

## The Effect of Soaking, Germination and Cooking on the Protein Quality of Mash Beans (*Phaseolus mungo*)

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The protein quality of mash beans (*Phaseolus mungo*) as affected by soaking, germination and cooking was determined at the 10% dietary protein level using weanling rats. Gains in body weight were 11.5 g for raw beans, 68.5 g for soaked-cooked and 33.0 g for germinated-cooked beans. The protein efficiency ratio values were 0.4, 1.9 and 1.1 for raw beans, soaked-cooked and germinated-cooked beans respectively. Net protein utilisation was improved from 44% for raw beans to 58% after soaking and cooking, but reduced to 47% after germinating and cooking. These changes were entirely accounted for by changes in digestibility, 72, 90 and 81% respectively, and biological values were unchanged at 61, 64 and 59 respectively.

### 1. Introduction

The food legumes are major sources of protein and other nutrients in the diets of many developing countries. However, their role appears to be limited by several factors (Elias and Bressani<sup>1</sup>) including low protein digestibility and flatulence. Although numerous toxic constituents are found in raw legumes (Liener<sup>2</sup>), many of them are destroyed by adequate heat treatment, such as might be employed in common cooking procedures. It becomes important, therefore, to establish those processing conditions, which are necessary to inactivate or eliminate these toxic constituents. In many parts of the world, legumes are often consumed after germination, during which process the proteins are hydrolysed to peptides and amino acids,<sup>3</sup> due to protease activity,<sup>4</sup> while the carbohydrates are converted to simpler sugars.<sup>5</sup> Whether such changes affect the nutritive value is not well established. Everson *et al.*<sup>6</sup> reported improvement in biological value of soybean on germination, while Chattopadhyay and Banerjee<sup>7</sup> observed a decrease in other legumes. In the present paper, the results of studies on the effect of soaking, germination and cooking on the protein efficiency ratio (PER), true digestibility (TD), net protein utilisation (NPU) and biological value (BV) of mash beans (*Phaseolus mungo*) are reported.

### 2. Experimental

#### 2.1. Processing methods

Mash beans were obtained from the local market and processed as follows: the raw whole beans samples were soaked in water overnight and germinated on damp cloth for 48 h, during which sprouts up to 1-2 cm in length appeared. Soaked and germinated beans was cooked for 10 min at 15 lb pressure, the cooking time being taken from the moment the pressure reached 15 lb. All the treated samples were dried by a stream of hot air at 80°C for 18 h<sup>8</sup> and then ground in a laboratory mill.

#### 2.2. Chemical analysis

Moisture and nitrogen were estimated by the AOAC methods.<sup>9</sup>

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### 2.3. Biological trials

Diets were prepared by mixing the beans samples with corn starch to a calculated protein level of 10% and supplemented with 5% corn oil, 2% vitamin mixture and 4% mineral mixture. In order to measure the metabolic faecal nitrogen, a group of rats was fed on a protein-free diet consisting of corn oil 5%, glucose 15%, vitamin mixture 2%, mineral mixture 4% and corn starch 74%.

The experimental procedure has been described by Khan *et al.*<sup>10</sup> Forty-eight weanling rats of Wistar strain, weighing between 50–60 g, were grouped by randomised block design. Each group consisted of four rats (mixed males and females) housed in a screen mesh-bottomed cage, and a sheet of filter paper was placed under each cage for the collection of faeces. The experimental diets were randomly assigned to these groups in such a way that each diet was fed *ad libitum* to two groups of rats for a period of 10 days. Gains in body weight were recorded daily.

