Peanut Proteins as Food Supplements: A Compositional Study of Selected Virginia and Spanish Peanuts[1]

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ABSTRACT

Three peanut cultivars (Virginia, red-skinned, and white-skinned Spanish) were analyzed and compared as potential protein supplements for food uses. The seeds were solvent-extracted in the laboratory to yield defatted flours with 9-10% nitrogen contents. Protein isolates were prepared from the flours by subsequent extraction with dilute salt solutions buffered at pH 7.0. Various parameters were compared, such as total protein contents, soluble proteins, amino acid compositions of flours and protein isolates, free amino acids and free sugars of defatted flours, and certain trace minerals in flours and soluble proteins. The application of these results to the selection of certain types of peanuts for potential uses as protein supplements in food products is discussed.

INTRODUCTION

Because of projected shortages of food proteins throughout the world, it is expected that plant materials will play an increasing role in supplying protein for human as well as animal consumption. Oilseeds, an excellent source of good quality plant protein, offer a partial solution of this problem. Peanuts are one of the world's leading oilseed crops. For economic reasons, most of the U.S. production is classified as food grade and is processed whole, whereas in other countries peanuts are processed for oil and the residual meal is used in animal feed or fertilizer (1). Certain properties of peanuts—bland flavor and low concentration of flatulence-producing carbohydrates—make them more desirable for food supplements than some of the plant proteins in use today. To evaluate the potential of peanut flours and/or isolates as food supplements, a study of the composition of Virginia and Spanish peanuts was undertaken.

EXPERIMENTAL PROCEDURES

Three peanut cultivars were compared in this study: Virginia VA-56R, 1972 crop, purchased from a commercial supplier in Suffolk, VA; Spanish, Starr, red-skinned, 1971 crop from Texas; Spanish, Pearl, white-skinned, 1972 crop from Texas. Peanut flours and isolates were prepared as described by Conkerton et al. (2). Flours were analyzed for sugar, sulfur, ash, phosphorus, nitrogen, and available lysine contents by official AOCS methods (3). Tannins were determined by the method of Stansbury and Hoffpauir (4). Metals were determined by neutron activation analysis. Nitrogen solubility patterns were obtained by suspending 0.500 g of the meal in 35 ml of water, adjusting to the desired pH with hydrochloric acid or sodium hydroxide, and stirring 15 min at room temperature. After diluting to 50 ml, the soluble fractions were separated by centrifugation at 14,000 x g for 30 min at 22 C, then filtered aliquots were analyzed for dissolved nitrogen. Total amino acids were determined by the Moore and Stein procedure (5) through a Beckman amino acid analyzer.

Free amino acids and sugars were removed by suspending the flour in 70% ethanol (1:10 w/v), stirring 15 min at room temperature, and centrifuging at 14,000 x g for 30 min at 15 C. The supernatant was decanted and the residue resuspended in 70% ethanol. Four successive extractions were required to remove the free amino acids completely. The combined supernatants were reduced in volume on a rotary evaporator under vacuum at 40 C, frozen, then freeze-dried. A portion of the dried sample was suspended in 50% ethanol and passed through a micro column of Dowex 50X8, 100-200 mesh in the acid form. Sugars were eluted with water, and amino acids bound by the resin were eluted with 7N ammonium hydroxide. Sugars were determined by gas chromatography as their silyl derivatives according to methods developed at this laboratory (6). Amino acids were determined by gas chromatography as their n-propyl-N-acetyl esters according to the method of Adams (7).

Electrophoretic mobility of the proteins was determined on 10% polyacrylamide gels according to the method described by St. Angelo and Ory (8).

