

NUTRITIONAL VALUE OF RAPESEED MEAL FOR BROILER CHICKS AS INFLUENCED BY GAMMA IRRADIATION TREATMENTS

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A 5-week feeding trial was conducted on day-old broiler chicks to study the effect of incorporating radiation treated (5kGy) and untreated control rapeseed meal (RSM) in the diet on their performance. Differences among different groups regarding total feed intake per bird, total weight gain per bird and final weight per bird were statistically non-significant. It was clear from the results that, although non-significant, feed consumption was maximum in 5 and 10 kGy groups, indicating some taste improvement, which, however, was not paralleled by a concomitant increase in weight gain and, consequently, the feed to gain ratio was maximum with 5 kGy diets. Data regarding dressing percentage showed minimum value for 10-kGy group, while values observed for control, 5 kGy and standard group were comparable to each other (56 to 57%). Values noted for heart weight ranged from 0.58g/100g of body weight (10kGy group) to 0.67g/100g of body weight (5kGy group), Liver weight ranged from 2.09g/100g body weight (control and 10kGy group) to 2.44g/100g body weight (5 kGy group) and gizzard weight ranged from 1.31g/100g of body weight (10 kGy group) to 1.61g/100g of body weight (5 kGy group). It can be concluded from the study that irradiation of rapeseed meal enhanced its nutritional value in terms of feed consumption and final weight per chick. Irradiation of the meal resulted in sizable reduction in its glucosinolate contents.

Keywords : Gamma irradiation, Poultry feed, Rapeseed, Nutrition, Broiler chicks

1. Introduction

The non-availability of locally produced soybean and soybean meal in substantial amounts and with cheaper rates, compels the local poultry feed producers to use combinations of different feed concentrates as protein source. These commonly include fish-meal, meat meal, blood meal, corn gluten of different protein concentrations etc. They are not only very costly, but also unsafe, both hygienically and nutritionally. This puts immense pressure on the local feed resources and suggest a search for cheaper protein concentrates which can be easily available in the local market, and will be nutritionally safe.

Rapeseed as an oilseed crop ranks first in area and production among the oilseed crops in Pakistan [1]. It ranks third in the world production of other oilseed crops [2]. As an agricultural product rapeseed is important for its oil and protein contents. The seeds contain about 40 % oil and on extraction of oil yield a meal with about 38 to 43 % protein. The protein of rapeseed has a well-

balanced amino acid profile and in terms of several essential amino acids supplements favourably the protein from cereals.

The meal left after the extraction of oil has a protein content of upto 50%. Its use is however complicated by several anti-nutrients, the most prominent of them being the glucosinolates. These are sulphur rich compounds found in all members of the *cruciferae* family. Their hydrolysis products hamper the normal functioning of thyroid gland, resulting among other effects, in decreased levels of thyroid hormones production. These hormones are required to control the normal running of metabolism.

Although genetic manipulations have introduced much change in the chemical composition of rapeseed through reduction in erucic acid and glucosinolates [3]. These antinutrients have not yet been totally removed. These are also not the only factors detracting from the nutritional worth of rapeseed. Phytates present in the rapeseed meal cause the binding of divalent

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minerals and some proteins [4]. The phenolic compounds have their own effects, the most prominent and thoroughly investigated being the egg taint or the fishy odour in the eggs of brown-shelled-egg-layers.

Situation in Pakistan in this regard is different. Bulk of the rapeseed and hence of rapeseed meal (RSM) is that of high glucosinolate-varieties. A possible alternative to the breeding approach can be a technological processing method capable of removing the glucosinolates from rapeseed meal. Several methods have been proposed in this connection e.g. ammoniation, autoclaving, changes in desolventisation conditions, dehulling etc. each with its merits and demerits. The situation necessitates search for a suitable method, which can also be adopted on commercial scale. Irradiation treatment of rapeseed meal brings about some beneficial changes like reducing the contents of glucosinolates [5] and phytic acid [6]. Biosynthesis of ascorbic acid in irradiated germinating seeds has also been higher than the unirradiated controls [7]. This treatment has also been reported to break the macromolecules of protein and carbohydrates, resulting in their enhanced bioavailability.

A series of experiments [8-18] therefore, were conducted to explore the possibilities and limitations of including rapeseed meal in the broiler ration under the feeding system prevalent in Pakistan, and to study the effects of different processing techniques on its nutritional value for broiler chicks. The present paper reports the data of our experiment to determine the nutritional value of rapeseed meal for broiler chicks as influenced by gamma irradiation treatments

2. Materials and Methods

2.1. Material

Rapeseed of commercial high glucosinolate (60.85 $\mu\text{mol/g}$) variety Pak-Cheen was obtained from the Mutation Breeding section of the Nuclear Agriculture Division of Nuclear Institute for Food and Agriculture (NIFA) Peshawar.

