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Processing of Edible Peanut Flour and Grits[1]

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ABSTRACT

Edible peanut flour and grits have been produced by a commercial prepress solvent extraction method. The finished flour exhibits excellent extrusion-expansion characteristics for use in both cereal and snack food items. Soluble carbohydrate profile indicates peanut flour is lower in raffinose and stachyose than commercial soy flour. The bland flavor and light tan color facilitates incorporation of peanut flour and grits into a wide range of food products.

INTRODUCTION

Peanuts show a good potential as a source of supplementary protein for human diet (1, 2). Numerous processes have been devised for producing low fat edible peanut flours (2), with major emphasis on conventional prepress, solvent extraction of peanuts. Recent work by Rhee, et al., described simultaneous recovery of protein and oil from peanuts in an aqueous system (3). Although this process has many advantages, the oil content was 9-10% in the finished protein concentrate produced by pilot plant-scale equipment (4). This high oil residue could lead to oxidative deterioration (3) and also may render flour unsuitable for extruded food preparations.

For many years, it has been assumed that heat applied during initial wet cooking and expelling of oil has an adverse effect upon protein quality (5). However, recent work by Neucere, et al., (6) indicates that heating wet peanuts at 110 C for 1 hr increased protein efficiency rating PER and this increase was attributed to elevated available lysine levels. Anantharaman and Carpenter (7) reported that wet and dry heat treatments at 107 C and 121 C of peanut meal for 0.5 hr did not reduce available lysine in peanut meal. These heating conditions are similar to the heating parameters used in commercial peanut meal production.

Conventional screw pressing and solvent extraction has been directed mainly toward rapid and efficient removal of peanut oil with little attention toward sanitary handling of high protein meal. This investigation describes production of edible peanut flour and grits using a modified prepress solvent extraction plant.

EXPERIMENTAL PROCEDURES

Processing

Split or whole shelled peanuts with skins were used in this study. All lots were tested to assure low damage kernels and low foreign material. All lots were sampled using U.S. Department of Agriculture prescribed methods and assayed for aflatoxin (8). Only lots which showed negative test for aflatoxin, less than 8 ppb, were used for peanut grits or flour production.

The processing of the peanuts is outlined in Figure 1. Peanuts were ground in a hammer mill or bar cracking machine, moisture added to a total moisture level of 10%, and granulated peanuts passed through a stack cooker

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INDEX

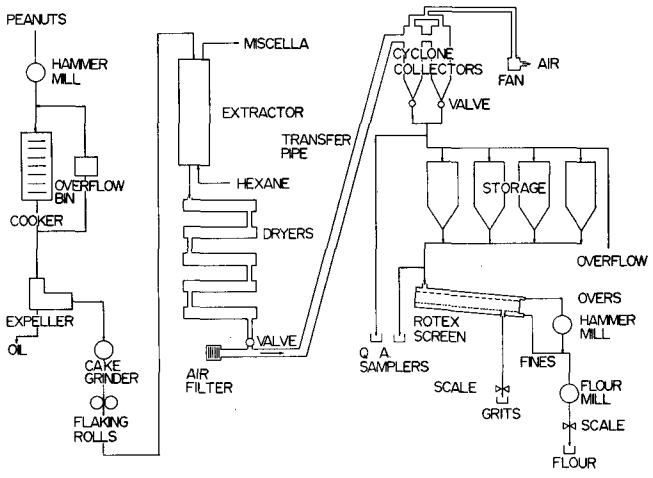

FIG. 1. Process flow for edible peanut flour and grits.

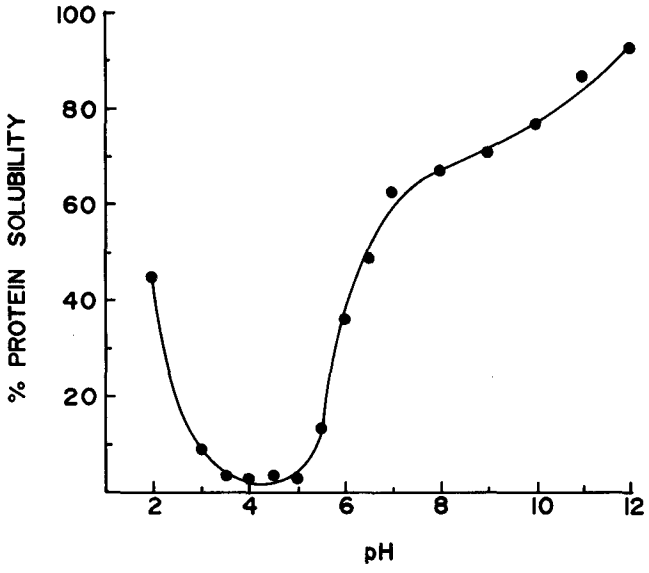

FIG. 2. Protein solubility of peanut flour.

