18. Pomeranz, Y., and J.A. Shellenberger, Am. Miller Process. 94(6):9 (1966).
19. Mustakas, G.C., W.J. Albrecht, J.E. McGhee, L.T. Black, G.N. Bookwalter and E.L. Griffin, JAOCS 46:623 (1969).
20. Gardner, H.W., and D. Weisleder, Lipids 5:678 (1970).
21. Gardner, H.W., G.E. Inglett and R.A. Anderson, Cereal Chem. 46:626 (1969).
22. Fellers, D.A., in "Wheat: Production and Utilization," edited by G.E. Inglett, The AVI Publishing Co., Westport, CN, 1974, p. 464.
23. Bookwalter, G.N.; A.J. Peplinski and V.F. Pfeifer, Cereal Sci. Today 13:407 (1968).
24. Bookwalter, G.N., J. Food Sci. 42:1421 (1977).
25. Anderson, R.A., H.F. Conway, V.F. Pfeifer and E.L. Griffin, Cereal Sci. Today 14:4 (1969).
26. Bookwalter, G.N., H.F. Conway and E.L. Griffin, U.S. Patent 3,579,352 (1971).
27. Fellers, D.A., A.D. Shepherd, N.J. Bellard and A.P. Mossman, Cereal Chem. 43:715 (1966).
28. Fellers, D.A., and M.M. Bean, J. Food Sci. 42:1143 (1977).
29. Holsinger, V.H., C.S. Sutton, H.E. Vettel, L.F. Edmondson, P.R. Crowley, B.L. Berntson and M.J. Pallansch, Proc. IV Int. Congress Food Sci. Technol. 5:25 (1974).
30. Highland, H.A., J. Econ. Entomol. 68:217 (1975).
31. Purchase of Sweetened Instant Corn-Soya-Milk for Use in Export Programs, Announcement CSM-6, Agricultural Stabilization and Conservation Service, Shawnee Mission, KS, 1975, amended to 7-3-80.
32. Purchase of Sweetened Wheat-Soy Blend for Use in Export Programs, Announcement WSB-4, Agricultural Stabilization and Conservation Service, Shawnee Mission, KS, 1975, amended to 7-3-80.
33. Bookwalter, G.N., W.F. Kwolek, L.T. Black and E.L. Griffin, J. Food Sci. 36:1026 (1971).
34. Bookwalter, G.N., K. Warner and R.A. Anderson, Ibid. 42:969 (1977).
35. Tsen, C.C., and W.J. Hoover, Bakers Dig. 45(3):38 (1971).
36. Code of Federal Regulations 21, Food and Drugs, Part 137.235, Enriched Corn Grits, U.S. Government Printing Office, Washington, DC, 1980, p. 228.
37. Kwolek, W.F., and G.N. Bookwalter, Food Technol. 25(10): 1025 (1971).
38. Bookwalter, G.N., R.J. Bothast, W.F. Kwolek and M.R. Gumbmann, J. Food Sci. 45:975 (1980).
39. Holsinger, V.H., M. Womack, C.S. Sutton, E.S. Dellamonica, P. McDowell and F. Talley, J. Dairy Sci. 61:1061 (1978).
40. Bookwalter, G.N., H.A. Moser, W.F. Kwolek, V.F. Pfeifer and E.L. Griffin, J. Food Sci. 36:732 (1971).
41. Bookwalter, G.N., H.A. Moser, V.F. Pfeifer and E.L. Griffin, Food Technol. 22(12):1581 (1968).
42. Marnett, L.F., R.J. Tenney and V.D. Barry, Cereal Sci. Today 18:53 (1973).
43. Fellers, D.A., and M.M. Bean, Bakers Dig. 44:40 (1970).
44. Hayes, R.E., G.N. Bookwalter and E.B. Bagley, J. Food Sci. 42:1527 (1977).
45. Borenstein, B., in "Wheat, Production, and Utilization," edited by G.E. Inglett, The AVI Publishing Co., Westport, CN, 1974, p. 366.
46. Anderson, R.A., C. Vojnovich and G.N. Bookwalter, Cereal Chem. 53:937 (1976).
47. Code of Federal Regulations 21, Food and Drugs, Part 110, p. 76, "Current Good Manufacturing, Processing, Packing, or Holding Human Food," U.S. Government Printing Office, Washington, DC, 1980.
48. "Cereal Laboratory Methods," 7th Edition, American Association of Cereal Chemists, St. Paul, MN, 1962.
49. "Official Methods of Analysis," 12th Edition, edited by W. Horowitz, Association of Official Agricultural Chemists, Washington, DC, 1975.
50. "Official and Tentative Methods," 3rd Edition, edited by V.C. Mehlenbacher, T.H. Hopper and E.M. Solle, American Oil Chemists' Society, Champaign, IL, 1970.
51. Highland, H.A., Package Dev. Syst. 7(3):36 (1977).
52. Tollefson, B., Cereal Sci. Today 12(10):438 (1967).
53. Horan, F.E., Ibid. 18(1):11 (1973).
54. Crowley, P.R., JAOCS 52:277A (1975).
55. Graham, G.C., E. Morales, G. Acevedo, R.P. Placko and A. Cordano, Am. J. Clin. Nutr. 24:416 (1971).
56. Graham, G.C., J.M. Baertl, R.P. Placko and E. Morales, Ibid. 26:491 (1973).
57. Graham, G.C., J.M. Baertl, R.P. Placko and A. Cordano, Ibid. 25:875 (1972).
58. Graham, G.C., and J.M. Baertl, Ibid. 51:152A (1974).
59. Food for Peace, PL 480 Title II Commodities Reference Guide, Agency for International Development, Department of State, Washington, DC, 1977.