RESULTS AND DISCUSSION

Chemical Composition of Flours

Chemical composition of the three flours illustrates the similarities among these materials (Table I). Only slight variations in phosphorus contents were noted, and there were no tannins in the white-skinned cultivar. Acidification

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TABLE I

Composition of Peanut Flours[a]

		Spanish	
	Virginia	Red-skinned	White-skinned
Sugar, %	24.3	25.3	25.9
Sulfur, %	0.6	0.6	0.6
Ash, %	4.4	4.9	4.2
Nitrogen, %	9.1	9.0	9.8
Phosphorus, %	0.9	1.1	0.8
Tannin	+	+	-
Calcium, ppm	92	31	1019
Iron, ppm	55	133	52
Copper, ppm	10	5	22
Magnesium, ppm	3120	2063	3430
Sodium, ppm	10	33	9
Zinc, ppm	18	45	14

[a]Hexane-defatted, air-dried flours.

TABLE II

Essential Amino Acid Contents of Peanut Flours g/16gN

		Spanish	
	Virginia	Red-skinned	White-skinned
Isoleucine	3.2	3.4	3.3
Leucine	5.9	6.2	6.2
Lysine	3.1	3.3	3.1
Available lysine	2.0	1.7	1.8
Methionine	0.9	1.1	0.9
Cystine	0.6	0.8	0.9
Phenylalanine	3.8	4.6	5.2
Tyrosine	3.4	3.4	4.0
Threonine	2.3	2.4	2.4
Valine	4.1	4.0	4.0

TABLE III

Ethanol Extraction of Peanut Flours

	Virginia	Spanish Red-skinned	Spanish White-skinned
Weight extracted, %	18.1	16.9	14.1
Nitrogen content, %	1.9	1.9	1.3
Free Amino Acids			
U-1[a]	++	++++	++++
U-2	+	-	-
Asp	++	++	+
Phe	++	+	++
Glu	++	+++	+++
U-3	-	-	+

[a]U = unidentified.

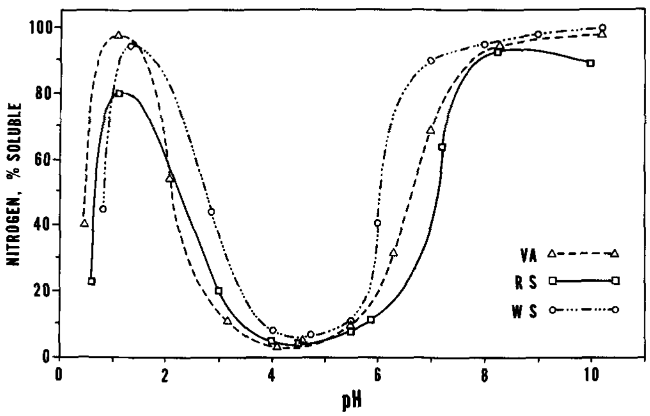

FIG. 1. Nitrogen solubility patterns of Virginia (VA) and Spanish red-skinned (RS) and white-skinned (WS) peanut flours.

of flours from unblanched red-skinned peanuts immediately produced a bright red coloration whereas flours from the unblanched white-skinned peanuts showed no coloration upon acidification as low as pH 2. This absence of color-producing tannins would be advantageous in a flour used as a food supplement, because incomplete removal of skins would not affect the color of the food products. In fact, removal of the skins from these peanuts—the blanching step in processing—could be eliminated for most food uses, thereby reducing production costs.

Trace metal contents of these samples indicate some variations, but sufficient data are not available to interpret them. A more complete study of metal contents of flours and their retention in protein isolates is under way.

A comparison of the essential amino acid composition of these three flours (Table II) shows a typical peanut protein amino acid profile with the most limiting amino acids being methionine and cystine. Total and available lysine determinations on these three samples show a high degree of similarity. More than 50% of the lysine was available as determined by chemical analysis.

Free Sugars and Free Amino Acids

The 70% ethanol soluble fractions isolated from these samples showed the widest variations (Table III). These fractions contain most of the free sugars and free amino acids. The total nitrogen contents of these fractions varied, and a slightly larger amount of material was recovered from the Virginia peanut. The principal sugar in all samples was sucrose; but, although analysis of both red-skinned varieties indicated the presence of some reducing sugars and raffinose, the white-skinned peanuts did not appear to contain either of these. Free amino acid profiles of these samples were similar, but relative amounts were different. No specific correlations were apparent, except that both Spanish peanuts had a high concentration of an unidentified component.

