EFFECT OF FEEDING A LATHYRUS TOXIN ON EGG WEIGHT, EGG PRODUCTION AND EGG MALFORMITY IN LAYING CHICKEN

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Summary

Beta-aminopropionitrile (BAPN)-a *Lathyrus* toxin was fed to laying chicken to investigate effects on egg weight, production and malformity. Two feeding trials were conducted where the levels of BAPN varied from 0.1 to 0.6 g per kg diet. The responses with regard to egg weight, egg production and the incidence of malformed eggs due to varying concentrations of the toxin were recorded and the results on weekly changes in these important variables were evaluated by plotting graphs. The results showed that there were increasing trends in egg weight and egg shell abnormalities and a decreasing trend in egg production as the dietary level of BAPN was increased indicating that the responses of layers were dose dependent. The effects on egg weight, egg production and egg malformity disappeared following withdrawal of the toxin from the diets.

(**Key Words**: BAPN, Egg Weight, Egg Production, Egg Malformity, Basal Period, Supplementation Period, Post-supplementation Period)

Introduction

Beta-aminopropionitrile (BAPN) is a toxin present in seeds of certain *Lathyrus* plants namely *Lathyrus odoratus* (sweet pea), *L. pusillus* (singletary pea), *L. hirsutus* (caley pea) and *L. roseus*. The seeds contain 23 to 27 percent protein (Lewis et al., 1948) and are grown in many countries of the world particularly Algeria, Bangladesh, Ethiopia, France, India, Italy and Spain. They are considered as low cost protein source feed ingredients for poultry where scarcity of protein particularly of animal origin exists (Chowdhury, 1988; Chowdhury, 1990a, 1990b, 1991). In spite of this advantage, the problem of utilizing *Lathyrus* seeds is their toxic effects on egg weight, egg production and egg shell. A number of recent reports indicated that heavier eggs, abnormal in shape and shell texture are frequently obtained when BAPN (*Lathyrus* toxin) was included in the diet of layers and that effects on both egg weight and egg shell were found with or without a reduction in egg production rate (Chowdhury, 1988; Chowdhury and Davis, 1988; Chowdhury and Davis, 1989; Chowdhury, 1990a, 1990b). Information is also available in those literature that these effects on layer performance are reversible.

Although a great deal of work concerning the toxicity of *Lathyrus* toxin in laying chicken has been published by this time, little information is available with regard to the trends of the problem particularly the upward and downward trends in egg weight, egg production and egg malformity resulting from inclusion of the toxin in the diet at different concentrations. The study presented in this paper was therefore undertaken to look more closely into the weekly changes in the egg weight, egg production and egg malformity of layers following ingestion of toxin treated diets and also upon withdrawal of the toxin from the diets.

Materials and Methods

Experiment 1–Feeding BAPN at low levels (0 to 0.3 g/kg diet)

Four treatment diets which contained either 0, 0.1, 0.2 or 0.3 g BAPN/kg were prepared. BAPN was added to the control diet as mono-beta-aminopropionitrile fumarate. In order to calculate the active constituents, the stated values

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should be adjusted in proportion to its relative formula weight multiplying by 0.546. All diets were made isocaloric and isonitrogenous in addition to furnishing an equal amount of calcium and phosphorus content in each kg of mash. The detailed composition of the control diet is available in a previous communication (Chowdhury, 1990b). Forty-eight pullets aged 20 weeks were selected and randomly distributed into 4 treatment groups. The birds were housed in individual laying cages and each pullet was considered as an experimental unit.

The 20-week experimental period was divided into three phases. During the first phase, all birds were adjusted to the new management condition for 2 weeks by feeding only the control diet. This period was termed as basal period. The second phase was started at 22 weeks of age during which time all groups except the control group were fed different BAPN containing diets at the levels already stated. This period was termed as supplementation period and continued for 15 weeks. After that toxin from respective test diets was withdrawn and birds belonging to all treatment groups were maintained on a control diet. The duration of this last phase was only 3 weeks. This was termed as post-supplementation period. The birds were individually fed and feeding and watering were done *ad libitum*. Rearing was done under a 17 hr lighting programme. Eggs were collected every day in the morning between 10 a m and 12 noon. All eggs including those which were broken and/or escaped through cage floors due to uncontrollable factors were recorded. Eggs collected on each day were considered as having been formed during previous 24 hours. Egg production data were transformed into hen day per cent. Weight of eggs was taken individually to the nearest 0.01 g. The weights of broken and lost eggs were considered as being averages of the remaining eggs laid in that week. In this way, total egg weight was calculated for each bird for every week and divided by the total number of eggs laid at that week to determine average egg weight. Records of the number of malformed eggs and soft-shelled eggs were kept daily and expressed as percent of total eggs produced on weekly basis. The experiment was designed in a randomized block design and weekly data collected for each variable were subjected to analysis of variance following Steel and Torrie (1980). The differences between treatments were accepted as real when probability was found to be 0.05 or better. Least significant difference (lsd) was calculated where treatments showed a significant difference. Graphs were plotted by a computer using treatment means.

