Effects of dehulling and dry heating on the nutritional value of rapeseed meal for broiler chicks

A. Zeb¹, A. Sattar¹, A. B Shah¹, N. Bibi¹, G. Thinggaard² and U. ter Meulen²

Introduction

The non availability of locally produced soybeans and soybean meal in substantial amounts, as well as the cost economics and technological reasons for the limited usefulness of animal protein concentrates in poultry feeds, suggest a search for cheaper, easily available feed components in the local market, and nutritionally safe alternatives. Rapeseed as an oilseed crop with a total production area of 0.6 million ha and total production of 0.5 million tons ranks first in area and production among oilseed crops in Pakistan (ANONYMOUS, 1996). As an agricultural product rapeseed is important for its oil and protein contents. The seeds contain about 40% oil and after extraction of oil yield a meal with about 38 to 43% crude protein. The protein of rapeseed has a well balanced amino acid profile (MANSOUR et al., 1993) and in terms of several essential amino acids supplements favourably the protein from cereals.

However, the content of anti-nutrients, as glucosinolates, aromatic choline esters, phytate and dietary fibres, restricts the use of rapeseed meal in feeding sensitive animals (BJERREGAARD et al., 1998). Although genetic manipulations have introduced many changes in the chemical composition of rapeseed through reduction in erucic acid and glucosinolates, these antinutrients have not yet been totally removed. These are not the only factors reducing the nutritional value of rapeseed. The carbohydrates in the meal, which are mostly pectins, cellulose and amyloids, are not regarded as readily digestible, leading to low content of metabolizable energy. Phytates present in the rapeseed meal cause the binding of divalent minerals (COSGROVE, 1980; MARCH, 1987) and some proteins (MAGA, 1982). The phenolic compounds present in substantial amounts in rapeseed meal (NAČZK and SHAHIDI, 1989) have their own antinutritional effects (VERMOREL et al., 1987).

Reduction in the glucosinolate content in rapeseed through quality breeding has been limited only to alkenyl-glucosinolates. Almost half of the remaining glucosinolates in the double improved varieties are indolyl glucosinolates. Probably due to that reason even the double low glucosinolates varieties are used only in restricted amounts in feeding mono-gastric animals (SORENSEN, 1988). A possible alternative and/or combination to the breeding approach can be a technological processing method capable of removing the glucosinolates and other antinutritional factors from rapeseed meal (JENSEN et al., 1995 a; b; LIU et al., 1995).

Several methods have been proposed as e.g. autoclaving (ZEB et al., 1994, 2000), ammoniation (PAIK, 1991), changes in desolventisation conditions (SHIRES et al., 1983), irradiation (NUGON-BAUDON et al., 1988) etc., each with its merits and demerits. Dry heating of different seed grains has been reported to have beneficial effects on the nutritive value of their protein (WOODY et al., 1972; HAEFFERMANN et al., 1993). Seed hulls of most of the plants contain most of the seed fibre and phenolic compounds (DIETRYCH and OLESZEK, 1999). Dehulling of seeds, therefore, has been related to improvement in the nutritional quality determined in different animal species (LESSIRE and BAUDET, 1986; GRAŁA et al., 1998; DIETRYCH and OLESZEK, 1999; DUHAN et al., 2000).

A series of experiments was carried out to quantify the effects of different treatments of rapeseed on the nutritional quality of the resultant meal for broiler chicks (ZEZ et al., 1994, 1999, 2000). The present paper reports the results of our similar experiment, conducted to study the effects of dehulling and dry heating of rapeseed on the nutritional value of the resultant meal for broiler chicks.

Materials and Methods

A five week feeding trial was conducted to study the effect of including rapeseed meal (processed in different ways) in the diet of broiler chicks on their biological performance. Rapeseed meal was prepared in three different ways:

1. Normal procedure was adopted.
2. Seeds were given dry heat (80 °C) treatment and then extracted in the normal way.
3. Seeds were dehulled and the remaining cotyledon part of the seeds was extracted.

Samples

Rapeseed of commercial high glucosinolate (60.9 μmol/g) variety Pakcheen was obtained from the mutation breeding section of the Nuclear Agriculture Division of Nuclear Institute for Food and Agriculture (NIFA), Peshawar (Pakistan).

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Oil extraction

Crushing and extraction of oil was conducted according to the standard procedures (SHAHIDI, 1990). The seeds were pre-pressed to reduce the oil content from above 40% to about 23% and to compress the material into large cake fragments. These fragments were then broken by hand and extracted with petroleum ether (b.p. 40 °C) to remove the residual oil. The cooking of the crushed seeds was omitted in the control samples since it was an experimental variant.

Dry heat treatment

The seeds were given dry heat treatment at 80 °C in an oven for 60 minutes prior to crushing and were then extracted as in control samples.

Dehulling

The seeds were given dry heat treatment at 105 °C for 15 minutes and were then rubbed between two wooden plates with slight pressure. The heat treatment rendered the seed coat brittle and rubbing separated it easily. The separated seed-coats were then removed by blowing air.