PER (g weight gain/g protein intake) was calculated. At the end of the experiment the rats were killed with chloroform. Incisions were made into the skull, thoracic and abdominal cavities and the carcasses of each group were dried to a constant weight at 105°C. Dried carcasses were weighed and ground in an electric grinder. The nitrogen contents of diets, faeces and carcasses of each group were determined by the Kjeldahl method. Net protein utilisation was estimated according to the method of Miller and Bender.<sup>11</sup> The formulae used to calculate the true digestibility and biological value were as follows:

$$\frac{\text{Nitrogen intake} - (\text{faecal nitrogen} - \text{metabolic nitrogen})}{\text{Nitrogen intake}} \times 100 = \text{TD} (\%)$$

$$\frac{\text{Net protein utilisation}}{\text{True digestibility}} \times 100 = \text{BV} (\%)$$

### 2.4. Statistical analysis

The data were subjected to statistical analysis by applying Duncan's Multiple Range Test.<sup>12</sup>

## 3. Results

### 3.1. Protein efficiency ratio (PER)

PER was calculated from a 10-day period in the present study, and may not be the same value as the standard PER value (28 days). The average PER of the diet containing raw mash beans was 0.4, and it improved significantly ( $P < 0.05$ ) to 1.9 and 1.1 when beans were cooked after soaking and germination respectively. Soaking, germination and cooking after germination of beans had similar effects on the PER values of the diets. The PER of the diet containing soaked-cooked beans was the highest.

Table 1. Effect of soaking, germination and cooking on the nutritive value of mash beans

Parameter	Raw beans	Treatment			
		Soaked		Germinated	
		Uncooked	Cooked	Uncooked	Cooked
Food intake/group (g)	231.0	256.0	313.8	267.2	265.2
Gain in weight/group (g)	11.5	31.5	68.5	29.5	33.0
Protein efficiency ratio	0.4	1.1	1.9	1.0	1.1
Net protein utilisation (%)	44.0	49.0	58.0	46.0	47.0
True digestibility (%)	72.0	77.0	90.0	74.0	81.0
Biological value (%)	61.0	63.0	64.0	62.0	59.0

### 3.2. Net protein utilisation (NPU)

NPU increased from 44% in the raw beans to 58% and 47% in soaked-cooked and germinated-cooked mash beans respectively. NPU increased significantly when soaked beans were cooked, but no improvement in NPU was observed when germinated beans were cooked.

### 3.3. True digestibility (TD)

The TD of the raw beans were increased significantly by soaking, germination and cooking. The average TD of the various experimental diets ranked in the following order: soaked-cooked 90%, germinated-cooked 81%, soaked-uncooked 77%, germinated-uncooked 74% and raw mash beans 72%. A maximum increase in TD of 25% was noticed when the raw beans were cooked after soaking in water.

### 3.4. Biological value (BV)

The BV of raw, soaked-cooked and germinated-cooked beans were 61, 64 and 59% respectively but the differences were not statistically significant.

## 4. Discussion

The nutritive value of a protein depends on the physiological availability of its constituent amino acids. Other factors affecting the nutritive value of legumes are (a) the relative proportions of the different amino acids, (b) the indigestible carbohydrates<sup>13</sup> and (c) the presence of antinutritional substances. All these factors can lead to impaired digestion, absorption or utilisation of any amino acid likely to be limiting in the diet.

Germination may affect the nutritive value of the proteins by improving availability of some essential amino acids.<sup>6</sup> It improved the growth-promoting value and digestibility of proteins of Bengal gram but not that of peas and greengram.<sup>14</sup> An increase in the BV of chickpea, blackgram and lentil proteins, and a decrease in BV in greengram and pea protein as a result of germination, have been reported by Chattopadhyay and Banerjee.<sup>7</sup> Heat treatment applied to legume foods can improve their texture and palatability and also destroy or inactivate heat labile toxic compounds, and probably other enzymes inhibitors as shown by several investigators.<sup>15-17</sup> The cooking of pigeon peas improved their nutritional value but supplementary soaking or germination did not further improve protein quality.<sup>18</sup>

In the present study the soaking, germination and cooking of mash beans improved growth rate, PER and TD. Hydrolysis of proteins during the treatment may possibly account for the better digestibility of the proteins. The NPU for soaked-cooked beans were better than for raw and germinated-cooked mash beans. This is primarily due to increase in the TD of the diet. Soaking, germination and cooking did not improve the BV of mash beans in the present study. Further studies are required to elucidate the cause of the above findings.

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