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Effect of Cooking on Phytic Acid Content and Nutritive Value of Pakistani Peas and Lentils

Fazli Manan,* Tajammal Hussain,* Inteaz Alli† & Parvez Iqbal*

* Department of Agricultural Chemistry and Human Nutrition, Northwest Frontier Province Agricultural University, Peshawar, Pakistan

†Food Science and Agricultural Chemistry Department, McGill University, Macdonald College, Ste. Anne-de-Bellevue, Quebec, Canada, H9X 1C0

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ABSTRACT

The effects of a traditional domestic cooking procedure on the phosphorus/phytate relationship and the nutritional quality of three varieties of Pakistani (a) peas and (b) lentils were investigated. A cooking procedure which involved steeping, followed by boiling, of the seeds resulted in (a) a reduction of considerable amounts of phytic acid from both peas (82% reduction) and lentils (76% reduction), and (b) an improvement in the net protein utilization, true protein digestibility and biological value of the legume seeds. No apparent relationship was observed between the loss of phytate from the seeds and the improvement of nutritional quality which resulted from the cooking procedure.

INTRODUCTION

Peas (*Pisum sativum* L.) and lentils (*Lens esculenta*) are important constituents of the diets of many Asian communities. The crude protein content of these legumes ranges from 20% to 30% (Shekib *et al.*, 1985) and

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is two to three times higher than the crude protein content of cereal grains. Peas and lentils are also good sources of certain essential nutrients, e.g. vitamins and minerals (Wassimi *et al.*, 1977). Nevertheless, the overall nutritional quality of raw (uncooked) peas and lentils is a matter of concern. The relatively low content of the sulphur-containing amino acids (Khan *et al.*, 1977) and the presence of heat-labile anti-nutritional factors (Bressani *et al.*, 1963) in these legumes have been reported. In addition, phytic acid (1,2,3,4,5,6-hexakis dihydrogen phosphate myoinositol), a common storage form of phosphorus in seeds, is also considered to be an anti-nutritional factor. The complexing of phytic acid with nutritionally essential elements and the possibility of interference of phytate with proteolytic digestion have been suggested (O'Dell & de Boland, 1976; Erdman, 1979; Maga, 1982).

Concern for the nutritional quality of the diets of developing countries has resulted in many recent investigations of the quality of locally consumed foods. For example, several publications have dealt with the nutritional quality of Egyptian diets (Gad *et al.*, 1982; Shekib *et al.*, 1985) and of Pakistani diets (Khan & Eggum, 1978, 1979). The present work was conducted to determine the effect of a traditional domestic cooking procedure on the phosphorus/phytate relationship and the overall nutritional quality of Pakistani peas and lentils.

MATERIALS AND METHODS

Materials

Samples of dried seeds of (a) three varieties (Tarnab, Blue Bantum, Pakhewal) of peas and (b) three varieties (VM-25, 9-6, Local) of lentils produced at the Agricultural Research Institute, Tarnab, Peshawar, were obtained. The raw seeds were ground to pass through a No. 35 mesh sieve.

Cooking procedure

The cooking procedure used in the present study was similar to that used in Pakistani homes in NWFP. The raw seeds of peas and lentils were steeped in excess deionized water for 4 h at room temperature. After imbibition, the excess water was discarded. An additional quantity (400 ml) of deionized water was added to the steeped seeds and the mixture was boiled for 40 min. After cooking, the excess water was removed and the cooked seeds were oven-dried (105°C). The cooked, dried seeds were ground to pass through a No. 35 mesh sieve.

Analytical procedures

Samples of the raw and cooked seeds were analyzed for phytic acid using the iron precipitation method of Wheeler & Ferrel (1971). Total phosphorus content was determined using the procedure described by O'Dell *et al.* (1972). Nitrogen content was determined using the macro-Kjeldahl method (AOAC, 1980).

Nutritional evaluation of raw and cooked seeds

The raw and cooked seeds of peas and lentils were evaluated for true protein digestibility (TD), net protein utilization (NPU) and biological value (BV) using the procedure of Miller & Bender (1955). This involved a 10-day feeding trial using 21-day-old albino rats with groups of four rats for each treatment. The protein level of the experimental diets was maintained at 10%.

RESULTS AND DISCUSSION

Table 1 shows the contents of phytic acid (Phy-A), phytate phosphorus (Phy-P), total phosphorus (TP) and crude protein of the raw peas and lentils. It may be recalled that the cooking procedure included a steeping period of 4 h prior to boiling. The phytic acid content of both the peas and lentils decreased during the steeping and cooking processes; the decreases in phytate observed in our study are somewhat higher than those observed by previous workers (Tabekhia & Luh, 1980; Beal & Mehta, 1985) with peas and beans. The Phy-P content of the three varieties of peas decreased by a factor of 5·2 to 5·6 and, in the case of the three varieties of lentils, decreased by a factor of 3·8 to 4·8. It is likely that the decrease in phytic acid content is, at least in part, the result of hydrolysis of phytic acid during the steeping procedure. Phytic acid decrease could have occurred also during the cooking procedure; several workers (de Boland *et al.*, 1975; Reddy *et al.*, 1978; Gad *et al.*, 1982) have reported that a reduction in phytate content results from heating.