2.2. Processing

2.2.1. Irradiation treatment

The seeds were given gamma irradiation treatment (5.0 and 10.0 kGy doses) in a research irradiator (Issledovatel, USSR) at Nuclear Institute for Food and Agriculture, Peshawar. The dose rate

of the radiation source at the time of irradiation was 1.0 kGy per hour.

2.2.2. Oil extraction

Crushing of the seeds and extraction of oil was conducted according to the standard procedures [2]. The seeds of control as well as irradiated samples were crushed to fracture their fibrous coat and rupture the oil cells. The crushed seeds were then pre-pressed to reduce the oil contents from above 40% to about 23% and compress the material into large cake fragments. These fragments were then broken by hand and extracted with petroleum ether (boiling point 40°C) to remove the residual oil. The rapeseed meal (RSM) left after extraction was used in this experiment. The control and treated rapeseed meal samples were analysed for their amino acid contents using the LKB 4101 (Biochem, UK) amino acid analyser. Glucosinolate contents were determined in the meal by the method of [19].

2.2.3. Chick bioassay

A feeding trial of 5 week duration was conducted on day-old broiler chicks to study their performance on diets containing control or irradiated RSM at 10% level. The experiment was conducted in the poultry shed of Nuclear Institute for Food and Agriculture (NIFA), Peshawar. Group size was 8 birds per group and replicated three times. Cages constructed for this purpose were of size 120 x 60 x 60 cm, with wooden floor and steel wire walls. Temperature and lighting were maintained and altered according to the recommendations of the supplier of the broiler chicks. Saw-dust was used as litter.

The treatments were;

1. Standard, having no rapeseed meal,
2. Control, having 10% untreated rapeseed meal in the diet,
3. Rapeseed meal irradiated at 5 kGy dose and included in the diet at 10% level, and
4. Rapeseed meal irradiated at 10 kGy dose and included at 10% level in the diet.

Since the irradiation treatments did not change the Kjeldahl nitrogen content, all RSM-diets would have the same composition as shown in the relevant column of the Table 3. Rapeseed meal was included in the diet at the expense of other protein concentrates. All diets were adjusted to provide almost similar protein and energy. Data on

Table 1. Effects of irradiation treatments on the amino acid profile (%) of rapeseed meal.

| Amino Acid | Control | Irradiation 5kGy | Irradiation 10kGy |
|---------------|---------|------------------|-------------------|
| Aspartic acid | 3.12 | 2.60 | 2.41 |
| Threonine | 1.29 | 1.35 | 1.17 |
| Serine | 1.43 | 1.49 | 0.72 |
| Glutamic acid | 2.03 | 2.03 | 1.80 |
| Proline | 3.51 | 2.46 | 2.15 |
| Glycine | 1.78 | 2.39 | 1.94 |
| Alanine | 1.53 | 2.14 | 1.46 |
| Cystine | 0.32 | 0.23 | 0.21 |
| Valine | 1.38 | 1.59 | 1.67 |
| Methionine | 0.70 | 0.50 | 0.65 |
| Isoleucine | 1.31 | 2.01 | 1.69 |
| Leucine | 2.55 | 3.09 | 2.38 |
| Tyrosine | 1.96 | 1.20 | 1.39 |
| Phenylalanine | 1.98 | 1.94 | 1.24 |
| Histidine | 3.16 | 1.39 | 2.76 |
| Lysine | 2.30 | 1.16 | 2.01 |
| Arginine | 2.22 | 2.93 | 2.70 |

Table 2. Effect of irradiation on the total glucosinolate content of rapeseed meal.

| Treatment | Total Glucosinolates ($\mu\text{mol/g}$) | Reduction (%) |
|---------------------|--|---------------|
| Control - untreated | 60.8 | 0.0 |
| Irradiation-5 kGy | 55.9 | 8.1 |
| Irradiation-10kGy | 39.13 | 35.6 |

^a Expressed as sinigrin equivalent

weight record, feed consumption and weight gain were noted weekly for duration of 5 weeks and calculated on per chick basis. Feed to gain ratio and weekly gain in weight were calculated from these data. At the end of the experiment the chicks were slaughtered and dressed and their weight was taken to calculate dressing percentage in each group. In addition to this, organ weights (liver, heart and gizzard) were also recorded and reported as g/100g of body weight. Data so obtained was subjected to statistical analysis (ANOVA) using the computer CO-STAT software package.