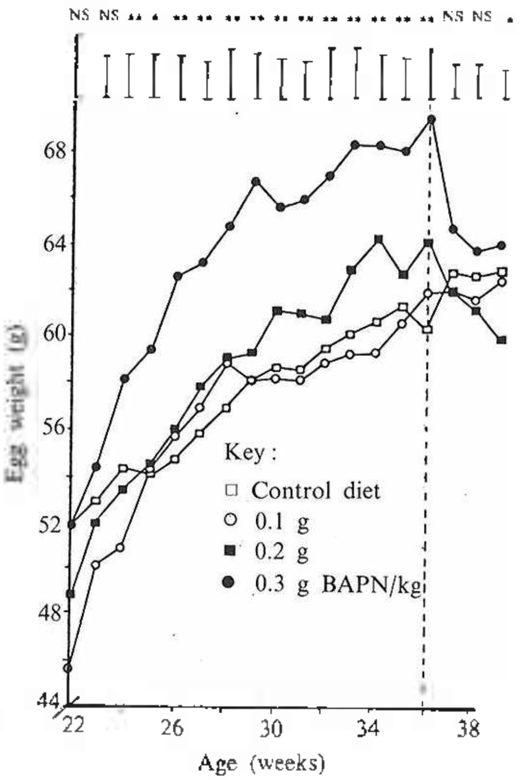
Experiment 2–Feeding BAPN at high levels

Five treatment diets were prepared to contain either 0, 0.3, 0.4, 0.5 or 0.6 g BAPN/ kg of which 0.3 g BAPN/kg served as BAPN control. Thirty laying hens aged 57 weeks were selected and randomly divided into 5 treatment groups with 6 birds on each treatment. The duration of the feeding trial was 15 weeks which was divided into three phases of 5 weeks each: basal period, supplementation period and post-supplementation period. The control diet was fed to all the experimental birds during the basal period and post-supplementation period. During the supplementation period, one group was fed the control diet while the other four groups the four different diets containing the toxin at the levels stated. Eggs showing all sorts of shell abnormalities were considered as malformed eggs.

Other routine procedures, methods of record keeping and statistical analyses of data were similar to those already described during experiment 1.

Results

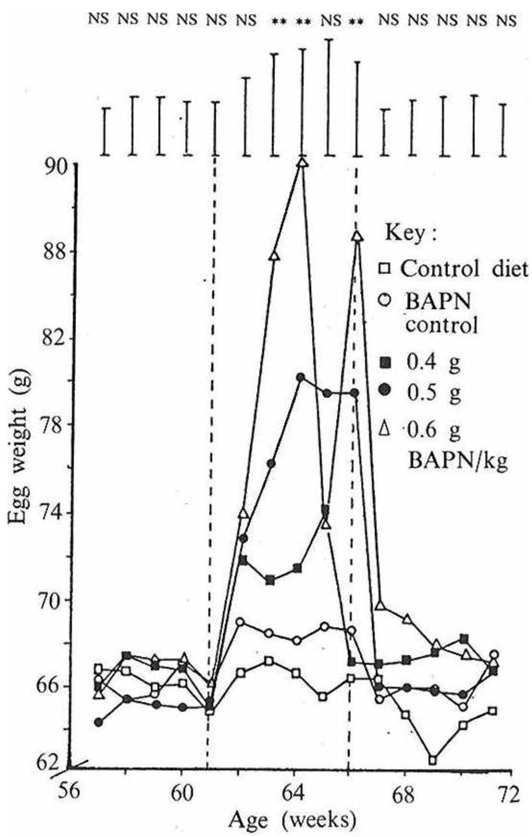
Figure 1 shows weekly changes in egg weight of the experimental birds in experiment 1 during the supplementation period and the post-supplementation period. The results obtained during the basal period was not included here because, most of the pullets did not commence laying at that time. The figure indicates that the birds which received the highest level of BAPN(0.3 g/kg) in the diet started to lay big sized eggs in comparison with control immediately after feeding such diet and followed more or less the same trend throughout the supplementation period. Pullets fed 0.2 g/kg diet showed a little increase after three weeks of supplementation but for all BAPN treated groups the peak increase in egg weight was at the last week of the supplementation period. During the post-supplementation period, this increase in egg weight was



Weeks 22 – 36 = supplementation period
Weeks 36 – 39 = post-supplementation period

The verticle bars at the top of the figure depict SED values.
NS : non-significant;
* : $p < 0.05$
** : $p < 0.01$

