Influence of Soybean Supplementation on Nutritional Status of Poor in Semi-arid Tropics

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Introduction and Methods

Adequate nutrition is both a measure and goal of development. Indeed it is an ideal target of any developmental efforts. A better understanding of the dynamics of food needs and wants is essential. Food has a dual function; it meets a basic physiological need but also has a social dimension which depends on tradition, taste, economic status etc. Food is not just a collection of chemicals which keep us alive and functioning like machine; it also satisfies psychological needs of the individual. Undernutrition however, is today the single most important factor that determines the health, productivity and quality of human resources and must threrfore command immediate major concern and highest priority.

Sorghum (*Sorghum bicolor* (L) moench) is the king of millets and occupies an important place among cereals grown in India, especially in the arid and semi-arid regions of the country. It is a staple food for more than 700 million people of the world. India is a major sorghum growing country, covering about one third of the total area under sorghum globally. Sorghum has been used exclusively as food for centuries in India. It forms a major source of protein and calories to the poorest people of the semi-arid tropics.

Sorghum has imbalanced protein of less digestibility. By selecting the suitable resources for effective combination, the protein quality of the diet could be improved. Traditionally this was accomplished through mixed diets using pulses to supplement cereals. Pulses were known as " Poor man's protein ". They are no more so. Pulse availability is almost stagnant resulting in to considerable increase in prices. An appropriate substitute to the conventional pulses such as pigeon pea, bengalgram, greengram, blackgram etc. is required.

Soybean has double protein compared to other pulses. The present productivity in India, although low is twice that of other pulses. The use of soybean for human food can thus make an eight fold impact on the protein availability to combat prevailing malnutrition without increasing the cropped area if the productivity of soybean is raised to the world average. An attempt has therefore been made to formulate a sorghum based composite flour in combination with soybean. Present price of whole soybean per unit quantity protein is about a quarter compared to other pulses. This would ensure that sorghum-soybean combination can reach the real needy and make the balance nutrition an achievable reality for the poor.

The choice of legume to be used for incorporation is decided primarily on the basis of compatibility, cost and its availability to the section of population for whom it is needed most. The change in amino acid score by incorporation of different legumes such as soybean, bengalgram, pigeonpea, greengram and blackgram was estimated by using the method suggested by Madl (1993). Earlier the protein efficiency ratio (PER) was the preferred method of estimation of protein quality. Recently there is a recognition by nutritionists that PER method reflects the amino acid requirement for the rat rather than the humans. The essential amino acid patterns for younger children (2-5 yrs.) are also considered adequate for the older children and adults by FAO/WHO in 1989. After reviewing the FAO/WHO report FDA in 1991 proposed the use of protein digestibility corrected amino acid score (PDCAAS) for determining protein quality in foods intended for children over 1 yr. old and for adults. For estimation of PDCAAS each amino acid is compared with the required level established in 1985 for preschool children (2-5 yrs.). The amino acid present in the lowest level relative to the standard level is identified as a limiting amino acid. The PDCAAS is the ratio of limiting amino acid in test food to the standard amino acid level multiplied by the digestibility factor for the test food. The use of PDCAAS is consistent with recent worldwide consensus of nutritionist. The weighted average digestibility of composite flour was considered while arriving at level of desirable intake of protein required to meet the protein need.

The level of desirable intake of protein for different blends of composite flour using different source of plant protein was established by using the formula given by FAO/WHO.

$$\text{Desirable intake} = R \times \frac{100}{AAS} \times \frac{100}{\text{Protein digestibility}} \qquad (1)$$

Where, R = recommended level of milk or egg protein
AAS = Amino acid score

The weighted average digestibility for different blends were considered for calculation.

$$AAS = \frac{FLAAP}{FLAAR} \times 100 \qquad (2)$$

FLAAP = First limiting amino acid present
FLAAR = First limiting amino acid required

Findings

Protein forms an essential component of the human diet. They provide the essential amino acids which are the building blocks for protein synthesis. The quality of a protein is determined by the quantity of each essential amino acid provided and the availability of the amino acids through digestion. The first limiting amino acid in sorghum is lysine which is present in excess in the legumes. The incorporation of the legume protein with cereal protein can therefore improve the protein quality of the composite flour. Protein sources such as bengalgram, pigeonpea, greengram, blackgram and soybean are considered for supplementation to sorghum.