Soybeans and Soy Products in the Feeding of Children

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ABSTRACT

Soya products are used in infant formulas, hypoallergenic foods and vegetable mixtures mainly because of their good protein quality. They have good potential in feeding children from birth to adolescence and seem to satisfy the needs for total nitrogen and essential amino acids when ingested in adequate amounts. Other factors, however, must be considered for their use. The availability of calcium and phosphorous from soy formulas may be inadequate to support for any length of time the rapid bone mineralization of growing premature infants and should thus be fed to such infants only for a few weeks as therapeutic agents rather than as routine feeding formulas. Allergy to soya exists and may be serious, especially among infants with severe allergy to cow's milk. Industrial processing may affect the quality of soya protein and it can produce allergenic substances in some protein foods. Thus, it may be necessary to evaluate the overall nutritional quality of new soya products before recommending their use. The effect of methionine supplementation on soya protein quality is not clear but it may be advisable in infant formulas. Soybean protein has great advantages when it is part of a food or a food system, particularly those based on cereal grains. Finally, the prevention by soya formulas of diarrhea induced by phototherapy is interesting, but its overall metabolic implications need further study.

INTRODUCTION

The increase in soya production in many parts of the world (1) and advances in food technology (e.g., review in ref. 2) have resulted in the appearance of many soybean-based products in the food market and more are certain to become available in future years in industrialized and developing countries of the world. Their use in infants formulas, hypoallergenic foods and vegetable protein mixtures, as well as protein supplements, mainly reflects the good protein quality of soybeans. Although limited in sulfur-amino acids, when soya protein is fed in adequate amounts, it can satisfy in humans of all ages needs for total nitrogen and essential amino acids. This was discussed in more detail elsewhere in this conference (3). This paper presents a brief review of the nutritional implications of the use of soybeans and soya products in the feeding of children.

PREMATURE INFANTS

Soya-based formulas for feeding of infants were designed and are used primarily to replace milk or milk-based formulas in the diets of children who are allergic or intolerant to milk. Premature babies of low gestational age have lower lactase activity at birth than full-term newborns. This fact and the apparent relationship between the incidence of necrotizing enterocolitis and the ingestion of formulas with high osmolality have prompted some neonatologists to prescribe soya formulas with low osmolality for the feeding of low-birth-weight infants. The Clinical Research Conference (4) was held recently to assess nutritional adequacy of a formula based on isolated soya protein supplemented with L-methionine (Isomil, Ross Laboratories) for the feeding of low-birth-weight babies. Comparisons were made with a cow's milk formula with similar protein, energy, mineral and vitamin contents. Among the results of the investigations reported in that conference were: (a) infants with birth weights between 1,000 and 1,750 g and gestational ages less than 34 weeks grew less with the soya-formula in one study (5), but there were no differences related to the feeding formulas in other investigations (6,7); (b) nitrogen balances were highly positive (mean values 356 and 503 mg N/kg/day in two different studies [7,8]) and they did not differ from the milk formula, but retention was 62% of the soya nitrogen intake compared with 70% of the milk N intake; (c) the variability of the results from calcium and phosphorous balance studies was greater with the soya than with the milk formula. Absorption of calcium and phosphorous from Isomil and other soya-based formulas was less than that from milk formula (9). It seemed that the availability of those minerals from soya formulas may not be adequate to support for any length of time the rapid bone mineralization of growing, low-birth-weight infants; (d) infants fed the soya formula developed fewer complications related to the gastrointestinal tract than infants fed the milk formula.

