0	38.1	38.9	1.7	2.5	2.7	1.1	0.98
18 Ep	11.2	1.9	38.1	39.0	2.2	2.6	3.4	1.4	0.98
19 Ep	12.5	1.7	37.3	39.8	1.9	2.8	2.8	1.1	0.94
20 Ep	11.6	1.7	34.0	47.2	1.2	1.6	1.6	0.9	0.72
21 Ep	11.2	1.4	31.0	51.8	0.9	1.2	1.6	0.9	0.60
Var. *aequatoriana* (M)	11.69a	1.60b	32.73c	48.24c	1.27a	1.54a	1.92a	0.83c	0.68c
SD (n = 7)	±0.86	±0.18	±1.64	±2.45	±0.20	±0.19	±0.34	±0.20	±0.08
22 Ea	11.7	1.8	33.2	46.1	1.6	1.5	2.7	1.2	0.72
23 Ea	12.1	1.4	34.0	47.5	1.1	1.3	1.8	0.7	0.72
24 Ea	10.1	1.5	30.3	51.8	1.5	1.6	1.7	0.8	0.58
25 Ea	11.5	1.5	31.1	50.3	1.3	1.5	1.9	0.9	0.62
26 Ea	11.3	1.5	32.0	50.1	1.1	1.6	1.8	0.6	0.64
27 Ea	12.7	1.6	34.8	45.8	1.2	1.4	1.8	0.7	0.76
28 Ea	12.4	1.9	33.7	46.1	1.1	1.9	1.8	0.9	0.73

[a]Mean values (M) and standard deviations (S.D.) for each variety. Means followed by the same letter within each column are not significantly different at P = 0.05.

Table 4. Sterol composition (relative percentages) of oils from Ecuadorian peanut cultivars.

Cultivar	Sterol composition[a]						
	Chol.	Camp.	Stig.	Sit.	Δ^5-av.	Δ^7-st.	Δ^7-av.
	g/100 g of total sterols[c]						
Var. *hypogaea* (M)[b]	2.12a	14.94a	9.09a	62.11a	9.91a	1.42a	0.47a
SD (n = 8)	±0.73	±1.01	±0.76	±1.36	±1.40	±0.47	±0.42
1 Eh	2.1	15.4	8.2	61.9	10.0	1.5	0.9
2 Eh	3.4	13.7	9.9	62.7	8.6	1.7	tr.
3 Eh	0.9	16.0	10.2	62.7	8.8	1.6	tr.
4 Eh	1.8	15.7	8.3	63.2	9.2	0.9	0.9
5 Eh	2.3	14.8	8.9	59.9	12.1	1.4	0.6
6 Eh	2.7	13.3	9.7	60.2	12.0	1.1	1.0
7 Eh	1.7	15.9	8.5	62.7	8.9	2.3	tr.
8 Eh	2.1	14.7	9.0	63.6	9.7	0.9	tr.
Var. *hirsuta* (M)	2.15a	13.90a	10.10b	62.60a	8.65a	1.95b	0.65a
SD (n = 2)	±0.35	±0.28	±0.42	±0.14	±0.21	±0.35	±0.07
9 Ehi	2.4	13.7	9.8	62.5	8.8	2.2	0.6
10 Ehi	1.9	14.1	10.4	62.7	8.5	1.7	0.7
Var. *fastigiata* (M)	1.25b	15.02a	9.07ac	61.82ab	11.12a	0.80a	0.95b
SD (n = 4)	±0.37	±0.94	±0.97	±2.84	±0.88	±0.84	±0.26
11 Ef	1.0	13.9	9.6	62.2	10.8	1.2	1.3
12 Ef	0.9	14.7	7.9	65.5	10.2	tr.	0.8
13 Ef	1.7	15.4	8.7	60.9	12.3	tr.	1.0
14 Ef	1.4	16.1	10.1	58.7	11.2	1.8	0.7
Var. *peruviana* (M)	2.46a	14.39a	10.07bc	60.41b	10.69a	1.30a	0.51ab
SD (n = 7)	±0.80	±0.55	±1.31	±1.84	±1.95	±0.62	±0.45
15 Ep	1.4	13.7	12.0	63.0	8.3	1.6	tr.
16 Ep	1.8	14.3	11.1	59.3	9.9	0.9	0.7
17 Ep	2.6	14.7	10.8	59.4	13.1	tr.	tr.
18 Ep	2.3	14.0	8.7	59.1	12.7	1.9	1.3
19 Ep	2.2	15.0	9.9	62.0	8.6	1.6	0.7
20 Ep	3.1	15.1	9.6	58.2	12.1	1.3	0.6
21 Ep	3.8	13.9	8.4	61.9	10.1	1.7	tr.
Var. *aequatoriana* (M)	2.01ab	14.81a	10.69b	60.43b	9.90a	1.53a	0.66ab
SD (n = 7)	±0.77	±0.75	±0.93	±1.73	±1.70	±0.69	±0.43
22 Ea	3.7	16.1	10.1	58.0	10.9	1.2	tr.
23 Ea	0.9	14.0	12.1	62.4	7.7	1.9	1.0
24 Ea	1.3	15.2	11.0	58.4	12.8	tr.	1.2
25 Ea	1.2	15.0	11.7	60.4	9.6	2.1	tr.
26 Ea	2.1	14.9	10.3	62.2	8.2	1.7	0.6
27 Ea	2.3	13.9	9.9	61.4	10.0	1.8	0.7
28 Ea	2.6	14.6	9.7	60.2	10.1	1.9	0.9