which had a residence time of 45-60 min at an exit temperature of 240 F. The cooked peanuts were conveyed to V.D. Anderson Super Duo Expellers, Cleveland, Ohio, and oil expressed to form a cake containing 8-12% oil. This cake was ground, moisture conditioned to 10%, flaked, and conveyed to a continuous V.D. Anderson extractor of a modified Bonotto design (9). The extracted flakes were passed through a series of horizontal steam jacketed tubes with stripping steam passing countercurrent to flake flow. Temperature in each tube was adjusted so that meal progressively increased from 150 F to 225 F and total residence time was 25 min. Hot, extracted flakes were passed through rotary air lock valve into a 16 in. vacuum transfer pipe and drawn into dust collectors. Air quality in the transfer pipe was maintained utilizing a series of air filters and a fan provided an 8 psig vacuum on the transfer line. The transfer pipe provided cooling of the meal from 225 F to 100 F during a transit of 300 ft at a speed of ca. 100 ft/sec. The collected cooled meal was transferred through rotary air lock valves to one of four 50 ton storage bins. During transfer, 10 lb/ton of meal was removed continuously from the meal for sampling purposes.

When sufficient material was obtained in storage, the meal was sifted using a reciprocating screener to obtain three different particle ranges. Particles which passed over a 16 in. U.S. screen (overs) were passed through a hammer mill to reduce particle size and subsequently passed through a flour mill. The particles in the 16-60 mesh screen size were packaged as grits. The particles passing through a 60 mesh screen were conveyed directly to the flour mill. After milling, the finished flour was packaged.

TABLE I

Composition of Peanut Flour

Component	Percent
Protein (N x 6.25)	57.0
Fat	0.6
Fiber	4.6
Moisture	7.0
Ash	4.6
Total carbohydrates	30.0
Water adsorption	280.0
Nitrogen solubility index	59.0
Pepsin digestible protein	95.6
Calcium	0.14
Phosphorous	0.76
Potassium	1.29
Sodium	0.18
Iron	0.0021
Magnesium	0.37
Manganese	0.0049
Zinc	0.0051
Copper	0.0018
Choline chloride	0.0028
Niacin	0.027
Calcium pantothenate	0.0028
Riboflavin (vitamin B_2)	0.00048
Thiamine (vitamin B_1)	0.00070

Grits and Flour Composition

Protein, fat, fiber, moisture, and ash were determined by standard methods (10). Total carbohydrates were calculated by difference. Water absorption was obtained by mixing peanut grits with water and measuring wt of water absorbed in 30 min at 25 C. Nitrogen solubility index (NSI) was obtained by official method (11). Digestible protein was determined utilizing the standard pepsin digestion method (12).

Calcium, potassium, sodium, iron, magnesium, zinc, and copper were determined by atomic absorption spectrophotometry (13). Phosphorous was determined using the Molybdovanadate method (14).

Niacin, calcium pantothenate, riboflavin, and choline chloride were determined microbiologically (15). Thiamine was determined fluorometrically (16). Amino acids were determined by amino acid autoanalyzer using both acid and base hydrolysis (17).

Soluble carbohydrates were isolated using a modification of the method of Shallenberger and Moyer (18). Peanut flour, 0.5 g was weighed accurately into a 40 ml centrifuge tube and 30 ml of 80% aqueous ethanol was added. The tube was heated to boiling in a water bath with slight stirring. The tube was cooled, centrifuged at 16,000 x g for 5 min using a centrifuge with a bucket rotor. The supernatant was decanted, and the extraction was repeated on the residue 3 times with 30 ml portions of 80% aqueous ethanol. The combined supernatants were evaporated in vacuo and dissolved in 10 ml water. Aliquots were freeze-dried prior to derivatization using the method of Brobst and Lott (19) utilizing B-phenyl-galactopyranoside as internal standard. The sugar derivatives were quantified using a dual column gas chromatograph equipped with dual flame detectors and electronic integrator. Columns used were 3 ft x 1/8 in. stainless steel packed with 3% SE-52 on Chromosorb W-DMCS. Columns were programed from 140-290 C, at 6°/min increase and nitrogen flow was 20 ml/min. Injection port was maintained at 260 C and detector at 290 C. Sugar identification was confirmed using borate impregnated silica gel thin layer chromatography plates as described by Jacin and Mishkin (20).