The consensus of the Conference was that soya formulas could be fed to low-birth-weight infants for short periods of time (2-3 weeks), handling them as therapeutic agents in managing premature infants, rather than as routine formulas for long-term feeding.

FULL-TERM INFANTS

The adequacy of formulas based on soya proteins to feed full-term infants has been documented in many studies (10-21). Although in some of those studies it was not mentioned whether the formulas were fortified with methionine and the role played by the addition of that amino acid is not completely settled, as discussed in another section of this conference (3), it is generally accepted that formulas based on soya protein promote growth and/or nitrogen retention of infants to the same extent as do milk-based formulas. Figure 1 in the paper presented in this conference by Torún et al. illustrates a study which failed to show an effect of methionine supplementation on the good N retention and growth rate supported by a formula based on a soya protein isolate and fed at a level of ca. 2.5 g protein/kg/day, although supplemented infants had lower concentrations of urea nitrogen in serum.

The use of a soya-rice-egg mixture as a milk substitute to feed infants in the People's Republic of China was recently presented in a workshop on protein and energy requirements (22). Feeding experiments with 100 infants using the formula with 28% soybean meal shown in Table I resulted in a growth-promoting effect similar to that of human or cow's milk. Metabolic balance studies were also conducted with 9 full-term infants between the ages of 1 and 7 months. They were fed the formulas shown in Table I, either alone or supplemented with 3 drops of cod liver oil (1,500 IU vitamin A and 500 IU vitamin D), during 5 sequential periods of 21-28 days each. Growth was adequate with all diets. Watery stools were passed more frequently with the milk than with the experimental diets; fecal bulk was ca. 30% greater with experimental diets. Table II summarizes the metabolic balance results. Although the soya-rice-egg diets had lower N digestiblity than the milk formula, at the levels of protein intake used in these studies (4.1-4.6 g/kg/day and 5.4 g/kg/day for the high protein diet), the amounts of dietary nitrogen that were retained did not differ among diets.

In addition to the advantages of soya formula for the feeding of infants who are allergic or intolerant to milk, its application in feeding jaundiced infants undergoing treatment with phototherapy has recently been postulated (23).

TABLE I

Dietary Formulas Used in the People's Republic of China to Feed Infants 1-7 Months Old[a]

	Dietary formulas		
	Milk	Soya	High-soya-protein
Whole cow's milk powder	71.5[b]		
Soybean meal		28.0	43.0
Rice meal		45.0	30.0
Cane sugar	28.5	16.5	16.5
Egg yolk Powder		5.0	5.0
Soybean oil		3.0	3.0
Degelatinized bone meal		1.5	1.5
Fermented millet		0.5	0.5
Salt		0.5	0.5
Protein	18.5	16.6	22.6
Fat	19.6	12.8	15.5
Carbohydrate	55.9	62.9	53.8
Crude fiber	0	0.7	0.9
Ash	4.0	3.2	3.9
Moisture	2.0	3.8	3.2
Total energy	474[c]	433	445

[a]Tabulated from data of Chou et al. (22).
[b]As g/100 g of dry weight, except for total energy.
[c]As kcal/100 g of dry weight.

