Nutritive value of proteins of pearl millet of high-yielding varieties and hybrids

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1. Two high-yielding varieties and three hybrids of pearl millet were evaluated for their chemical composition and protein efficiency ratio (PER) for rats at a level of 6·38% dietary protein. PER values ranged from 0·94 to 1·21 and were significantly different.

2. Tryptophan contents of the proteins were above the optimum level of the FAO reference protein. Lysine content was deficient in all the samples and was probably the limiting amino acid in the PER test.

Pearl millet (*Pennisetum typhoideum*) is one of the important small millets of tropical and subtropical regions of Asia and Africa. It is a staple food for a large number of people of these areas. The present shortage of food has drawn the attention of the breeders to this millet; male sterile lines have been exploited and high-yielding hybrids introduced (Athwal, 1966). Some information is available about the protein quality of pearl millet varieties (Ramachandran & Phansalkar, 1956; Kurion, Swaminathan & Subrahmanyan, 1961; Rama Rao, Murthy & Swaminathan, 1953; Phansalkar, Ramachandran & Patwardhan, 1957). However, little information is available about the nutritive value of the proteins of the high-yielding hybrids. Phul, Rana & Goswami (1969) reported a reduction in protein content accompanied by a considerable amount of heterosis for grain yield in pearl millets. This work was, therefore, undertaken to evaluate some high-yielding varieties and hybrids of pearl millet with respect to their chemical composition and nutritive value.

EXPERIMENTAL

Samples consisted of finely ground flour of two high-yielding varities (A 1/3 and T55) and three hybrids (23A × Bil 1, 23A × Bil 3B and 101A × Bil 3B) of pearl millet grown under identical conditions. Crude protein was estimated by the Kjeldahl method of McKenzie & Wallace (1954); crude fat, cellulose and ash were estimated according to the methods recommended by the Association of Official Agricultural Chemists (1960). The lysine was separated from the acid hydrolysate of defatted samples by the procedure of Moore, Spackman & Stein (1958) and then estimated by the ninhydrin colorimetric method of Moore & Stein (1954). Methionine was determined by the colorimetric procedure of Horn, Jones & Blum (1946) in acid hydrolysate, and tryptophan was determined by the method of Smith & Agiza (1951) in alkaline hydrolysate.

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The nutritive value of the proteins in the five flours, obtained by milling grains to 40 mesh, was evaluated by the protein efficiency ratio (PER) method (Campbell, 1961). Each of the five diets containing millet was made up of groundnut oil 10, salt mixture no. 4 (Hawk, Oser & Summerson, 1947) 4, vitamin mixture (Chapman, Castillo & Campbell, 1959) 1, pearl millet flour at a level which provided 6·38% crude protein in the diet and starch *ad* 100. A sixth, reference diet, was made up with pearl millet flour replaced by casein (Merck Ltd; 88% crude protein) 7·3, groundnut oil 5 (i.e. bringing the total level of this ingredient to 15) and cellulose 2. Six randomized groups of eight weanling male albino rats from the same litter, about 1 month old and of average weight 40–45 g, were fed *ad lib.* for a period of 4 weeks. During this period weekly gains in weight and daily food consumptions were recorded. Animals were housed in individual cages with screen bottoms and the cages were arranged in a randomized block design consisting of eight blocks with six cages in each block for the six diets. PER was calculated for each rat as g weight gain per g protein consumed.

RESULTS AND DISCUSSION

The chemical composition of the pearl millet varieties and hybrids is presented in Table 1. The protein intake, gain in weight and PER of diets made from pearl millets as the sole source of protein and reference protein (casein) are presented in Table 2. PER values ranged from 0·94 to 1·21. The values were considerably lower than the values of 1·4 and 1·8 reported by Rama Rao *et al.* (1953) and Phansalkar *et al.* (1957) respectively for PER of pearl millets determined at a 10% protein level. It is not, however, possible to compare values at different protein levels. The PER of reference protein (casein) was also lower in the present study. Swaminathan (1937) reported a PER of 1·2 for pearl millet proteins determined at a 5% protein level.

