Peanut Science (1983) 10:56-58

Chemical and Functional Properties of Peanut and Rice Bran Flour Blends

E. J. Conkerton* and R. L. Ory[1]

ABSTRACT

Plant proteins are being added to foods and beverages to improve nutritive value or change functional properties. No one protein can supply all the desirable characteristics. Blends of peanut and rice bran flours in 1:3, 1:1, and 3:1 ratios had different protein solubility than the original materials. Methionine, lysine, available lysine, hydration capacity, and fat absorption increased as the amount of rice bran increased. Emulsifying capacity and emulsion stability were highest in all blends.

Key Words: Properties of peanut and rice bran flours and blends.

Projected shortages of food throughout the world have prompted investigations into the use of plant materials as sources of proteins for human beings (4). With consumer acceptance of soybean products as meat substitutes in the early 1970's, the prospect for wider utilization of plant proteins has increased. Food manufacturers have become interested in ways in which low cost plant proteins could improve marketability and profitability of their products (12). However, before these materials can be successfully incorporated into food systems, their chemical and functional properties must be determined and understood. As various sources other than soy were studied, it became apparent that no one protein would have all the desired nutritional and/or functional characteristics (13). Various blends of legumes and cereals (15); peanut and wheat (9); and chickpea and peanut (14), among others, have been studied. In all cases the legumes fortified the nutritional value of the cereal products and appeared to mix well in the food systems used. In an additional study, Ory et al. (13) improved the nutritional value of peanut meal by blending with citrus seed meal, a relatively unused citrus industry by-product with an excellent amino acid profile (2). Another food crop by-product, rice bran, is also underutilized, considering the quality and quantity of nutrients present (7). In many countries it serves only as fertilizer or fuel (7). In the study reported here, rice bran and peanut meal were blended in varying amounts and selected chemical and functional properties of the blends were compared to those for each commodity alone.

[1]Research Chemist and Research Leader, Southern Regional Research Center, USDA, ARS, P.O. Box 19687, New Orleans, Louisiana 70179.

Experimental

Materials. The peanut flour was prepared by solvent extraction of unblanched white skin peanuts (P. I. 288160) in the pilot plant, Engineering and Development Laboratory, SRRC. Rice bran flour was furnished by Rivianna Foods, Inc., Beaumont, Texas. Forty gram samples of 3:1, 1:1, and 1:3 peanut to rice bran flour were prepared by mixing and quartering with a spatula on aluminum foil on a flat surface. In some of the functional studies reagent grade hydrochloric acid, sucrose, and sodium chloride were used. A commercial corn oil was purchased at a local grocery.

Analytical Procedures. Nitrogen contents were determined using the standard A.O.A.C. macro-Kjeldahl method (1). Methionine was measured on intact flours by reaction with cyanogen bromide (5). Lysine and available lysine (AVL) were determined according to Couch (6). Nitrogen solubility was determined on flour and H_2O mixtures; 1:10, w:v; at various pH levels from 1.5 to 8.2. The mixture was adjusted to the desired pH with 1.0 N HCl or 1.0 N NaOH using a Radiometer[2] pH meter, expanded scale. Samples were stirred at room temperature for 15 min then centrifuged at 38,000 x g for 30 min. Nitrogen in the supernatant was determined by Kjeldahl analysis.

Functional Properties. Emulsification and emulsion stability were measured by the method of Inklaar and Fortuin (8) except that sample size was reduced from 5g to 1g with comparable reductions in H_2O, NaCl and oil. The amount of oil emulsified was calculated as follows:

$$\% \text{ Oil Emulsified} = \frac{\text{mL oil added} - \text{mL oil separated}}{\text{mL oil added}} \times 100.$$

Fat absorption was measured according to Lin, et al. (11) using a 0.5g sample and 3.0 mL of corn oil. The amount of fat absorbed was calculated as follows:

$$\% \text{ Fat Absorption} = \frac{\text{Total mL oil} - \text{mL oil separated}}{\text{Weight of flour}} \times 100.$$

Using a modification of the Sosulski method (16), water absorption was determined by placing a 1.00g sample of flour in 20 mL of H_2O in a tared, stoppered 40 mL centrifuge tube, shaking vigorously to thoroughly suspend the sample. The suspension was allowed to stand for 10 min, with vigorous remixing at 5 and 10 min. The sample was centrifuged for 15 min at 1,000 x g, stopping without braking. The liquid was decanted and the unit reweighed. Calculation of H_2O absorption was as follows:

$$\% \; H_2O \text{ Absorbed} = \frac{(\text{Wt. Flour} + H_2O) - \text{Wt. Flour}}{\text{Wt. Flour}} \times 100.$$

Foaming capacity and stability were determined at pH 1.5, 4.0, 6.0, and 8.0 using a sample weight equivalent to 0.5g N in 100 ml H_2O, 3% NaCl, or 3% sucrose. The sample was weighed into a 100 ml beaker, 35 mL of H_2O were added, and the material suspended by stirring with a glass rod. The mixture was adjusted to the desired pH with 1.0 N HCl or 1.0 N NaOH using a Radiometer pH meter, expanded scale. The slurry was transferred to a 500 mL graduated cylinder rinsing in with the remaining H_2O. Foaming was induced by a Tekmar Ultra-turrax with a probe consisting of a SK5K shaft and a G301 generator using maximum torque speed. Homogenization was conducted for a total of 40 sec in 5 sec intervals with 30 sec pauses to prevent heating. The probe was lifted out of the graduated cylinder and rinsed with a small amount of H_2O. Foam volume was measured immediately and after 120 min.