It was known (24) that phototherapy reduces jejunal lactase activity which results in loose stools when breast milk or cow's milk formulas are fed. Sisson (23) investigated whether the diarrhea secondary to phototherapy could be prevented if a soya-based formula without lactose was used to feed the babies. He studied the effects of a soya-based formula (Isomil, Ross Laboratories) and of a milk formula (Similac, Ross Laboratories) in normal infants, infants who were jaundiced but did not require phototherapy and jaundiced infants who received that treatment. Table III shows that the soya-based formula prevented the diarrhea and the appearance of reducing substances in stools. It is notable, however, that tolerance tests after feeding 1.5 g lactose/kg in a 15% solution were normal during phototherapy in children who were fed the soya formula. It was speculated that the enzyme lactase in concert with the substrate may be more susceptible to phototherapy than it would be without the substrate. Although there is not a satisfactory explanation for that observation and it was also suggested that the transient diarrhea (normal stools appeared ca. 24 hr after dicontinuance of phototherapy) may be one of the beneficial effects of phototherapy because it might increase bilirubin losses, this potential use of soya-based formulas is very interesting and its theraputic implications should be further explored.

PRESCHOOL CHILDREN

Several metabolic balance studies conducted in well-nourished children 1-7 years old (e.g., refs. 25-29) have shown that diets with soya products as the only or main source of protein allowed adequate nitrogen retention and growth, at least for the duration of those relatively short-term investigations. The conclusions drawn from such studies, as recently reviewed (30,31), were that protein quality was comparable to that of milk, especially when well processed soya products were fed in adequate amounts to satisfy the children's nitrogen and amino acid needs. Methionine supplementation was used in some studies and its importance is debatable, as already mentioned and discussed elsewhere in this conference (3). Choline supplementation of soya protein fed to preschool children is unnecessary (28), in contrast to the findings of studies where diets limited by their methionine content were fed to growing rats and chicks.

Vegetable mixtures with soya as one of their major protein sources have also been used with very good results. Table IV summarizes the nitrogen retentions from predominantly vegetable mixtures and compares them with retentions from milk fed at equivalent levels of protein intake to the same or similar children. Except for the children studied by Huang et al. (32), all were between 1.5 and 5 years of age. When diets were given in amounts that satisfied N needs—at least based on short-term N balance studies—there were no differences between the milk and soya-containing diets.

Diets based on soya products or with soya as one of their protein sources have also been used successfully in the feeding of preschool children with protein-energy malnutrition (e.g., refs. 38-41, and Torun and Viteri, unpublished observations).

TABLE II

Summary of Metabolic Results with the Diets Shown in Table I (average values for 9 infants)[a]

	Dietary formulas				
			With cod liver oil		
	Milk	Soy	Milk	Soya	High-soy-protein
Age (days)	73	73[b]	111	111[b]	144
Body weight (kg)	5.12	5.26	6.21	6.17	6.83
Energy intake (kcal/kg/day)	112	117	107	108	106
N intake (mg/kg/day)	698	732	663	667	864
N retention (mg/kg/day)	193	196	159	162	196
Apparent N digestibility (%)	90	77	93	81	82

[a]Tabulated from data of Chou et al. (22).
[b]Milk diet preceded soy diet in 4 infants.

TABLE III

Abnormal Stools and Lactose Tolerance Tests in Jaundiced Infants Undergoing Phototherapy (PTx)[a]

Formula group	No. of infants	Abnormal stools	Reducing substances in stools	Abnormal LTT[b]
Control				
Soya formula	10	0[c]	0	1
Milk formula	12	2	1	1
Jaundiced				
Soya formula	10	1	0	0
Milk formula	10	1	1	1
Jaundiced and PTx				
Soya formula	13	0	0	2
Milk formula	20	17	15	16

[a]From Sisson (23).
[b]Abnormal lactose tolerance test = rise in blood glucose less than 20 mg/dl after nasogastric administration of 1.5 g lactose/kg.
[c]Number of children.

TABLE IV

Calculations from Some Studies with Vegetable Mixtures Containing Soya Proteins Fed to Well-Nourished Children

Proportions of protein foods in vegetable mixtures	Age (months)	Protein intake (g/kg/day)	Nitrogen retention (% of intake)		Reference
			Veg. mix	Milk	
Soya 75/rice 25	9[a]	3.6[a]	24.1[a]	24.9[a]	(32)
Soya 10/mixed diet 90[b]	20	2.2	22.1	21.4[c]	(33)
Soya 9/mixed diet 91[d]	30	2.2	25.5	19.7[c]	(34)
Soya 40/corn 60	42	1.5	28.3	23.1	(35)
Soya 20/cottonseed 20/corn 60	29	1.5	20.5	23.1	(35)
Soya 8/lysine 0.15/corn 98	30	1.2	16.2	19.5	(36)
Soya/cassava	30	1.5	25.9	23.1	(37)
Soya/sorghum	38	1.5	28.0	23.1	(37)
Soya/rice	45	1.5	23.9	23.1	(37)

[a]Mean values, n = 4-6 children.
[b]Rice, beans, potatoes, milk.
[c]Milk, instead of soya, added to the mixed diet.
[d]Rice, beans, potatoes, corn.

