Nutritional Sciences 3(2), November, 2000, pp. 66-70

Nutritional Improvement of Masoor *(Lens esculenta)* by Supplementation with Different Kinds of Meat

Nighat Bhatty[1], Abrar Hussain Gilani[1] and Saeed Ahmad Nagra[2§]

[1]*Department of Rural Home Economics, University of Agriculture, Faisalabad, Pakistan*
[2]*Institute of Chemistry, University of the Punjab, Lahore 54590, Pakistan*

ABSTRACT

The study was conducted to determine the nutiritional value of Masoor (*Lens esculenta*) in raw and cooked forms. Supplement value of various types of meat i.e. poultry, mutton and beef at 10, 15, and 20 percent levels for dite containing cooked Masoor was also assessed. Nutritional value of Masoor was determined by chemical analysis as well as through rat assay. Masoor contained an average of 23.18 percent protein and less than two percent fibre. Conventional method of cooking resulted in about 2 per cent increase in Masoor protein. Masoor had 0.83 percent of lysine and cooking destroyed 18 percent of it. Other amino acids in Masoor also showed losses on cooking. Protein efficiency ratio (PER) of diets containing raw Masoor was 1.49 and was reduced to 1.44 by cooking. Cooking of Masoor did not alter true digestibility (TD) percentage. However, net protein utilization (NPU) was improved from 44.60 in raw to 47.77 in cooked. Diets containing cooked Masoor and supplemented with different types of meat significantly improved PER (1.45 to 1.65), TD 76.03 to 87.84 percent and NPU 42.84 to 50.72 percent over non supplemented diets. 20 percent level of supplemented meat showed comparatively better results than other levels in case of improvement in PER, TD and NPU.

KEY WORDS: masoor, supplementation, cooking, Pakistan.

INTRODUCTION

In our earlier communication we have discussed the effect of supplementation on pulses such as Gram (*Cicer arietinum*) and Mash (*Vigna Mungo*) with different levels of poultry, mutton and beef.[1,2] Masoor (*Lens esculenta*) is an important source of protein in the diet of people in the Mediterranean area, Africa, the Middle East, South America and southern Asia.[3] Legumes are deficient in sulfur containing amino acids and Masoor is no exception to it.[4] It is a popular pulse crop in Pakistan. In the recent years the area under cultivation for this crop was 51.5 thousand hectares and the total annual production was 25.1 thousand tons with average yield per hectares as 487 kg.[5] As with other pulses, Masoor is also deficient in sulphur containing amino acids. The present study deals with the nutritional improvement of Masoor by supplementary effect of various kinds of meat at different levels of inclusion.

MATERIALS AND METHODS

Masoor (*Lens esculenta*) was procured from the local market and dried in hot air ovens. Flour was obtained by grinding and sieved through 20-mm mesh sieve. The flour was stored in air tight glass jars at room temperature for further use. Similarly flour was obtained after cooking the Masoor by conventional method, using natural gas as fuel. Cooking was carried out at 100℃ for 30-40 minutes and then on low flame at simmering temperature until the seed became tender. After cooking, the samples were air-dried first and then oven dried, pulverized and stored in jars as explained above. Casein (Merck, used for the preparation of standard diet), Corn Oil and Maize starch was also purchased from the market.

1. Mineral and vitamin mixture

This was prepared according to Oser[6] by mixing salts of different minerals obtained from Merck. Vitamin mixture was prepared according to the formula of Miller and Bender.[7] Vitamins used for the preparation of mixture were obtained from E. Hoffman. La Roche, Ltd (Switzerland).

2. Formulation of diets

The experimental diets were prepared using raw as well as cooked Masoor. Diets were also prepared by replacing 10, 15 and 20 per cent of Masoor protein with same amount of protein derived from poultry, mutton and beef.

Accepted : November 18, 2000
§To whom correspondence should be addressed.

Casein diet served as standard and a nitrogen free diet was used to determine the endogenous nitrogen. The composition of diets is shown in Table 1.

3. Biological assay

Biological evaluation was carried out according to the method of Bhatty *et al.*[11,12] At the end of trial, The nitrogen content of diets, feces and carcasses of each group of rats was determined by the Khjeldahl method. Data thus obtained was used to workout Protein Efficiency Ratios (PER); True Digestibility (TD) and Net Protein Utilization (NPU).

4. Proximate analysis

Samples of Masoor were analysed for its proximate composition (Moisture, Crude Protein, Ether extract, Crude fibre, Total ash, Nitrogen free extract (NFE), according to AOAC methods.[8] Samples of different types of meat were analysed for protein contents only.