3. Results and Discussion

3.1. Effects on amino acid profile

The amino acid profile of untreated control rapeseed meal in comparison to that of irradiated

rapeseed meal is given in Table 1. The different amino acids are variously influenced by different irradiation treatments. The amino acids of special interest in connection with poultry feeding are methionine and lysine.

As can be noted from the data, methionine content was 0.7% in untreated control rapeseed meal sample. Irradiation treatment resulted in reduction of this amino acid and was 0.50 to 0.65% in 5 and 10kGy samples, respectively. Lysine content also decreased from 2.3 to 1.16 and 2.01% with these treatments, respectively.

3.2. Glucosinolate contents

As can be seen from Table 2, the glucosinolate contents of control meal sample were 60.8 $\mu\text{mol/g}$. Irradiation treatments resulted in reduction in this

Table 3. Composition of the experimental diets

| Ingredients (%) | Experimental Diets | |
|---------------------------|--------------------------------|---|
| | Standard diet (Without RSM) | RSM- diet (Control and irradiated) *** |
| Wheat | 28 | 30 |
| Maize | 25 | 22 |
| Rice polishings | 5 | 5 |
| Wheat bran | 5 | 5 |
| Fish meal | 7 | 6 |
| Blood meal | 3 | 3 |
| Cotton seed cake | 8 | 0 |
| Corn gluten | 8 | 7 |
| Meat meal | 3 | 5 |
| RSM (rapeseed meal) | 0 | 10 |
| Molasses | 6 | 5 |
| Dicalcium phosphate | 1 | 1 |
| Lime stone | 1 | 1 |
| Total | 100 | 100 |
| Vitamin-minerals Premix * | 12.5g/5kg | 12.5g/5kg |
| Protein % (assayed) | 21.31 | 21.51 |
| ME Kcal/kg (calculated) | 3419 | 3409 |
| Calcium % | 1.24 | 1.42 |
| Phosphorous % | 0.94 | 1.02 |
| Available Phosphorous % | 0.64 | 0.70 |

* The Vitamin-Mineral mixture provided per kg of the diet :- 11022 iu Vitamin A, 1100 iu vitamin D3, 11 iu vitamin E, 2.25 mg Vitamin K, 2.25 mg thiamine, 4.5 mg riboflavin, 14.25 mg pantothenic acid, 32.5 mg nicotinic acid, 4.5 mg pyridoxine, 1.25 mg folic acid, 0.25 mg biotine, 1322.5 mg choline, 55 mg Mn, 550 mg Mg, 87.5 mg Fe, 11mg Cu, 44 mg Zn, 0.25 mg Se, and 0.25 mg I.

** Metabolizable energy

*** Glucosinolates $\mu\text{mol/g}$ content of the feeds (calculated) were Control = 6.08, Irradiated 5 kGy = 5.59 and Irradiated 10 kGy = 3.91.

**** The calculated lysine and methionine contents of standard, control, 5kGy diet and 10kGy diet were 1.08 and 0.51, 1.16 and 0.50, 1.04 and 0.48, and 1.13 and 0.49%, respectively.

anti-nutrient. The reduction was 8.1% with 5kGy dose and 35.6% with 10kGy dose, indicating some degree of dose dependency, although the reduction does not seem to have been in a linear fashion.

3.3 Chick bioassay

Differences among different groups regarding total feed intake per bird, total weight gain per bird and final weight per bird were statistically non-significant (Table 4). A comparison of the effects of

Table 4. Performance of broiler chicks fed on diets containing irradiated rapeseed meal.

| Groups | Feed Intake (g Chick ⁻¹) | Weight Gain (g Chick ⁻¹) | Final Weight (g Chick ⁻¹) | Feed : Gain Ratio | Dressing Percentage |
|----------|--------------------------------------|--------------------------------------|---------------------------------------|-------------------|---------------------|
| Standard | 2566 | 1174 | 1251 | 2.19 | 57.5 |
| Control | 2392 | 1145 | 1224 | 2.09 | 57.6 |
| 5 kGy | 2630 | 1108 | 1187 | 2.38 | 56.3 |
| 10 kGy | 2628 | 1241 | 1318 | 2.12 | 47.1 |
| CV | 4.39 | 4.82 | 4.44 | 5.93 | 9.25 |

