

Effect of antinutritional factors in khesari seeds (*Lathyrus sativus*) on the biological performance of chicks

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Introduction

To meet the protein requirement of the ever growing and predominantly vegetarian human population in India, efforts are in progress in the country to increase pulse production and to make those pulses consumable, which may otherwise adversely affect human health. Pulses constitute a primary source of proteins, add flavour and variety to a well-planned course of meals. These pulses are commonly called dhals and vary in their qualitative composition. Although the people consume pulses in most meals, excessive consumption of some pulses has been reported to result in adverse effects on human health due to the presence of certain anti-nutritional factors. Sometimes the pulses are found to be adulterated either intentionally or unintentionally. Among these adulterants, khesari (*Lathyrus sativus*) is the most important in pulses. In spite of restrictions on khesari cultivation, many poor and marginal people/farmers still grow khesari because it is a hardy crop, requires very little irrigation and other inputs and is resistant to drought and floods. Khesari contains 29-32% protein⁽⁴⁾ but various reports have confirmed that prolonged consumption of this pulse afflicts the central nervous system, characterised by weakness and paralysis of leg muscles and death in extreme cases (neurotoxicity). The causative agent of lathyrism is thought to be the presence of β -N-oxalylamino-L-alanine (BOAA or ODAP), additionally there are other antinutritional factors in khesari such as tannins and trypsin inhibitors.

With this consideration in mind, the present investigation with a local variety of khesari seed was undertaken with the following objectives:

1. To analyse the antinutritional factors.
2. To study the effect of treatments on antinutritional factors.
3. To assess the effect of khesari on the biological performance of chicks.

Material and Methods

Preparation/ procurement of samples:

The seeds of khesari were procured from local farmers, cleaned of dust, dirt or any other foreign material, dried and packed in polyethylene bags.

Because of the presence of antinutritional factors in khesari some treatments were also given for further analysis.

Treatments:

Soaking: khesari seeds were soaked overnight in water at room temperature making sure that all the seeds were completely covered with water.

Autoclaving: khesari seeds were autoclaved for 1 hour at 0.7 kg.cm⁻² pressure.

Chemical analysis:

The following antinutritional factors were studied using standard methods:

Total phenolic compounds/tannins⁽⁷⁾.

Trypsin inhibitor activities⁽⁶⁾.

Animal experiment:

Table 1. Composition of diets used.

Ingredients*	Diets, % vegetable protein replaced by khesari		
	0	25%	50%
Premix (%)	30	22.5	15.0
Khesari (%)	-	11.1	22.2
Maize (%)	32.8	31.1	21.7
Wheat (%)	30.0	28.2	34.0
Fish meal (%)	5.0	5.0	5.0
Di-calcium phosphate (%)	2	2	2
Trace min./ vit. (%)	0.156	0.156	0.156
Total crude protein	22.3	21.9	21.9

*Premix (Ground nut cake, sunflower cake, soya flakes providing 13% crude protein or CP in total), khesari (26.25% CP), maize (9.0% CP), wheat (13.1% CP) and fish meal (48% CP).

To assess the toxic effect of khesari a feeding trial on day old male layer chicks (Anderson Thomson Strain), obtained from Embrocia Hatcheries in Pathankot, was conducted in the Department of Animal Nutrition, CSKKV. Random samples of 7 day old chicks

(according to average body weight) were housed in groups, in brooder compartments and care was taken to feed the chicks on isonitrogenous diets. The diets ⁽²⁾ were prepared using different levels of khesari (0, 25 & 50%; Table 1) and fed to the chicks for 4 weeks.

Results and Discussion

Total phenolic compounds/ tannin contents of the samples analyzed were a maximum in raw khesari (0.96g/100g) followed by soaked and autoclaved seeds (Table 2). Statistically significant differences were observed between the treatments and could be due to the water-soluble nature of these antinutritional factors. The tannin contents present in were observed higher from those found in khesari in other studies ⁽¹⁾. Trypsin inhibitor activities (TIA), commonly present in Leguminosae, have an antinutritional effect. An attempt was made to estimate these inhibitory activities in khesari (treated as well as untreated; Table 2). Maximum TIA was observed in untreated khesari samples (18.61mg/g), in the soaking and autoclaving treatments lower activities were observed (9.61 and 2.63mg/g, respectively), this could be due to the water soluble nature of these protease inhibitors. Mean TIA in advanced *Lathyrus sativus* lines has been found to be 18.16 ± 2.38 mg/g ⁽¹⁾.

Table 3. Observations on physical activities of chicks.