OLDER CHILDREN

Studies done with school-age girls (42) and in adolescents (43), mainly to assess the effects of supplementing soya protein with methionine, indicated that nitrogen balance can be achieved with relatively low intakes of supplemented soya protein. There is no reason to believe that the nutritional quality of soybean proteins would be worse for school-age and adolescent children than for younger children—as already reviewed—or adults—as reviewed elsewhere in this conference (3).

ADVERSE REACTIONS TO SOYBEANS AND SOYA PRODUCTS

The evaluation of real and potentially undesirable effects of soya must be included in the assessment of its overall nutritional quality. This is especially an important consideration in the feeding of children, because some of the undesirable effects are more likely to occur among them and may result in more serious implications than in adults.

Even though soya protein is frequently used as a milk substitute for infants allergic to cow's milk or intolerant to lactose, soya can also be a primary cause of allergy (e.g., review in ref. 44). It seems that sensitization to soybeans can occur not only during extrauterine life but also in the prenatal period: Kuroume et al. (45) reported that 5 newborns developed eczema upon first postnatal contact with soybeans, apparently a result of intrauterine sensitization. Halpern et al. (46) reported an incidence of allergy or intolerance to soya products as high as 0.5% among 1,753 children in the first 6 months of age. The main symptoms include diarrhea, vomiting, weight loss, fever and, in some cases, hypertension and lethargy. A syndrome clinically similar to neonatal necrotising enterocolitis with vomiting, bloodstained stools and villous atrophy has been reported (47-48) in infants who had similar symptoms when fed milk formula. Therefore, it is advocated that infants with severe allergy to cow's milk should be monitored closely when a soya protein is introduced in their diets.

Substances that have been called "antigrowth" or "antinutritional" factors have been identified in raw soybean meal, and these are more of a problem in animal than in human nutrition. the main antinutritional factors are proteins such as trypsin inhibitors and hemagglutinins which are readily inactivated by moist heat. Therefore, cooking and/or several industrial processes reduce or eliminate them during the preparation of soy products for human consumption. These and other alleged antinutritional factors are a part of several reviews (e.g., refs. 44,49) and they are addressed in other presentations in this conference.

The production of lysinoalanine during the alkaline treatment for the commercial processing of some soy protein products does not seem to represent a toxicological problem in the human diet. This issue is addressed in more detail in another section of this conference (50).