5. Amino acid analysis

Amino acid analysis of Masoor was done by the method of Spackman, *et al*[9] on Beckman-Model 120C Amino Acid Analyzer.

6. Statistical analysis

The experimental data regarding various parameters i.e. PER, TD, and NPU were subjected to analysis of variance using completely randomized design. The analysis was computed using SPSS-400 as software. Multiple comparison of means was made by Fisher PLSD test.[10]

RESULTS AND DISCUSSION

1. Chemical composition

1) Proximate composition

The proximate composition of raw and cooked Masoor has been given in Table 2. In the present study raw Masoor was found to contain 7.25 percent moisture. Siddique,[11] Shah *et al*[12] *and Afzal*[13] *reported moisture content to range from 10.32 to 10.79 percent. Dhindsa et al*[14] reported moisture within a range of 9.68 to 10.00 percent. The variations in moisture may be due to different varieties grown in different locations.

Masoor was found to contain 23.18 percent protein. Vimala *et al*[15] noted small seeded types to contain the highest protein levels. A bimodal distribution of protein content with peaks in the region of 18 – 19 and 22 – 23% was observed. The value observed in the present study fell within the higher range of protein. Siddique,[11] Shah *et al.*[12] and Afzal[13] also showed higher range of protein in their studies. But Savage[16] and Sayeed *et al*[17] showed much wider range of protein in lentils. Krober *et al.*[18] in their survey of the protein content of lentils in India

Table 2. Proximate composition of masoor(%)

Proximate principals	Raw masoor	Cooked masoor
Moisture	7.25	7.00
Crude protein	23.18	25.15
Ether extract	1.88	2.25
Crude fiber	1.34	1.50
Nitrogen free extract	70.10	68.06
Ash	3.50	3.04

Table 1. Percent composition of experimental diets

Diets	Ingredients*						
	Maize starch	Casein	Raw masoor	Cooked masoor	Poultry meat	Mutton meat	Beef meat
Standard	56.12	12.5	–	–	–	–	–
Nitrogen free	68.62	–	–	–	–	–	–
Containing raw masoor	22.12	–	46.50				
Containing cooked masoor	28.62	–	–	40.00	–	–	–
Cooked masoor+10% poultry	30.84	–	–	36.00	1.78	–	–
Cooked masoor+15% poultry	31.95	–	–	34.00	2.67	–	–
Cooked masoor+20% poultry	33.06	–	–	32.00	3.46	–	–
Cooked masoor+10% mutton	30.66	–	–	36.00	–	1.96	–
Cooked masoor+15% mutton	31.68	–	–	34.00	–	2.94	–
Cooked masoor+20% mutton	32.70	–	–	32.00	–	3.92	–
Cooked masoor+10% beef	30.79	–	–	36.00	–	–	1.83
Cooked masoor+15% beef	31.88	–	–	34.00	–	–	2.74
Cooked masoor+20% beef	33.06	–	–	32.00	–	–	3.56

*In addition each diet contained Glucose 15%, Corn Oil 5%, Vitamin Mixture 3.5%, Mineral Mixture 3.13%, Choline chloride 0.15%, Inositol 0.10%, Calcium Carbonate 2.0% and Di Calcium Phosphate 2.5%.

showed significant differences due to widely differing locations.

Masoor was found to contain 1.88 percent ether extract. Shah *et al*[12] reported somewhat lower values. Siddique[11] and Afzal[13] reported much lower fat contents. The amount of oil present in the seed of lentils is generally low and never rose above 4 percent. These variations could be due to varietal differences. It is reported that Masoor are well placed to make a return to western diets as they are good source of cheap protein, fibre and vitamins and are low in fat, cholesterol and sodium.[16]

Masoor had 1.34 percent crude fibre. Siddique[11] and Shah *et al.*[12] reported higher fibre contents. However, Afzal[13] reported very low amount (0.64 percent) of fibre. Savage[16] on the basis of data of different authors reported that crude fibre ranged from 0.2 to 3.0 percent in their studies. Such wide variations are probably due to varying extent of dehusking and dehulling. Nitrogen free extract (NFE) of raw Masoor in this study was 70.10 percent. Afzal[13] reported a lower NFE content. However, Siddique[11] reported somewhat higher contents of soluble carbohydrates (63.10%). Shah *et al*[12] reported much lower content of NFE. Masoor was found to contain 3.50 percent ash. Savage,[16] Siddique[11] and Shah *et al*[12] reported ash content to range from 2.2 to 3.47 percent. However, Afzal[13] reported lower ash content (1.93%). These variations were probably due to variations in the soils and extent of dehulling.