Protein solubility as determined over a pH range from 2-12 using a modified NSI procedure (11). The peanut flour

TABLE II

Amino Acid Composition of Peanut Flour

Essential amino acids	Percent of sample	Nonessential amino acids	Percent of sample
Isoleucine	1.84	Glutamic	10.9
Leucine	3.64	Alanine	2.18
Lysine	1.70	Glycine	3.34
Methionine	.51	Proline	1.82
Phenylalanine	2.69	Serine	2.72
Threonine	1.46	Aspartic	6.49
Tryptophane	.55	Arginine	5.39
Valine	2.18	Histidine	1.05
		Cystine[a]	.59
		Tyrosine[a]	2.10

[a]Cystine and tyrosine are essential amino acids only to the extent of sparing methionine and phenylalanine, respectively.

was dispersed in water and pH adjusted using 1N HCl or 1N NaOH. After stirring for 30 min, the pH was readjusted if necessary. The pH was checked again before centrifugation.

Expansion and Extrusion Studies

A Wenger X5, pilot model extruder, was utilized to determine the ease of expansion of the peanut flour and grits. Operating under manufacturer's directions for textured soy protein, tests were conducted using peanut flour; peanut grits; blends of peanut, corn, and wheat flours; and blends of peanut and soy flours. Expanded product from peanut, corn, and wheat flours was deep fat fried to prepare a snack and sugar-coated to simulate a frosted cereal. Expanded peanut-soy blends were tested in hamburger formulations to determine fat binding and flavor character.

RESULTS AND DISCUSSION

The rigorous cooking before and during expelling oil from peanuts reduces protein solubility substantially, as indicated by NSI. The NSI for raw peanuts defatted with hexane was 92%; whereas the NSI for prepress solvent extracted flour was 59%. However, increased use of oilseed protein in meat products and in cereals as a protein fortifier indicates that high protein solubility is not the critical factor for oilseed protein utilization. In the process outlined in Figure 1, the initial cooking step has two valuable assets other than oil mobilization. First, the cooking reduces microbial counts to near sterility, less than 100/g standard plate count. Dry heating of finished meal could not accomplish this reduction without extensive discoloration of meal. Second, the wet heating gelatinizes some of the starch, giving the finished product some unique functionality not observed in other high protein oilseeds. The protein solubility vs. pH is shown in Figure 2.

Peanut flour and grits are high in magnesium, thiamine, and niacin, as indicated in Table I. This, in addition to the high protein concentration, indicates peanut flour is an excellent fortifier for cereal flours.

Peanut flour contains lower levels of lysine and leucine (Table II) than soy flour (21). However, due to the lack of beany flavor of the peanut flour and grits, higher levels of peanut flour can be used for fortification of lysine deficient cereal flours.

TABLE III

Soluble Carbohydrate Composition of Peanut and Soy Flour

Sugars	Soy flour (%)	Peanut flour (%)
Monosaccharides	1.14	.13
Sucrose	6.75	7.70
Raffinose	1.13	0.14
Stachyose	5.03	0.71
Total	15.2	8.85

Table III indicates that peanut flour contains only 0.14% raffinose and 0.71% stachyose; two poorly digestible sugars. Soy flour from commercial production contains about seven times this level. Work by Rackis, et al., (22) indicates that these sugars are partially responsible for flatulence in human subjects. This is an important factor when preparing infant formula and diet drinks for obvious reasons.

Extruded snack type products can be prepared easily using peanut flour in combination with corn and wheat flours. A basic formulation of 50% peanut flour, 25% corn flour, and 25% wheat flour was extruded and fried at 400 F for 5 sec. The finished snack was crisp, flavorful, and contained 23% protein which is ca. 3 times the level found in most snack foods. The high expansion of peanut flour is due to the initial wet cooking of the peanuts before oil removal. Under similar extrusion conditions, toasted and untoasted soy flours formed textured products which were not crisp and judged too heavy for snack fortification. Using the same basic peanut-wheat-corn flour combination, extruded product was artifically colored, flavored, and sugar-coated to form a sugar frosted cereal. The finished product contained 16% protein which is 3 times the level of conventional sweetened cereals.

Extruded peanut flour when placed in water has very little structural integrity. This is probably the result of the initial moist cooking step, since undenatured peanut protein can be texturized. However, peanut-untoasted soy flour blends ranging from 95% peanut-5% soy to 50% peanut-50% soy provide excellent textured vegetable protein. When patties were prepared using 70% ground beef, 29% hydrated textured vegetable protein, and 1% salt, 95% peanut flour-5% soy flour textured vegetable protein showed equivalent fat binding and superior flavor compared to two commercial all soy textured vegetable proteins. Probably the greatest advantage of combining peanut and soy flours for textured vegetable protein is increased expansion.

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