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REFERENCES

1. Lam-Sánchez, A., Arch. Latinoam. Nutr. 28:155 (1978).
2. Waggle, D.H., and C.W. Kolar, in "Soy Protein in Human Nutrition," edited by H.L. Wilcke, D.T. Hopkins and D.H. Waggle, Academic Press, NY, 1979, pp. 19-51.
3. Torún, B., and V.R. Young, presentation at World Conference on Soya Processing and Utilization, Acapulco, 1980.
4. "Ross Clinical Research Conference: Low-Birth-Weight Infants Fed Isomil," edited by W.H. Bachhuber, J.D. Benson, M.C. Dame and I.M. Gray, Ross Laboratories, Columbus, OH, 1979.
5. Bustamante, S.A., and S. Schreck, Ibid., pp. 59-66.
6. Rudolph, N., Ibid., pp. 67-76.
7. Shenai, J.P., J.W. Reynolds and S.G. Babson, Ibid., pp. 123-139.
8. Wu, P.Y.K., Ibid., pp. 141-148.
9. Ziegler, E., Ibid., pp. 113-122.
10. Fomon, S.J., Pediatrics 24:577 (1959).
11. Bates, R.D., W.W. Barrett, D.W. Anderson, Jr., and S. Saperstein, Ann. Allergy 26:577 (1968).
12. Cowan, C.C., Jr., R.C. Brownlee, Jr., W.R. DeLoache, H.P. Jackson and J.P. Matthews, Jr., South. Med. J. 62:389 (1968).
13. Andrews, B.F., and L.N. Cook, Am. J. Clin. Nutr. 22:845 (1969).
14. Graham, G.G., R.P. Placko, E. Morales, G. Acevedo and A. Cordano, Am. J. Dis. Child. 120:419 (1970).
15. Sellars, W.A., S.R. Halpern, R.B. Johnson, D.W. Anderson, Jr., S. Saperstein and B.S. Shannon, Jr., Ann. Allergy 29:126 (1971).
16. Wiseman, H.J., Ibid. 29:209 (1971).
17. Dean, M.E., Med. J. Aust. 1:1289 (1973).
18. Fomon, S.J., L.N. Thomas, L.J. Filer, Jr., T.A. Anderson and K.E. Bergmann, Acta Paediatr. Scand. 62:33 (1973).
19. Aversa, S., and V. Cordaro, Minerva Pediatr. 28:946 (1976).
20. Jung, A.L., and S.L. Carr, Clin. Pediatr. 16:982 (1977).
21. Fomon, S.J., and E.E. Ziegler, in "Soy Protein in Human Nutrition," edited by H.L. Wilcke, D.T. Hopkins and D.H. Waggle, Academic Press, NY, 1979, pp. 79-99.
22. Chou, C.-Y., S. Liu and Y. Chang, "Protein and Energy Metabolism of Soybean Milk Substitute 5410 in Infants," presented at the UNU/IUNS Workshop on Protein-Energy Requirements, Cambridge, MA, May 1980.
23. Sisson, T.R., in "Ross Clinical Research Conference: Low-

Birth-Weight Infants Fed Isomil," edited by W.H. Bachhuber, J.D. Benson, M.C. Dame and I.M. Gray, Ross Laboratories, Columbus, OH, 1979, pp. 101-107.
24. Bakken, A.F., Acta Paediatr. Scand. 66:91 (1977).
25. DeMaeyer, E.M., and H. Vanderborght, J. Nutr. 65:335 (1958).
26. Bressani, R., F.E. Viteri, L.G. Elías, S. Zaghi, J. Alvarado and A.D. Odell, Ibid. 93:349 (1967).
27. Graham, G.G., in "Amino Acid Fortification of Protein Foods," edited by N.S. Scrimshaw and A.M. Altschul, the M.I.T. Press, Cambridge, MA, 1971, pp. 222-236.
28. Torun, B., in "Soy Protein and Human Nutrition," edited by H.L. Wilcke, D.T. Hopkins and D.H. Waggle, Academic Press, NY, 1979, pp. 101-119.
29. Torun, B., M.I. Cabrera-Santiago and F.E. Viteri, United Nations University Food Nutr. Bull. (in press).
30. Bressani, R., in "Proceedings of the International Soya Protein Food Conference," Republic of Singapore, Jan. 1978, pp. 30-34.
31. Young, V.R., N.S. Scrimshaw, B. Torun and F. Viteri, JAOCS 56:110 (1979).
32. Huang, P.C., T.C. Tung, H.C. Lue, C.Y. Lee and H. Wei, J. Trop. Pediatr. 13:27 (1967).
33. Dutra de Oliveira, J.E., N. de Souza, T.A. de Rezende, L.R. Valente, V.F. Boyd and E.E. Daggy, J. Food Sci. 32:131 (1967).
34. Dutra de Oliveira, J.E., and N. de Souza, Arch. Latinoam. Nutr. 17:197 (1967).
35. Bressani, R., F. Viteri, D. Wilson and J. Alvarado, Ibid. 22:227 (1972).
36. Viteri, F.E., C. Martínez and R. Bressani, in "Nutritional Improvement of Maize," edited by R. Bressani, J.E. Braham and M. Behar, INCAP Publication L-4, Inst. Nutr. Centro America Panama, Guatemala City, 1972, pp. 191-204.
37. Viteri, F.E., B. Torún and R. Bressani, INCAP research report to World Health Organization, 1974.
38. Dutra de Oliveira, J.E., L. Scatena, N. Oliveira-Netto and G.G. Duarte, J. Pediatr. 69:670 (1966).
39. Graham, G.G., W.C. MacLean, Jr., and R.P. Placko, J. Nutr. 106:1307 (1976).
40. Baker, R.D., S.S. Baker, G.M. Margo and H.H. Reuter, Afr. Med. J. 53:674 (1978).
41. Alabastro, V.Q., C.M. del Rosario, S.C. Roldan, P.E. de Guzmán and V.T. Ferrer, Philipp, J. Nutr. 32:48 (1979).
42. Parthasaraty, H.N., T.R. Doiraswamy, M. Panemangalore, M. Narayana Rao, B.S. Chandrasekhar, M. Swaminathan, A. Sreenivasan and V. Subrahmanyan, Can. J. Biochem. 42:377 (1964).
43. Korslund, M., C. Kies and H.M. Fox, J. Food Sci. 38:637 (1973).
44. Anderson, R.L., J.J. Rackis and W.H. Tallent, in "Soy Protein and Human Nutrition," edited by H.L. Wilcke, D.T. Hopkins and D.H. Waggle, Academic Press, NY, 1979, pp. 209-233.
45. Kuroume, T., M. Oguri, T. Matsumura, I. Swasaki, Y. Kanbe, T. Yamada, S. Kawabe and K. Negishi, Ann. Allergy 37:41 (1976).
46. Halpen, S.R., W.A. Sellars, R.B. Johnson, D.W. Anderson, S. Saperstein and J.S. Reisch, J. Allergy Clin. Immunol. 51:139 (1973).
47. Bandon, J.J., J. Boulesteix, B. Lagardere and J.L. Fontaine, Arch. Fr. Pediatr. 33:153 (1976).
48. Powell, G.K., J. Pediatr. 88:840 (1976).
49. Liener, I.E., and M.L. Kakade, in "Toxic Constituents of Plant Foodstuffs," edited by I.E. Liener, Academic Press, NY, 1969.
50. Struthers, B.J., presentation at World Conference on Soya Processing and Utilization, Acapulco, 1980.