2) Amino acid composition

Amino acid composition of Masoor has been summarized in Table 3. In the present study raw Masoor was found to contain 0.83 percent lysine. Siddique[9] showed a higher value (1.39-%). Shah *et al.*[12] reported much higher content of lysine i.e. 6.79 g/100 gm of protein. The lysine content of both raw and cooked lentils (Masoor) seems to the well above the recommended levels. The available amino acid content of raw and cooked was measured by Ahmad *et al*[19] after papain inculcation. They observed that the available lysine in the raw and cooked were similar at 84 percent. Histidine content of Masoor in this study was observed to be 0.64 percent. Savage[16] showed histidine to range from 2.18 to 3.36 percent. Siddique[10] showed lower value (0.42%). The threonine content of Masoor was found to be 0.42%. Siddique[11] showed higher quantity of threonine (0.83%). Leucine in raw Masoor was similar to that reported by Siddique.[11] Sosulki *et al.*[20] and Aykroyed *et al.*[21] reported comparatively higher range of leucine 6.7 to 7.4 percent. Shah *et al*[12] reported mush higher amounts. The differences may be due to the difference in blending, variety, climatic conditions and method of flour preparation. Siddique[11] reported similar content of Isoleucine as observed in the present study. Shah *et al.*[12] reported much higher values. They also reported a relatively higher content of phenylalanine than that determined in this study. Siddique[11] reported higher value.

Valine was 5.6 g/100 gm protein in Masoor. Savage[16] reported valine to range from 3.57 to 4.4 g/100 N. Shah *et al*[12] reported higher content 5.37 g/100 gm of protein but Siddique[9] reported very low value. Bhatty *et al.*[22] reported that Masoor contained significantly lower levels of valine and it was the second limiting amino acid. The major amino acids were glutamic acid, proline, aspartic acid, leucine lysine and arginine. It was deficient in sulphur containing amino acid. These values are in agreement with those of Khan *et al*[23]. The limiting essential amino acids in Masoor are methionine and cystine. It is also a poor source of tryptophan but rich in leucine, lysine and phenylalanine. These amino acids values are in fair agreement to that of Bhatty *et al.*[22]

Table 3. Amino acid composition of masoor(%)

Amino acid	Raw masoor	Cooked masoor	% of reference*
Lysine	0.83	0.68	56.83
Histidine	0.64	0.56	–
Arginine	–	–	–
Threonine	0.42	0.28	36.20
Leucine	1.17	1.19	56.00
Phenylalanine	0.96	0.94	69.00
Valine	1.31	0.70	76.35
Alanine	0.58	0.51	–
Tyrosine	0.51	0.23	–

*Egg Albumin

3) Effect of cooking

As a result of cooking the crude protein content of Masoor increased by about 2%. A slight rise in ether extract and crude fiber was also noted. However, significant decline in NFE was observed on cooking. Abu-Shakra *et al.*[24] showed that differences in chemical composition were dependent upon time taken to cook the mature seeds. This was probably due to drastic loss of NFE on cooking. Masoor contains a number of anti nutritional factors and these may be controlled by processing or possibly by plant breeding programs. However, these factors are less important in human diet because of cooking and processing which normally occur before eating.[17] Batra[25] reported that the treatments such as dry heat, autoclaving boiling and soaking resulted in marked decrease in haemaglutinin

activity. Manan *et al*[26] observed that cooking lentils at 100 ℃ for 40 minutes resulted in a considerable improvement in the nutritional quality of lentils grown in Pakistan. Savage *et al*[3] reported that cooking not only destroyed some of the anti nutrients factors but it also allowed some of the tannins to be leached from the seeds. Naheed *et al.*[27] reported that heat treatments applied to legume can improve their texture and palatability and also destroys or inactivate heat labile toxic compounds. It was observed that cooking affected the amino acid profile. Morcos *et al*[28] reported that cooking whole lentils (Masoor) and kernels resulted in slight losses of amino acids, except for tryptophan and lysine which showed slight gains. The differences found between raw and cooked were probably dependent upon the sulphur containing amino acids. Batra[25] reported that dry heat, autoclaving, boiling and soaking treatments resulted in a marked decrease in haemaglutin activity. Boiling in water for 20 minutes was the most economical way of reducing haemaglutin activity.

2. Biological evaluation

The results of biological trial, using different diets are presented in Table 4 and 5.