A comparison of the phytate content of peas with those of lentils indicates a significantly lower content of phytate in the seeds of lentils. In the lentils, the Phy-P represented 43%–46% of the TP, while, in the peas, the Phy-P represented 64%–66% of the TP (Table 1).

Table 2 shows the NPU, TD and BV of the raw and cooked peas and lentils. These results indicate that, overall, the nutritional quality of the raw peas was higher than that of the lentils. Cooking of both peas and lentils

TABLE 1

Total Phosphorus (TP), Phytic Acid (Phy-A), Phytate Phosphorus (Phy-P) and Crude Protein Contents of Varieties of Raw and Cooked Peas and Lentils

Seeds	*TP* ($g\,kg^{-1}$)		*Phy-A* ($g\,kg^{-1}$)		*Phy-P* ($g\,kg^{-1}$)		*Phy-P* (*% of TP*)		*Crude protein* ($g\,kg^{-1}$)	
	Raw	*Cooked*	*Raw*	*Cooked*	*Raw*	*Cooked*	*Raw*	*Cooked*	*Raw*	*Cooked*
Pea										
Tarnab	3·53	3·53	8·19	1·52	2·31	0·44	65·4	12·5	2·63	2·62
Blue Bantum	3·37	3·38	7·66	1·39	2·16	0·39	64·1	11·5	2·80	2·80
Pakhewal	3·42	3·42	7·93	1·41	2·23	0·40	65·2	11·7	2·49	2·49
Mean	3·44	3·44	7·93	1·44	2·23	0·41	64·9	11·9	2·64	2·64
Lentil										
VM-25	3·31	3·31	5·36	1·34	1·51	0·38	45·6	11·5	2·17	2·16
9-6	4·67	4·68	7·19	1·50	2·03	0·43	43·5	9·2	2·39	2·37
Local	3·89	3·89	5·98	1·57	1·68	0·44	43·2	11·3	2·06	2·05
Mean	3·95	3·96	6·18	1·47	1·74	0·42	44·1	10·7	2·21	2·19

Results are means of three determinations.

TABLE 2
Net Protein Utilization (NPU), True Protein Digestibility (TD) and Biological Value (BV) of Varieties of Raw and Cooked Peas and Lentils

Seed	*NPU* (%)		*TD* (%)		*BV* (%)	
	Raw	*Cooked*	*Raw*	*Cooked*	*Raw*	*Cooked*
Peas						
Tarnab	36·2	46·0	78·6	91·1	46·0	56·0
Blue Bantum	38·7	51·3	82·0	98·2	47·2	54·4
Pakhewal	36·9	48·7	80·8	94·0	45·0	51·6
Mean	37·3	48·7	80·5	94·4	46·1	54·0
Lentils						
VM-25	25·5	44·5	64·3	88·7	40·1	50·2
9-6	28·5	48·7	67·0	90·2	42·5	54·0
Local	26·7	46·9	65·9	89·6	40·5	52·3
Mean	26·9	46·7	65·7	89·5	41·0	52·2

resulted in increased TD, NPU and BV of the seeds. The improvement in overall nutritional quality, as a result of steeping and cooking, was greater in lentils than in peas. Cooking of the three varieties of peas resulted in an increase in the average TD, NPU and BV from 80·5%, 37·3% and 46·1% to 94·4%, 48·7% and 54·0%, respectively. In the case of the three varieties of lentils, the average TD, NPU and BV increased from 65·7%, 26·9% and 41·0% to 89·5%, 46·7% and 52·2%, respectively.

From the results of phytic acid content and the nutritional quality (TD, NPU, BV) of the seeds, it appears that there is little apparent relationship between them. Raw lentils, with an average lower phytic acid content than raw peas, were of lower nutritional quality than raw peas. In addition, there was little apparent relationship between the loss of phytate from the steeping and cooking of the seeds and the improvement in the TD, NPU and BV of the seeds. The lentils, which lost less phytate than the peas, showed greater improvement in the TD, NPU and BV than the peas. The results suggest that water-soluble and/or heat-labile anti-nutritional factors might be more important than phytic acid in affecting the overall nutritional quality of the seeds as measured by TD, NPU and BV. Previous work (Bressani *et al.*, 1963) has established the effect of heat-labile anti-nutritional factors on the nutritional quality of legumes; these workers reported that cooking of the beans destroyed a toxic factor, possibly a trypsin inhibitor, present in the beans. Other researchers (Grant *et al.*, 1982) have reported that toxic lectins present in certain legumes are sensitive to heat treatment and this is greatly improved by soaking of the seeds. Further

research (Grant *et al.*, 1983) on a group of legumes indicated that peas and lentils showed no appreciable lectin-related toxic effect. Nevertheless, these researchers recommended that legume seeds should be fully hydrated and heated at 100°C for 10 min before use.

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