Soy Protein in Feeding the Elderly

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ABSTRACT

Protein needs of the elderly may be moderately higher than those of younger adults when expressed as a percentage of total calories. Most experts recommend an intake of ca. 0.8 g protein/kg/day or ca. 12-15% of the total calories. Soya protein appears to be as good as animal protein in meeting the amino acid and protein needs of adult humans when consumed in adequate quantities. Attention must be given to the appropriate heat treatment and processing of soybeans to inactivate non-nutritional factors. The mineral and vitamin content of the diet should be monitored, because some of these nutrients may be altered or removed in the preparation of soya protein fractions or isolates for use in food products. Further research is needed to fully identify the nutritional requirements of the elderly, especially as affected by disease, trauma and drugs. In addition, nutrient interaction and bioavailability should be studied in foods which are processed by new techniques.

INTRODUCTION

Aging is a normal physiologic process which continues from birth to death. Typically, those in the U.S. population over 65 years of age are categorized as elderly. As the average life expectancy increases, the elderly constitute an ever increasing proportion of the total population. It is estimated that the elderly currently account for ca. 15% of the U.S. population, and this is projected to increase to ca. 20% by the year 2000.

The health and nutritional status of the elderly are of special concern. The elderly comprise a disproportionate share of hospital admissions; ca. 25% of the elderly in the U.S. are admitted to hospitals each year. The elderly also make more visits to their doctors than do younger persons, and about one in every 20 are in institutions for long-term care. These and other factors are important considerations in assessing the nutritional status and the utility of various foods and nutrient sources in the care of the elderly population.

FOOD INTAKE AND NUTRITIONAL STATUS OF THE ELDERLY

Food intake and nutritional status of the elderly are affected by a number of factors which are associated with aging. As aging progresses, normal physiologic changes occur. Functional renal capacity declines, muscle tone and strength decrease, basic metabolic rate and cardiac index decline and physical activity is commonly reduced. The elderly may tire more easily, get less exercise and therefore have lower caloric needs than younger persons.

Reduction in gastric secretions may affect dietary iron and vitamin B_{12} requirements, because stomach acid enhances iron absorption and the intrinsic factor secreted by the stomach is needed for B_{12} absorption. However, the absolute daily requirements for protein, vitamins and minerals are not significantly affected by age. The primary implication of these physiologic changes is that the elderly may need a diet which, except for energy, is comparatively rich in nutrients.

A decrease in glucose tolerance is a common metabolic change in the elderly. Although this can be overcome in many cases by reduction in body weight, this is often