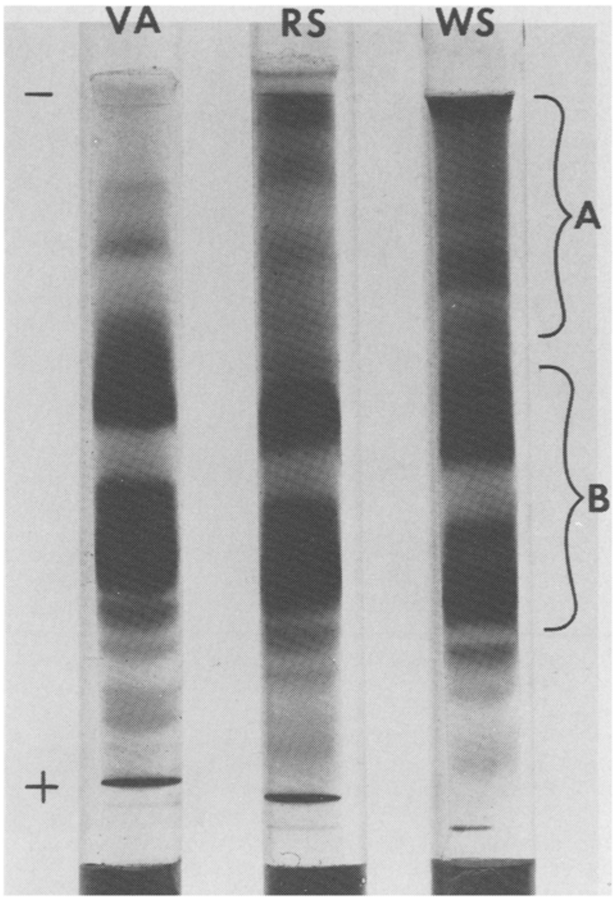

FIG. 2. Gel electrophoretic patterns of Virginia (VA) and Spanish red-skinned (RS) and white-skinned (WS) peanut protein isolates. A = High molecular weight proteins, B = Storage proteins.

Both free amino acids and sugars are known to be involved as flavor precursors, but their specific contributions to peanut flavor have been only partially defined. W.B. Bailey (private communication) stated that there is a lack of flavor in this Pearl white-skinned cultivar. To try to confirm this, a small sample of white-skinned peanuts was roasted for 13 min at 160 C. Only a faint aroma of roasted peanuts and a very slight typical flavor were noted. The five persons who tasted the peanuts did not detect any off-flavor and reported only a slight beany taste.

Nitrogen Solubility

The nitrogen solubility patterns of the three peanut flours were similar (Fig. 1), showing minimum solubility at pH's between 3 and 6 and almost complete solubility above pH 7 and at pH 1. The slightly lower nitrogen solubility of the flour from the red-skinned Spanish peanuts could be due to its higher phosphorus content. Phytic acid, the principal storage form of phosphorus in seeds, has been shown to decrease protein solubility in oilseed flours (9).

Protein Isolates

Although present utilization of peanut proteins would probably be limited to flours, the preparation of isolates is possible and not difficult. Approximately 75% of the proteins are soluble in the salt solutions used for extraction, and the white powders obtained after drying contain 15-16% nitrogen. Gel electrophoretic patterns of these isolates (Fig. 2) indicated similar concentrations of the major storage proteins, but the Spanish peanuts appeared to contain more high molecular weight compounds than the