Figure 1. The changes n weekly egg weight caused by low dietary levels of BAPN



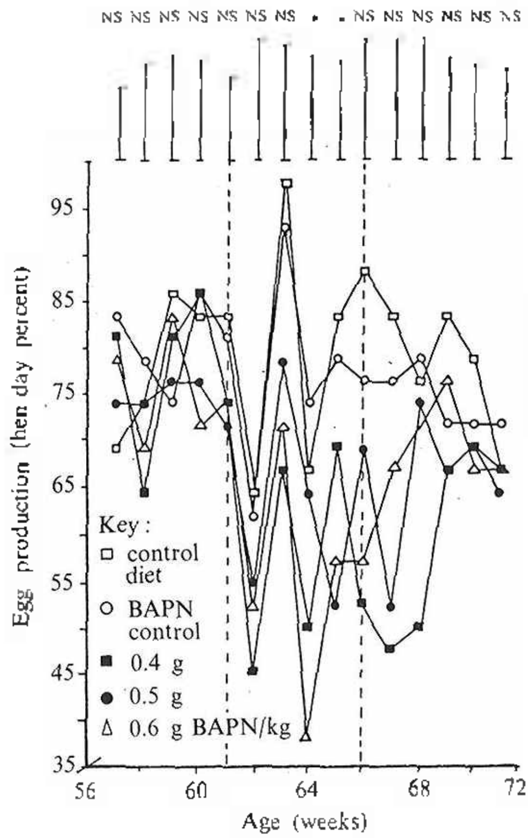
Weeks 57 – 61 = basal period
Weeks 61 – 66 = supplementation period
Weeks 66 – 71 = post-supplementation period

The vertical bars at the top of the figure depict SED values.
NS: non-significant
**: $p < 0.01$

Figure 2. The changes in weekly egg weight of hens fed high cietary levels of BAPN

substantially decreased due to withdrawal of toxin from the diets. This decreasing trend in weight continued for subsequent two weeks for the highest level and for the whole supplementation period in the 0.2 g BAPN receiving group. The changes in weekly egg weight due to feeding BAPN at higher levels (0.3 g/kg or more) are shown in figure 2. In agreement with experiment I, the birds respond quickly upon ingestion of BAPN diets and egg weight started to increase from the first week of supplementation and followed the same trend throughout the same period. The exception to this trend within the supplementation period was obtained for the group that received the highest level (0.6 g/kg) in the fourth week and for 0.4 g/kg level group in the fifth week.

In experiment I, the egg production data showed no significant difference for any of the week during the supplementation period. When the level of BAPN was increased above 0.3 g/kg in experiment 2, the weekly analysis of data showed a depressing effect of BAPN on egg production. Figure 3 shows the effect of BAPN

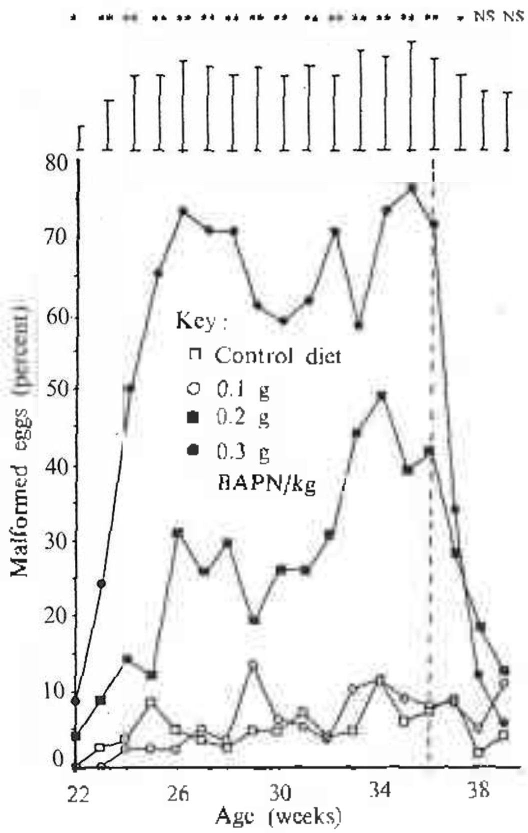


The vertical bars at the top of the figure depict SED values.

NS : non significant;
* : $p < 0.05$

Weeks 57 – 61 = basal period
Weeks 61 – 66 = supplementation period
Weeks 66 – 71 = post-supplementation period

Figure 3. The efffect of high dietary levels of BAPN on the egg production of laying hens



Weeks 22 – 36 = supplementation period
Weeks 36 – 39 = post-supplementation period

The vertical bars at the top of the figure depict SED values.
NS: non-significant;
*: $p < 0.05$, **: $p < 0.01$

Figure 4. The weekly production of malformed eggs from pullets fed low dietary levels of BAPN

containing diets on the egg-laying pattern. There was no difference in egg production performance during the basal period. During the first two weeks of supplementation period, week to week production varied widely while within week variation among treatments was non-significant. It was only during the third and fourth week of supplementation that significant differences ($p<0.05$) between treatments were obtained. Upon withdrawal of BAPN from the diets, it took two weeks to improve egg production. Egg production at the third week and subsequent of the post-supplementation period was comparable not only among treatments but also almost with that of the performance of the basal period.