Results and Discussion

Although defatted rice bran flour is tan colored, blends of peanut and rice bran flour were cream colored, just slightly darker than the peanut flour. The protein content of the rice bran flour was significantly lower than peanut flour (See Table 1). However, the methionine,

Table 1. Composition of peanut (PN) and rice bran (RB) flours and blends.

Sample	Nitrogen %	Protein[1/] %	Methionine g/16g N	Lysine g/16g N	AVL[2/] g/16g N
PN	9.4	51	1.9	3.2	3.0
PN:RB, 3:1	7.8	43	2.0	n.d.[3/]	n.d.
PN:RB, 1:1	6.3	34	2.2	4.6	3.9
PN:RB, 1:3	4.8	26	2.4	n.d.	n.d.
RB	3.3	18	2.6	5.9	4.8

[1/] Protein = N X 5.46.

[2/] AVL = Available lysine.

[3/] n.d. = not determined, based on data reported amino acid (AA) contents of blends are mathematical averages of the AA contributed by each flour.

lysine and available lysine (AVL) contents of the rice bran protein were significantly higher than the peanut protein. The concentration of these amino acids increased in the blends with the protein of the 1:1 blend showing a 30% increase in AVL over the peanut protein. Since AVL has been positively correlated with nutritive quality of plant and animal proteins (2), it can be assumed that the nutritive quality of the blend would be better than the peanut flour. However, the volume of blended material required to provide this margin of improved nutritional value in a normal food product increases as the amount of rice bran increases, because of the lower total protein in rice bran than in peanut flour.

Protein solubility of the rice bran is lower than that of the peanut flour except at pH's 4-6.5, but the protein solubility of the rice bran never exceeds 55% (See Fig. 1). The 1:1 blend is similar to the peanut flour between

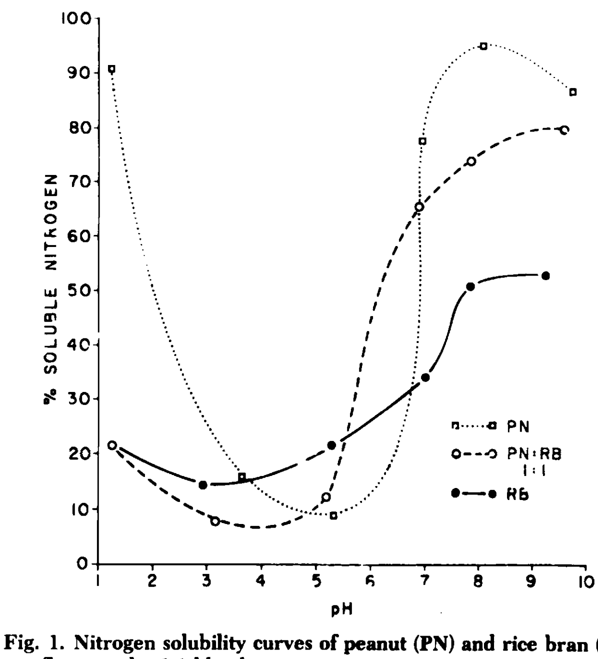

Fig. 1. Nitrogen solubility curves of peanut (PN) and rice bran (RB) flours and a 1:1 blend.

pH 3 and 10, but much lower in solubility at pH 1. This indicates a detrimental effect of rice bran flour on solubility at acid pH. Peanut flour, therefore, would be more

[2]Use of brand names does not indicate endorsement by the U. S. Department of Agriculture of one product over another of similar quality.

useful to supplement acidic beverages, such as colas or fruit juices, than would either the blends or rice bran flour alone.

Although water and fat absorption have been associated with protein solubility (10), the data in Table 2, indicate an inverse relationship, Lin et al. (11) reported a water absorption of 130% and a fat absorption of 84% for a soybean flour. All samples used in this study are similar or superior to the soybean flour. This would indicate a preferential applicability for their use as meat extenders and replacers and in viscous foods; such as soups, comminuted meats, processed cheese and doughs (10). The linear relationship noted between the amount of rice bran flour and the water and fat absorption is not duplicated in the oil emulsification studies. Rice bran flour is approximately 50% lower in protein solubility than in peanut flour and has a 50% lower oil emulsification capacity. The 1:1 blend, however, shows an 18% reduction in solubility accompanied by a 23% increase in emulsification capacity. Apparently, there are other components in these materials that affect functional properties.

Table 2. Some functional properties of peanut (PN) and rice bran (RB) flours and blends.