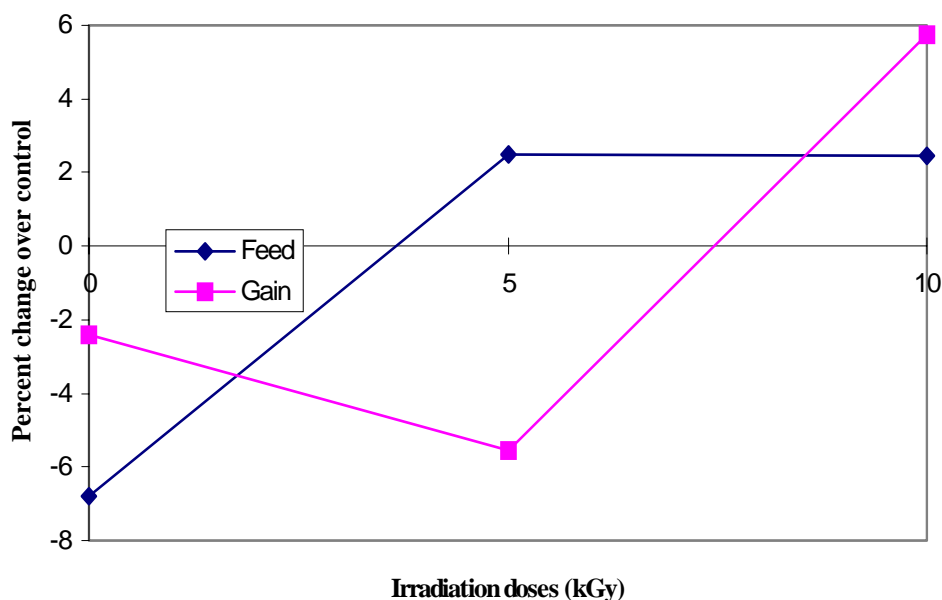


Figure 1. Percent changes in feed consumption and weight gain per chick due to control and irradiated RSM in the diet

different treatments on these parameters, in terms of percent change over control, is depicted in Figure 1. It is clear from the results that, although non-significant, feed consumption was maximum in 5 and 10 kGy groups, indicating some taste improvement, which, however, was not paralleled by a concomitant increase in weight gain and, consequently, the feed to gain ratio was maximum with 5 kGy diets. Data regarding dressing percentage (Table 5) showed minimum value for 10 kGy group, while values observed for control, 5 kGy and standard group were comparable to each other (56 to 57%). Organ (liver, heart and gizzard) weights were reported relative to the total body weight (g/100g of body weight) instead of absolute

value to account for the difference due to body size. Values noted for heart ranged from 0.58g/100g of body weight (10kGy group) to 0.67g/100g of body weight (5kGy group), Liver weight ranged from 2.09g/100g body weight (control and 10kGy group) to 2.44g/100g body weight (5 kGy group) and gizzard weight ranged from 1.31g/100g of body weight (10 kGy group) to 1.61g/100g of body weight (5 kGy group).

Gamma Irradiation has been frequently reported to have bearing on the nutritional quality of food and feed items. It improves the utilization, digestibility and absorption of large polymeric molecules of proteins and carbohydrates by

Table 5. Organ weights (% of body weight) of broiler chicks fed on diets containing irradiated rapeseed meal

| Groups | Heart | Liver | Gizzard |
|----------|-------|-------|---------|
| Standard | 0.61 | 2.18 | 1.49 |
| Control | 0.64 | 2.09 | 1.43 |
| 5 kGy | 0.67 | 2.44 | 1.61 |
| 10kGy | 0.58 | 2.09 | 1.31 |
| CV | 6.20 | 7.52 | 8.55 |

breaking these into small, easily digestible chains [20, 21]. Several reports have also indicated its beneficial effects on some antinutritional factors like trypsin inhibitors and phytates in some grains [22-24]. This treatment has also been used to reduce the microbial load of poultry feeds [5]. In the present experiment rapeseed meal was irradiated at two doses and included (10%) in the ration of broiler chicks to study its effects on growth performance of chicks. The results are explainable both in the light of results of our previous experiment [14] and also on the basis of glucosinolate contents of the diets. In the previous experiment we have seen that rapeseed meal from this variety (Pak-cheen) can be safely incorporated upto 15% in the broiler's diet (without any adverse effects on the growth performance). Irradiation of the rapeseed meal reduced its glucosinolate contents (Table 2). Consequently the contents of glucosinolates in the control (6.08 $\mu\text{mol/g}$), 5kGy irradiated (5.5 $\mu\text{mol/g}$) and 10kGy irradiated group diet (3.9 $\mu\text{mol/g}$) were not sufficient to cause reduction in the performance of broiler chicks [25]. Again the shorter length of the experiment did not allow the glucosinolates to exert adverse effects to any mentionable extent. The reason, as to why differences among different groups were non-significant, may be the fact that RSM was used only at 10% level in the diets. Therefore, even if radiation treatment has brought some favourable nutritional changes in RSM, it may not have been translated into significant edge in the performance of the consuming chicks.

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