Figure 4 shows weekly production of malformed eggs during experiment 1 while that of experiment 2 already appeared in a previous communication (Chowdhury, 1990b). It is clear from figure 4 that birds which received 0.2 and 0.3 g BAPN/kg diet showed more or less upward trends in the production of malformed eggs throughout the supplementation period, the peak production being 49 and 79 percent of total eggs produced respectively during 13th and 14th weeks of supplementation for those two groups. The incidence of malformed eggs was substantially decreased as soon as BAPN was withdrawn from the diets.

Discussion

The exception to increasing trend in egg weight as observed during the fourth and fifth week of supplementation respectively for 0.6 and 0.4 g/kg groups has probably resulted from the production of soft-shelled eggs of these groups most of which were either broken or lost through cage floors and therefore could not be weighed. This is quite logical since the remaining soft-shelled eggs from all treated groups were found to be larger in size. In spite of the difficulty encountered with those two groups in those two weeks in particular, the results on egg weight seemed to be quite clear and it could be said that higher the level of supplementation, the larger the egg size. Like experiment 1, a substantial decrease in egg weight was observed for all BAPN fed hens in experiment 2 and that was also immediately after the withdrawal of toxin from the diets.

It appears from the results on egg weight that the inclusion of BAPN in the diet increases the size of the eggs and that this effect on egg weight is dose dependent. Although early workers (Naber and Sunde, 1965) reported the non effect of BAPN on the size of the eggs, considerable evidence (Sparks et al., 1986; Chowdhury and Davis, 1988; Chowdhury, 1990a, 1990b) appeared during the recent years which supported the results of the present study. In agreement with the results of the present study, those researchers quite agreed that the effect of BAPN on egg weight is reversible and that the egg weight is increased due to an increase in the amount of thin albumen. The detailed mechanism as to why and how egg wight is increased is available in the report of Chowdhury and Davis (1988).

The downward and upward trends in egg production as observed respectively in the first and second week of supplementation were probably not due to treatment effect. The results on egg production clearly indicate that the *Lathyrus* toxin has an ability to inhibit egg-laying. Of course, this was again found to be dose dependent. Barnett et al. (1957) also observed a depressing effect of BAPN on egg production from 0.3 g/kg or higher levels of inclusion. Recently, Chowdhury and Davis (1989) and Chowdhury (1990b) obtained similar results during a supplementation period of 4 and 5 weeks respectively but none of them reported weekly trend in the egg production pattern of layers. Bannister et al. (1971) conducted a series of experiment using semicarbazide (SC) at high levels (0.5 g/kg or more) and showed the detrimental effects on egg production. The compound SC is a lathyrogen almost similar to BAPN in properties (Padmanaban 1980; Roy, 1981, Chowdhury, 1990a, Chowdhury, 1991). Chowdhury (1990c) was the first to report the weekly trend in the egg production pattern of laying hens due to feeding of SC. Now, the questions are: why and how the egg production is reduced in hens fed lathyrogens? The answers to the questions are available in the work of Chowdhury and Davis (1989). They gave a detailed account about the changes in the ovaries of laying birds resulting from BAPN and SC intoxication. They showed that BAPN caused a reduced growth rate of ovary and SC caused the atresia of large yolky follicles resulting in a reduction in egg production. Photographs are also available in support of these results (Chowdhury and Davis, 1989; Chowdhury, 1990a).

The incidence of malformed eggs due to BAPN intoxication was in agreement with the results of previous workers (Barnett et al., 1957; Chowdhury and Davis, 1988; Chowdhury, 1990 b). The nature of egg malformity together with their photographs is available in a recent communication (Chowdhury, 1990b). It was observed in this study that the egg malformity increased with an increase in the level of inclusion. Earlier studies (Barnett et al., 1957; Chowdhury, 1990b; Chowdhury, 1991) also supported this result. It was clear that egg deformity arises immediately after the ingestion of the toxin treated diets whereas the effect disappears more gradually.

The results of the feeding experiments suggest that the toxicity of lathyrogen is a factor of concern so long it remains in the diet but such intoxication fails to produce any long lasting or permanent effect on the performance of laying birds at least at the levels tested in this study. Thus the effects of *Lathyrus* toxin on layers are reversible which is in agreement with the observations of the several workers (Barnett et al., 1957; Chowdhury, 1990a, 1990b, 1991).

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