Table 1. *Chemical composition of pearl millet grain*

Variety ...	A 1/3	T 55	23 A × Bil 3 B	23 A × Bil 1	101 A × Bil 3 B
Moisture (%)	8·9	8·1	7·8	8·5	8·6
Crude protein (%)	7·50	10·51	7·49	9·75	8·44
Crude fat (%)	6·24	6·13	5·62	5·86	5·68
Cellulose (%)	1·79	1·88	2·00	1·91	1·88
Nitrogen-free extracts (%)	82·48	80·27	82·52	80·89	82·12
Lysine (g/g N)	0·22	0·21	0·18	0·21	0·24
Methionine (g/g N)	0·10	0·10	0·11	0·13	0·13
Tryptophan (g/g N)	0·12	0·12	0·13	0·11	0·12

Standard errors of the treatment means for protein intake and gain in weight revealed that the blocks were not very effective in removing experimental variations. However, differences in the gains in weight and PER values of the diets were highly significant ($P < 0·01$) and that of protein intake was significant ($P < 0·05$). Even without the reference protein, which was considerably superior to the pearl millet proteins, the PER values were significantly different ($P < 0·05$). The diet made from 101 A × Bil 3 B, as the sole source of protein, was significantly better than the remaining diets with the exception of 23 A × Bil 1. Nutritive value of the proteins of high-yielding

Table 2. *Growth-promoting value for rats of diets containing different varieties of pearl millet as the sole protein source*

Protein source	Protein intake (g/4 weeks)	Weight gain in 4 weeks (g)	PER
Pearl millet:			
A 1/3	8·75	8·9	1·01
T55	8·88	8·7	0·98
23A × Bil 3B	8·29	7·8	0·94
23A × Bil 1	8·39	9·4	1·11
101A × Bil 3B	8·38	10·1	1·21
Casein	8·68	16·4	1·88
SE of treatment mean	±0·121	±0·50	±0·055

Table 3. *Published values for the essential and semi-essential amino acid content (g/g nitrogen) of different varieties of pearl millet and ideal proteins*

	Values for millet protein		
Essential amino acid	Kurian *et al.* (1961)	Gopalan & Balasubramanyan (1963)	Hypothetical ideal protein (FAO, 1957)
Lysine	0·23	0·23	0·27
Methionine	0·13	0·13	0·14
Cystine	—	0·08	0·13
Tryptophan	0·10	0·09	0·09
Threonine	0·22	0·21	0·18
Phenylalanine	0·25	0·20	0·18
Leucine	0·59	0·58	0·31
Isoleucine	0·32	0·31	0·27
Valine	0·36	0·34	0·27

hybrids did not show a wide departure from that of the high-yielding varieties and it was evident from these findings that the protein quality of high-yielding pearl millet hybrids was as good as that of the high-yielding varieties.

Table 3 sets out published data for the essential amino acid content of pearl millet proteins. By comparison with a hypothetical reference protein (FAO, 1957), the pearl millet proteins were deficient in lysine and methionine; tryptophan content was just at the required level and the remaining essential amino acids were all well above the respective requirement. The lysine, methionine and tryptophan contents of the samples in which PER was evaluated are given in Table 1. Tryptophan was adequate in all the proteins. Lysine was below the requirement level in all the proteins. The protein with the highest lysine content (101A × Bil 3B) gave the highest PER value and that with the lowest lysine content (23A × Bil 3B) gave the lowest value; values for proteins with an intermediate lysine content did not show the same trends. Ramachandran & Phansalkar (1956) also reported that the limiting amino acid of the pearl millet proteins, fed as a sole source of protein, was lysine. Methionine content was slightly below optimum level for all the proteins but the content of cystine was not determined.

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