1) Protein efficiency ratio (PER)

The PER of the diet containing Masoor did not very much on cooking (1.49 vs 1.44). Majeed *et al.*[29] also reported that cooking did not seem to affect the nutritive value of Masoor. However, lower values for PER were reported by Hirwe *et al.*[30] who observed that PER of raw lentils as 0.92 and that of cooked 0.82. The PER of lentil protein in mice was reported as 0.73, which fell well within the large range of 0.1 to 2.17 reported in experiments on rats.[21] Tannous *et al.*[31] reported that PER values were generally higher for legume seeds autoclaved for 5 min than for raw seeds or those after 20 min of autoclaving. The PER of diets containing Masoor was somewhat improved when supplemented with different types of meat up to 1.65%. It was observed that PER, on an average, increased with the increase in the level of supplemental meat. However, in most of the cases, these differences were non-significant statistically.

Table 4. Comparison of experimental diets containing masoor only with standard casein diet

	Diets		
Parameters	Standard	Raw masoor	Cooked masoor
PER	2.08 ± 0.05^{a}	1.49 ± 0.03^{b}	1.44 ± 0.03^{b}
TD	89.48 ± 0.42^{a}	74.59 ± 0.64^{b}	74.37 ± 0.64^{b}
NPU	55.76 ± 0.42^{a}	44.60 ± 0.30^{b}	47.77 ± 0.35^{c}

Means within a row superscripted by different letters are significantly different at $p < 0.05$ level.

2) True digestibility

Like PER cooking did not improve the TD of diets containing Masoor. However Jaffe[32] showed that autoclaving lentils considerably improved the TD from 88.3 to 92.6%. Savage, *et al*[3] reported that TD was improved when raw lentils were compared with cooked and leached lentils. Pak and *et al.*[33] reported that the TD of nitrogen increased only from 80.3 percent for raw to 82.5 percent for cooked. The digestibility of diets containing Masoor increased significantly ($p < 0.05$) when supplemented with different types of meat up to 87.84 percent. The increase in the digestibility corresponded with the increase in the level of supplemental meat, the highest being at 20 percent level of supplemental meat.

3) Net protein utilization (NPU)

It was observed that cooking improved the NPU values of diet containing Masoor (44.6 vs 47.9). Pak *et al.*[33] also reported that NPU increased from 26.5 percent for raw lentils to 33.1 percent for cooked. However, the values reported by them were much lower than that observed in this study. Morcos *et al*[28] reported that rats fed

Table 5. Biological evaluation of experimental diets containing cooked Masoor and different supplementary levels of Poultry, Mutton and Beef

Parameters studied	Kind of meat	Level of supplementation(%)		
		10	15	20
Protein efficiency ratio	Poultry	1.50 ± 0.58^{a}	1.55 ± 0.02^{a}	1.61 ± 0.35^{a}
	Mutton	1.45 ± 0.04^{a}	1.55 ± 0.05^{ab}	1.65 ± 0.05^{b}
	Beef	1.46 ± 0.05^{a}	1.52 ± 0.03^{a}	1.59 ± 0.04^{a}
True digestibility %	Poultry	76.03 ± 0.65^{a}	78.60 ± 0.60^{a}	82.69 ± 0.53^{b}
	Mutton	80.40 ± 0.95^{a}	85.26 ± 0.58^{b}	87.84 ± 0.31^{c}
	Beef	78.43 ± 0.68^{a}	80.45 ± 0.63^{a}	85.58 ± 0.63^{b}
Net protein utilization %	Poultry	48.05 ± 0.60^{a}	49.68 ± 0.48^{a}	49.53 ± 0.89^{a}
	Mutton	47.75 ± 0.58^{a}	48.52 ± 0.53^{a}	49.00 ± 0.71^{a}
	Beef	42.84 ± 0.22^{a}	44.28 ± 0.8^{a}	50.72 ± 0.39^{b}

Means within a row superscripted by different letters are significantly different at $p < 0.05$ level

on diet containing whole raw lentil seeds showed less body weight and low NPU values. Cooking the raw seeds did not improve the nutritive value. Supplementation of different types of meat at different levels also increased the NPU. The NPU was improved to 50.72 percent ($p < 0.05$) when diets containing Masoor were supplemented with 20% level of beef. Improvement in NPUs values was observed when diets were supplemented with meat from 10 to 20 percent levels. Savage *et al*[3] also reported improvement in protein quality by cooking. They further observed significant improvement in the biological value on cooking. Yasmin[34] reported that biological value was improved by supplementation.

It may be concluded from the forgoing discussion that 20 percent level of supplemented meat resulted in the improvement of PER, TD and NPU of Masoor based diets.

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