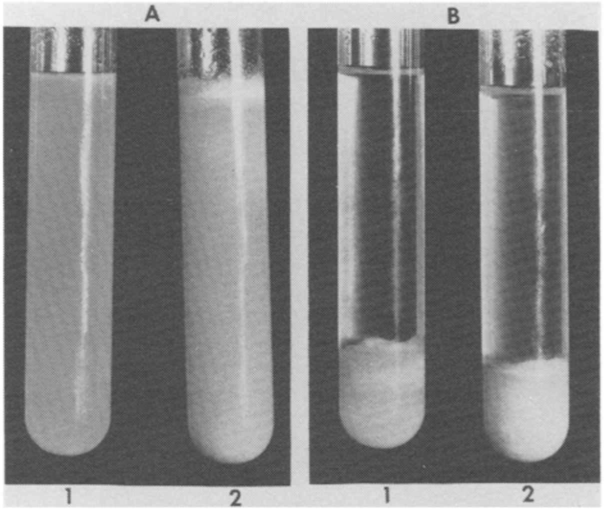

FIG. 3. Peanut flour supplementation of pineapple juice. A = Fresh sample, B = Sample stored overnight, 1 = Pineapple juice, 2 = Pineapple juice + 1% (w/v) peanut flour.

Virginia peanuts. Essential amino acid content of these materials is similar to that of the flours; thus selective fractionation of proteins did not occur.

From these data, it is evident that peanut flours are similar in composition; consequently potential uses would not be limited to one type of variety of peanut. This laboratory is not equipped to evaluate such materials as food supplements, but a supplemented drink was prepared by adding peanut flour to pineapple juice, an acid type beverage. When 1% (w/v) peanut flour was mixed with a commercial brand of pineapple juice without additional food emulsifiers, the protein content of the juice was tripled. Turbidity was slightly increased, but flavor, texture, and aroma of the juice were unaffected by the peanut protein supplement. After the samples were stored overnight in a refrigerator, there was no apparent difference in the amount of sediment (Fig. 3). Conceivably then, the nutritive value of any fruit juices that normally contain sediment could be increased by supplementation with peanut flour.

Another potential use of peanut flours is as meat extenders. The Georgia Peanut Commission (10) recently sponsored a luncheon for over 5,000 students in elementary schools. Peanut meal was incorporated in "Sloppy Joe" hamburger mixture at a ratio of seven lb meat to three lb meal. Students were unable to detect any peanut flavor in the mixture and did not object to the supplemented "Sloppy Joe" sandwich.

More recently, Khan and Rooney (11) reported a comparison of breads fortified with various oilseed proteins. When peanut flour in amounts up to 15% was substituted for wheat flour, the protein content of the bread was increased about 36% and the product was acceptable. Protein content of regular bread was increased from 8.5 to 13% by the addition of glandless cottonseed, sesame, peanut, sunflower, or soy flours; but loaves supplemented with peanut and sesame flours had the most acceptable properties when compared to regular bread.

Several products incorporating peanut proteins were test marketed–a natural protein drink containing 66% more protein than milk, hamburger patties, and barbecue and Worcestershire sauces (12). In 1974, Worthington Foods Corporation, an established manufacturer of soy protein simulated meats, sausages, and milk-type products, introduced a new line of vegetable protein for food uses called "Nu-Mete, the versatile peanut protein" (13). With the introduction of Nu-Mete, Worthington provided three recipes for formulating peanut protein into such foods as a simulated tuna casserole, sandwich spreads, and fortified cookies.

Incorporation of peanut flours into conventional foods could help alleviate two of the protein problems in the United States today–unbalanced diets and increasing costs of conventional protein. Replacement of a portion of the meat normally used in the diet with textured vegetable protein could reduce the cost as well as the amount of calories and animal fat per serving. Lower consumption of animal fats would provide a more well-balanced diet for upper income groups whose problem results from the other nutrients that accompany the protein (14). If fabricated foods became more popular, they would be correspondingly more appealing to lower income groups who would be most affected by the reduction in cost.

The low concentration of flatulence-producing carbohydrates and the bland flavor of peanuts are advantages not found in soybeans. One disadvantage, however, to more widespread use of peanut flours as protein supplements is that in today's market, they are more costly than soy flours. From this study, the white-skinned cultivar appears to have none of the undesirable carbohydrates and even less flavor than the red-skinned varieties. Production costs for this variety could be lowered by eliminating the blanching step. Since lack of flavor makes this type of peanut undesirable for use in candy and peanut butter or for consumption as roasted peanuts, its exclusion from the federal subsidy program could be considered. If this type of peanut could be cultivated specifically for use as a protein supplement, perhaps the price differential between soybeans and peanuts could be reduced.

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