NOTE

Amino Acid and Fatty Acid Profiles of the Inca Peanut (*Plukenetia volubilis*)[1]

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ABSTRACT

The Inca peanut (IP), *Plukenetia volubilis,* is a potential new crop indigenous to the high-altitude rain forests of the Andean region of South America. It grows as a vine and produces seeds that have a nutlike appearance and contain high amounts of oil (54%) and protein (27%). Amino acid analysis of the protein showed relatively high levels of cysteine, tyrosine, threonine, and tryptophan compared to other oilseed proteins found in the region. The IP protein is comparable to soy protein in its content of total essential amino acids and, if well digested, would compare well to the FAO/WHO/UNU amino acid scoring pattern, being marginally deficient only in lysine (43 vs. 58 mg/g of protein) and leucine (64 vs. 66 mg/g of protein). The oil contains high levels of linoleic and linolenic acids.

The Inca peanut (IP), *Plukenetia volubilis,* is a plant native to the high-altitude rain forests of the Andean region of South America. It grows as a vine and produces a tetralobular fruit with loculi that contain one seed each with white cotyledons and a hard, nutlike seed coat. Although not a cultivated crop, the seed collected in the wild has long been a component of the diets of the Chancas Indians and other tribal groups of the region. It is eaten either roasted or ground and mixed with maize meal and peppers (*Capsicum* spp.). No comprehensive agronomic or nutritional studies have been conducted on the seed, although a cursory examination at the Institute of Food Science, Cornell University (D. C. Hazen and Y. S. Stoewsand, *unpublished data*), showed the IP to have unusually high oil (49%) and relatively high protein (33%) content.

If found to be comparable in food and nutritional quality to the soybean, the IP could potentially be used as a substitute for imported oil and high-protein meal. A search is presently being conducted in the Andean region for alternative crops to reduce food imports and the region's economic dependence on coca cultivation. One solution to this problem could be to expand the use of or find new food or feed uses for indigenous food-producing plants. Research is now underway at the University of San Martín, Tarapoto, Peru, to cultivate the IP and to assess the potential of using it as a poultry-feed supplement. The long-range objectives of studies on the IP are to find new ways to use the seed for human consumption, e.g., as a cooking oil, a protein concentrate for weaning foods, a high-protein defatted flour, etc. In this report we present the amino acid and fatty acid profiles of the IP.

MATERIALS AND METHODS

Seeds from *P. volubilis* were collected from multiple plants grown in an experimental plot at the University of San Martín, Tarapoto, Peru, in 1989. The seeds were pooled and cracked, and the cotyledons were pulverized to a coarse flour with a mortar and pestle. Moisture, oil, and protein contents were determined using approved methods 44-19, 30-25, and 46-13 (AACC 1983). All analytical tests were performed in duplicate at least.

Amino acid analysis was performed following acid hydrolysis of the protein by cation exchange chromatography, using Method 982.30 (AOAC 1990). Cysteine and methionine were analyzed as their oxidized derivatives, cysteic acid and methionine sulfone, following performic acid digestion. Tryptophan was determined by alkaline hydrolysis followed by cation exchange chromatography.

Fatty acids were determined as their methyl esters by gas-liquid chromatography, using a Chromosorb 100/120 WAW column (Supelco, Bellefonte, PA) as described in methods 963.22 and 969.33 (AOAC 1990).

Total carotene of extracted oil was determined using approved method 970.64 (AOAC 1990). α-Tocopherol was measured in the oil of seeds taken from three locations using a modification of the method of Castle and Cooke (1985). This procedure utilized a high-performance liquid chromatography system with a C_{18} column and electrochemical detector (Bioanalytical Systems, Lafayette, IN).

RESULTS AND DISCUSSION

Protein

Protein content of the IP was approximately the same as for other oilseeds found in the Andean region (Table I). Protein content of the defatted flour was about 53%. The amino acid profile was comparable to, and in some respects better than, that of the other oilseeds. Leucine and lysine levels were lower than those of soybean protein, although equal to or better than the levels in peanut, cottonseed, or sunflower protein. The sulfur-containing amino acids (methionine + cysteine), tyrosine, threonine, and tryptophan were present in higher amounts than in the other oilseeds. Tryptophan was over twice and cysteine nearly twice the levels in other proteins. Phenylalanine content was relatively low. Total essential amino acids were comparable to or higher than those of the other protein sources.