Treatment	Growth	Dysentery/ Diarrhoea	Feathers	Feed intake	Gait
Control	Excellent	No	Normal	Normal	Normal
Khesari (25%)	Good	No	Slightly ruffled	Slightly affected	Normal
Khesari (50%)	Stunted	No	Ruffled	Affected	Hopping

Gain in body weight: The chicks fed on control diet gained maximum weight (225.7 ± 5.2 g) where as the chicks fed on 25% and 50% khesari diets showed lower gain of 150.5 ± 0.2 and 138.9 ± 6.0 g, respectively (Table 4). Neurotoxins, trypsin inhibitors, phenolic compounds etc. may be responsible for the growth retardation in the chicks fed on different levels of khesari. It was also clear from the study that by increasing the concentration of protein in the experimental chick's diet the gain in body weight was reduced as compared to the chicks fed on the control diet.

Feed efficiency ratio (FER): FER represents the weight gain of an animal per weight of feed consumed under specific conditions (Table 4). Determination of FER in experimental subjects fed on two levels (25% and 50%) of khesari, (Table 4) revealed that the FER values were the lowest for group fed on khesari diets and this difference could be due to the poor digestibility of the increased khesari concentration in the diet.

Changes in physical activity: In Table 3 some effect can be seen on the chicks fed 25% and 50% khesari. The group fed on 25% level of khesari showed good growth with no symptom of dysentery/ diarrhoea and a normal gait, however, the feathers were found to be slightly ruffled and feed intake slightly reduced. The group fed 50% khesari showed stunted growth with no symptoms of dysentery/ diarrhoea and a hopping gait was observed, the feathers were found to be ruffled and feed intake reduced. A few birds showed paralysis of legs (unable to bear weight on legs), hopping gait, lack of coordination (Fig. 1) in contrast to the control birds. The reasons for this kind of behaviour may be due to the neurotoxin and other antinutritional factors present in the khesari as reported previously ⁽³⁾.

Table 2. Antinutritional factors (tannins and trypsin inhibitor activities or TIA) in khesari seed treated in various ways.

Treatments	Tannins (g/100g)	TIA (mg/g)
Raw	0.96	18.61
Soaked	0.72	9.61
Autoclaved	0.52	2.62
LSD (P<0.05)	0.04	0.88



Fig. 1. Affected legs of chickens fed 50% khesari.

Protein intake: Protein intake for control diet was maximum (114.0 g) followed by 93.2 g and 89.9 g in case of 25% and 50% khesari respectively. From Table 4 it can be concluded that chicks consumed less protein level in case of 50% khesari because of the poor digestibility owing to the presence of neurotoxins and other antinutritional factors.

Protein efficiency ratio (PER): PER is the weight gain of an animal per gram of protein consumed under certain specific conditions. PER in the chicks was 1.62 and 1.54 in case of 25% and 50% khesari diets, respectively (Table 4), however control fed birds

showed the maximum value (1.98). It has been previously shown that ⁽⁵⁾ broiler chickens fed on 37% raw khesari seed showed decreased PER because of the presence of antinutritional factors.

Digestibility coefficient: Mean digestibility coefficient for chicks fed on control diet was found to be 79.7, the values for chicks fed on 25% and 50% khesari diets were significantly ($P < 0.05$) lower (71.9 and 68.6 respectively).

Table 4. Biological performance of experimental chicks fed khesari at varying proportions of the diet.

Parameters	Diet			LSD ($P < 0.05$)
	0% khesari	25% khesari	50% khesari	
Average initial body weight (g)	27.2 ± 0.22	27.2 ± 0.00	27.2 ± 0.22	-
Average gain in body weight (g)	225.7 ± 5.2	150.5 ± 0.2	138.9 ± 6.0	8.6
Feed efficiency ratio (FER)	0.44	0.36	0.34	0.014
Protein intake	114.0	93.2	89.9	-
Protein efficiency ratio (PER)	1.98	1.62	1.54	-
Mean digestibility coefficient	79.7	71.9	68.6	4.9

Conclusions

Because of the presence of antinutritional factors such as trypsin inhibitors, tannins and some neurotoxins; it was attempted to analyse trypsin-inhibitor and tannin contents as well as study different parameters of biological significance. Trypsin inhibitor activities (TIA) and tannin contents were greatest in raw seeds of khesari and lowest after autoclaving, with soaking in water intermediate.

The biological studies involving different levels (25 and 50%) of the khesari, isonitrogenous diet was fed to each group of chicks *ad libitum* in an *in vivo* study. Chicks fed on khesari revealed stunted growth, ruffled feathers, abnormal gait and significant reductions in the following: feed efficiency ratio (FER), gain in body weight, protein efficiency ratio (PER), digestibility co-efficient, protein intake in comparison to the chicks fed on the control diet.

The effects of antinutritional factors cannot be separated from each other and BOAA was not measured. However, it can be concluded that the various antinutritional factors have probably contributed to the poorer performance of chicks fed khesari. The abnormal gait exhibited is consistent with known effects of BOAA.

It has therefore been concluded from the study on chicks that the local variety of khesari could adversely affect human health if consumed extensively.

References

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