[a]Abbreviations: Chol.: cholesterol, Camp.: campesterol, Stig.: stigmasterol, Sit.: β-sitosterol, Δ^5-av.: Δ^5-avenasterol, Δ^7-st.: Δ^7-stigmasterol, Δ^7-av.: Δ^7-avenasterol. tr.: value less than 0.5%.

[b]Mean values (M) and standard deviations (S.D.) for each variety. Means followed by the same letter within each column are not significantly different at P = 0.05.

[c]Total sterols = approximately 0.5% oil.

detected (Table 4): cholesterol, campesterol, stigmasterol, β-sitosterol, Δ^5-avenasterol, Δ^7-stigmasterol, and Δ^7-avenasterol. These results showed similarity with peanut cultivars reported by Padley *et al.* (20). Some significant differences were found in sterols (Tables 4 and 5). The variety *fastigiata* showed lower cholesterol percentages than other varieties. The total sterols in peanut are about 0.5% of oil. The cholesterol is found in trace amounts to 1% of oil (24). Therefore, the percentages of cholesterol reported in Tables 4 and 5 could be considered trace values. Furthermore, the cholesterol found in peanut could be due to misindentified sterol or due to contamination.

This study on chemical composition of *A. hypogaea*

Table 5. Mean values and standard deviations (SD) obtained from the data of Ecuadorian peanut for the subspecies *hypogaea* (n = 10) and *fastigiata* (n = 18).

Trait	ssp. *hypogaea* Mean	S.D.	ssp. *fastigiata* Mean	S.D.
Protein (%)**	27.08	1.12	30.20	1.75
Ash (%)*	2.63	0.12	2.50	0.17
Iodine value*	103.60	3.53	108.17	6.11
Oil (%)	47.94	4.18	48.24	3.01
O/L**	1.16	0.24	0.81	0.15
Fatty acids				
% of total fatty acids				
16:0**	10.97	0.87	11.97	0.80
18:0	2.03	0.95	1.81	0.47
18:1**	43.18	4.98	35.09	2.77
18:2**	37.83	4.27	44.06	4.98
20:0*	1.22	0.18	1.48	0.35
20:1	1.68	0.34	1.94	0.61
22:0*	1.82	0.37	2.39	0.67
24:0	1.16	0.14	1.13	0.35
Esterols (% of oil)	0.5[a]		0.5[a]	
% of total sterols				
Cholesterol	2.13	0.66	2.02	0.90
Campesterol	14.73	1.00	14.69	0.73
Stigmasterol*	9.29	0.81	10.09	1.21
β-sitosterol*	62.21	1.22	60.73	2.01
Δ^5-avenasterol	9.66	1.34	10.48	1.66
Δ^7-stigmasterol	1.53	0.48	1.28	0.71
Δ^7-avenasterol	0.51	0.37	0.66	0.42

[a]Value estimated agree with literature (24).

*,** Means within each row are significantly different at P = 0.05 and P = 0.01, respectively.

seeds from Ecuador contributes useful information to characterize germplasm materials. The subspecies *hypogaea* was characterized by exhibiting low protein levels. The variety *hypogaea* cultivars from Ecuador showed high oleic acid content and O/L ratios, and they could provide sources of germplasm for these traits in peanut breeding programs of Argentina.

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