Compared to the FAO/WHO/UNU scoring pattern (Joint FAO/WHO/UNU Expert Consultation 1985) developed for preschool children two to five years of age and recently recommended for all age groups except infants (Joint FAO/WHO Expert Consultation 1990), the IP protein, if completely digested, would be deficient only in leucine and lysine (Table I). Protein digestibility needs to be determined because incomplete digestion lowers IP values. The sulfur-containing amino acids, usually

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TABLE I
Amino Acid Profile of Inca Peanut Protein Compared to Other Oilseed Protein[a,b]

Amino Acid	Inca Peanut	Soybean	Peanut	Cottonseed	Sunflower	FAO/WHO/UNU Scoring Pattern[c]
Total protein, %	27	28	23	33	24	
Essential						
His	26	25	24	27	23	19
Ile	50	45	34	33	43	28
Leu	64	78	64	59	64	66
Lys	43	64	35	44	36	58
Met	12	13	12	13	19	...
Cys	25	13	13	16	15	...
Met + Cys	37	26	25	29	34	25
Phe	24	49	50	52	45	...
Tyr	55	31	39	29	19	...
Phe + Tyr	79	80	89	81	64	63
Thr	43	39	26	33	37	34
Trp	29	13	10	13	14	11
Val	40	48	42	46	51	35
Nonessential						
Ala	36	43	39	41	42	...
Arg	55	72	112	112	80	...
Asp	111	117	114	94	93	...
Glu	133	187	183	200	218	...
Gly	118	42	56	42	54	...
Pro	48	55	44	38	45	...
Ser	64	51	48	44	43	...
TEAA[d]	411	418	349	365	366	...
TAA[e]	976	985	945	936	941	...
TEAA as percent of TAA	42	42	37	39	39	...

[a] Values for soybean, peanut, cottonseed, and sunflower were taken from Bodwell and Hopkins (1985).
[b] Values shown are milligrams/gram of protein, unless otherwise noted ($N \times 6.25$).
[c] Recommended level for children of preschool age (2–5 years), although recently recommended for evaluation of dietary protein quality for all age groups except infants (Joint FAO/WHO Expert Consultation 1990).
[d] TEAA = total essential amino acids.
[e] TAA = total amino acids.

TABLE II
Fatty Acid Profile of Inca Peanut Oil Compared to Other Oilseed Oil[a]

Fatty Acid	Inca Peanut	Soybean	Peanut	Cotton-seed	Sun-flower
Total oil	54	19	45	16	48
Saturated					
$C_{14:0}$, Myristic	0.0	0.0	0.0	0.0	0.0
$C_{16:0}$, Palmitic	4.5	10.5	12.0	18.7	7.5
$C_{18:0}$, Stearic	3.2	3.2	2.2	2.4	5.3
Unsaturated					
$C_{16:0}$, Palmitoleic	0.0	0.0	0.3	0.6	0.0
$C_{18:0}$, Oleic	9.6	22.3	41.3	18.7	29.3
$C_{18:2}$, Linoleic	36.8	54.5	36.8	57.5	57.9
$C_{18:3}$, Linolenic	45.2	8.3	0.0	0.5	0.0
$C_{20:1}$, Gadoleic	0.0	0.0	1.1	0.0	0.0

[a] All values shown are percents. Values for soybean, peanut, cottonseed, and sunflower are taken from Bodwell and Hopkins (1985).

marginal in oilseed proteins, were well above recommended amounts. Using the scoring pattern criteria to judge protein quality, lysine would be projected to be the limiting amino acid. This level, however, is still higher than the lysine content of the major cereal grains (Chung and Pomeranz 1985).

Oil

The content and fatty acid profile of IP oil was previously reported (Hazen and Stoewsand 1980), although not published. IP was highest in oil content of the oilseeds listed in Table II and comparable to peanut and sunflower. The striking difference between IP oils and the other oils is the high level of linolenic acid. This could lead to oxidative rancidity producing off-flavors and odors; however, preliminary studies in Peru have shown that unrefined IP oil appears to be fairly stable. This could be due to the presence of α-tocopherol and carotene in the oil (3.8–6.3 mg/100 g and 0.08 mg/100 g, respectively) and/or the fact that the seed was roasted prior to processing, probably inactivating the lipoxygenases. Roasting is the traditional method of preparing the IP for food use, apparently removing the bitter taste present in the raw seed.

CONCLUSIONS

In Peru the lack of sufficient good-quality protein continues to be a problem among the poorer segments of the population. Many Peruvians consume meat only once or twice a week. If the protein is well digested and amino acids are available, the IP would be a good source of well-balanced protein that could be added to the diet of the Andean poor. High-protein flour or protein concentrates might be used in weaning foods, as meat extenders, or in other applications for which soy protein is used.

The potential for oxidative rancidity in the oil needs to be investigated fully. Processing the oil for food-grade use may necessitate hydrogenation of the unsaturated fatty acids or the addition of other antioxidants. IP oil—like linseed oil, which has a high linolenic acid level—could also have an industrial application.

Studies are underway in Peru to evaluate the potential of the IP. Preliminary results show that chickens readily accept the roasted seed when used as a protein supplement. If a promising market can be demonstrated for the IP as an animal-feed supplement and/or human food, farmers may then have the incentive to cultivate it as a crop.

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