The Protein Digestibility Corrected Amino Acid Score (PDCAAS) was estimated for the different protein resources at different levels of incorporation as per the method given above. The estimated values of the PDCAAS is shown in the Table 1. Among all the plant protein sources soybean gives the maximum PDCAAS at 5, 10, 15 and 20 percent level of incorporation. Only in case of 25 % incorporation level, PDCAAS value is maximum for bengalgram. From these estimations it was observed that though the supplementation of sorghum protein quality, with any legume protein results in the improvement of protein, the maximum benefit of improvement is with soybean incorporation up to 20 %. The variation in protein content with the addition of legume protein to sorghum at different level is estimated and given in the Table 1. The percent protein content of the blend increases linearly with the increase in the percent incorporation. However, the rise in protein content in case of soy incorporation is markedly steeper than that of other legumes. The quantity of the flour to meet the protein need of a 2-5 yrs. child is calculated by using the equation (1). The calculated intake of flour is given in Table 1. The intake estimates are found to be too high for the stomach capacity of the age group when unenriched sorghum flour is used. The calculated intake rapidly decreases with the increased incorporation up to 10 % level. With further incorporation decrease in intake is reduced. Soy protein brings in maximum reduction in the calculated intake requirement as compared to other legumes. The calculated quantity of flour required to be consumed to meet the energy need of the child of 4 yr. age is about 240 g. In this case the weight of the child is taken as 10 kg. It is assumed that 80% of the total energy need is met through the primary diet of composite flour. The incorporation of legume with sorghum does not reduce the quantity of the composite flour required to meet the energy need. Therefore, the critical level of incorporation at which both the energy and protein needs are satisfied in each case is 10 % for soybean followed by 17, 18, 20 and 22 % for bengalgram, greengram, pigeonpea and blackgram respectively.

Next consideration concerns the need of essential fat requirement. The net fat available through the supply of calculated intake of flour, required to meet protein need is given in Table. Except in case of soybean, the net fat available decreases significantly, for all the legumes. This is due to the fact that soybean contents a fat of the order of about 20 %. As a result, the reduction in available fat through reduction in intake is compensated to certain extent by incorporation of soybean which is not the case in other legumes.

Comparison of the protein incorporation in sorghum flour through various legume proteins gives an interesting picture. The quantity of flour required to meet the protein needs are highest for unenriched sorghum flour. The decrease in the required quantity progressively increases with the level of incorporation. Moreover, the rate of decrease is a function of the protein resource. The highest rate of decrease is observed in the case of soybean followed by bengalgram, greengram, pigeonpea and blackgram. However, at higher levels of incorporation, the differential rates observed with various protein resources converge and come closer at 20 % incorporation. This indicates that the benefit of reducing the total flour intake to meet the protein needs can be reasonably accomplished at the level of 20%. With the increase in the level of incorporation and consequential decrease in the flour intake sufficient to meet protein need, there is a substantial decrease in the fat available except in case of soybean. The minimum fat intake that is considered desirable is usually taken to be as 15 g per day. All the diet based on sorghum and its composites do not meet this requirement. It would therefore be necessary to meet this minimum fat requirement at additional cost.

Reference

Madl, R.L. 1993. Evolution of protein quality determination. Cereal Food World. 38(8) : 576.

Table 1 Effect of sorghum supplementation by different plant protein source on nutritional parameters

Protein source	Parts/100 parts of sorghum					
	0	**5**	**10**	**15**	**20**	**25**
	PDCAAS					
Soybean	30	40	49	55	61	65
Bengalgram	30	38	45	53	60	66
Pigeonpea	30	37	44	49	55	59
Greengram	30	38	44	50	55	60
Blackgram	30	36	40	45	51	54
	Weighted average digestibility					
Soybean	73	75	77	78	79	80
Bengalgram	73	75	77	79	81	82
Pigeonpea	73	73	74	74	75	75
Greengram	73	74	74	75	76	76
Blackgram	73	74	74	75	76	76
	Protein content, %					
Soybean	10.4	12.04	13.68	15.32	16.96	18.60
Bengalgram	10.4	10.98	11.56	12.14	12.72	13.30
Pigeonpea	10.4	11.04	11.59	12.19	12.78	13.38
Greengram	10.4	11.11	11.81	12.52	13.22	13.93
Blackgram	10.4	11.08	11.78	12.44	13.12	13.80
	Fat content, %					
Soybean	1.9	2.77	3.66	4.52	5.54	6.27
Bengalgram	1.9	2.09	2.27	2.45	2.64	2.82
Pigeonpea	1.9	1.89	1.88	1.87	1.86	1.85
Greengram	1.9	1.86	1.83	1.79	1.76	1.72
Blackgram	1.9	1.87	1.85	1.82	1.80	1.77
	Estimated flour intake, g.					
Soybean	514.04	334.31	241.10	188.58	155.08	132.74
Bengalgram	514.04	380.96	304.66	245.33	209.85	181.12
Pigeonpea	514.04	400.24	316.19	268.74	231.75	201.82
Greengram	514.04	381.59	310.30	254.31	218.14	191.30
Blackgram	514.04	398.24	334.28	281.13	239.49	214.86