Sample	10% Dispersion[1/] pH	Protein Solubility %	Water Adsorption %	Fat Adsorption %	Oil Emulsified %
Peanut (PN)	6.77	78	132	130	31
PN:RB, 3:1	6.96	77	200	148	44
PN:RB, 1:1	6.95	66	228	186	38
PN:RB, 1:3	6.89	53	259	222	46
Rice Bran (RB)	6.80	35	328	240	17

1/In H_2O, natural pH.

Foaming capacity and stability have also been associated with the solubility and conformational change of proteins (10). Data obtained in these studies substantiate the association with solubility at pH 1.5 (See Table 3). Conformational changes were not measured, but the poor stability of all foams indicates a lack of this type of change. Salt appeared to reduce foaming capacity of the peanut flour. Foaming capacity of the 1:1 blend and the rice bran remained the same in water, salt, and sucrose solution. This could be due to the amount of material necessary to provide 0.5g of nitrogen. The larger flour to water ratio may have reduced exposure of the proteins to the solution or the higher water absorption capacity of the rice bran flour may have reduced foaming capacity. In all samples, foaming capacity and stability were poor at pH 4, 6 and 8. This again indicates that protein solubility is not the only criterion necessary to produce a good, stable foam and that relative concentrations of other components are also critical.

Unfortunately, the amount of material available was too small to provide sufficient replicates of the analyses for statistical evaluation. Data reported here, however, suggest several potential applications of these flours and/or blends for uses in food systems: in acidic beverages, in extended and comminuted meants, and in viscous foods, such as soups, sauces, processed cheese and bakery items. The results also suggest the involvement of constituents other than protein with the functional properties of plant materials. More research in this area is needed. As additional data on different plant proteins are obtained, perhaps some standards may be set up to aid food formulators in predicting the applicability of plant proteins in selected food systems.

Table 3. Foaming capacity and stability of peanut (PN) and rice bran (RB) flours and a 1:1 blend at pH 1.5 in water, salt, and sucrose.

Sample	Foam Volume, ml H_2O Initial	Final[1/]	3% NaCl Initial	Final[1/]	3% Sucrose Initial	Final[1/]
PN	315	68	230	55	330	12
PN:RB, 1:1	200	72	215	66	215	75
RB	170	70	165	65	170	70

1/After 120 mins.

Acknowledgment

The authors wish to acknowledge D. C. Chapital for technical assistance and in the development of modified methods for measurement of functional properties.

Literature Cited

1. A.O.A.C. 1980 "Official Methods of Analysis", 13th ed. Association of Official Analytical Chemists, Washington, D.C.
2. Braddock, R. J. and Kesterson, J. W. 1972. Amino acids of citrus seed meal. J. Am. Oil Chem. Soc. 49:671-672.
3. Carpenter, K. J. 1973. Damage to lysine in food processing: Its measurement and its significance. Nutr. Abstr. Rev. 43:424.
4. Childers, A. B. 1972. Vegetable protein foods - A review. J. Milk Food Technol. 35:604-606.
5. Conkerton, E. J., Chapital, D. C., Lee, L. S. and Ory, R. L. 1980. Effect of ammoniation on the physicochemical properties of peanut and cottonseed meals. J. Food Sci. 45:564-566, 569.
6. Couch, J. R. 1975. Collaborative study of the determination of available lysine in proteins and feeds. J. Assoc. Off. Anal. Chem. 58:599.
7. Houston, D. F. 1972. Rice bran and polish. In "Rice Chemistry and Technology" ed. D. F. Houston. Am. Assoc. Cereal Chem., Inc. St. Paul, MN, p. 277.
8. Inklaar, P. A. and Fortiun, J. 1969. Determining the emulsifying and emulsion stabilizing capacity of protein meat additives. Food Technol. 23:103-107.
9. Khan, M. N. and Rooney, L. W. 1975. Fortifying bread with oilseed protein. Tex. Agric. Prog. 21:10-11.
10. Kinsella, J. E. 1976. Functional properties of proteins in foods: A survey. CRC Crit. Rev. Food Sci. Nutr. 7:219-280.
11. Lin, M. J. Y., Humbert, E. S. and Sosulski, F. W. 1974. Certain functional properties of sunflower meal products. J. Food Sci. 39:368-370.
12. Mattil, K. F. 1973. Consideration for choosing the right plant protein. Food Prod. Dev. 76:40-44.
13. Ory, R. L., Conkerton, E. J. and Sekul A. A. 1978. Effect of blending plant materials on protein quality. I. Peanut and citrus seed protein. Peanut Sci. 5:31-34.
14. Rechigl, M., Jr. 1973. Man, food and nutrition. Chemical Rubber Co. Press, Cleveland, OH, pp. 257-258.
15. Sawar, G., Sosulski, F. W. and Holt, N. W. 1975. Protein nutritive value of legume - cereal blends. Can. Inst. Food Sci. Technol. J. 8:170-174.
16. Sosulski, F. W. 1962. The centrifuge method for determining flour absorption in hard red spring wheats. Cereal Chem. 39:344-350.

Accepted July 9, 1983