Feeding Trial

The feeding trial was conducted in the poultry shed of Nuclear Institute for Food and Agriculture (NIFA), Peshawar. Cages constructed for this purpose were (L x W x H) 120 x 60 x 60 cm, with wooden floor and steel wire walls. Day old broiler chicks were procured from MS. Big Bird (private) Ltd., Lahore through an agent in Peshawar. The chicks belonged to the Hubbard breed and are marketed under the trade name of Big Bird.

The meals prepared in the aforementioned methods were included in the diets of broiler chicks at a level so as to provide 25% of the total dietary protein as rapeseed meal protein (Table 1). Protein and energy of the diet ranged from 21.75 to 21.98% and 3,547 to 3,557 kcal/kg, respectively. Three replicate cages were assigned to each dietary treatment. Chicks were divided into groups of 8 and housed in separate cages. Chicks were sexed prior to grouping and put into groups so that each group consisted of 4 birds from either sex. Temperature and lighting were maintained and altered according to the recommendations of the supplier of the broiler chicks. Saw-dust was used as litter. Feed and water were given ad-libitum throughout the experimental period. The experiment was of 5 weeks duration. Data on feed consumption and weight gain were recorded weekly. All the data were analysed for Analysis of Variance (ANOVA) using the Costat computer software package.

Results

Results (Tables 2 and 3, Figure 1) showed that influence of both dehulling as well as dry heating (80 °C/60 minutes) treatments were statistically non significant. Total Feed consumption per chick ranged from 1,915 (Dehulling group) to 2,081 g (Heating group). Weight gain per chick was minimum in control group (712.8 g) and maximum in heating group (787.8 g). Feed to gain ratio was highest in control group (2.72) and lowest in dehulling group (2.49). The feed intake and weight gain were significantly different in different weeks, however differences among different groups at all stages of development were non significant (Table 2). Expressed in terms of % increase/decrease over control (Figure 1) it can be, however, noted that both treatments resulted in better performance of broilers than in the control chicks. The heating group consumed over 7% more feed and showed over 10% higher gain as compared to control, resulting in about 3% feed economy per kg of weight gain, whereas in case of dehulling the feed consumption was not influenced. However, the gain in weight was about 8% higher than in control, leading to feed economy of 5.6% per unit of weight gain.

Discussion

Dehulling effect

Dehulling of rapeseed was tested as experimental variant with the idea to improve the nutritional value of the resultant meal. This led to somewhat better performance of the broilers fed on ration containing such meal. However, the improvement was not significant. Protein digestibility in rapeseed meal is influenced to a large extent by the presence of relatively disproportionate amounts of hulls. Dehulling of rapeseed meals with low and high contents of glucosinolates has been reported to result in 7 to 11% higher digestibility for the respective rapeseed meals (LEESIRE and BAUDET, 1986). Also proteins and amino acids in rapeseed hulls have lower digestibility and contribute to the lower digestibility values of rapeseed meal protein and amino acids (BELL, 1984). Dehulling improves the true digestibility of amino acids (ZUPRIZAL and CHEGNEAU, 1991).
Table 2. Weekly performance of broiler chicks as influenced by processed rapeseed meal in the diet

<table>
<thead>
<tr>
<th>Weight/chick</th>
<th>Initial</th>
<th>Week – 1</th>
<th>Week – 2</th>
<th>Week – 3</th>
<th>Week – 4</th>
<th>Week – 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control 13.53</td>
<td>23.53 21.21</td>
<td>48.26 ± 0.44</td>
<td>68.57 ± 0.70</td>
<td>61.83 ± 7.01</td>
<td>75.00 ± 2.78</td>
<td></td>
</tr>
<tr>
<td>Heated 15.91</td>
<td>20.95 21.29</td>
<td>45.22 ± 0.95</td>
<td>64.32 ± 3.84</td>
<td>60.13 ± 5.24</td>
<td>83.01 ± 3.25</td>
<td></td>
</tr>
<tr>
<td>Dehulled 12.81</td>
<td>13.57 17.77</td>
<td>23.30 ± 1.64</td>
<td>29.11 ± 1.01</td>
<td>15.36 ± 4.80</td>
<td>20.54 ± 2.53</td>
<td></td>
</tr>
<tr>
<td>F-Value</td>
<td>Treatments 0.2266 ns, Weeks = 97.77 ***</td>
<td>Treatments 0.62 ns, Weeks = 29.96 ***</td>
<td>Treatments 0.3637 ns, Weeks = 6.58 ***</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

F-Value Treatments 0.2266 ns, Weeks 97.77 ***

Feed/Chick/day

<table>
<thead>
<tr>
<th>Weight gain/chick/day</th>
<th>Initial</th>
<th>Week – 1</th>
<th>Week – 2</th>
<th>Week – 3</th>
<th>Week – 4</th>
<th>Week – 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control 1.74 ± 0.09</td>
<td>1.97 ± 0.42</td>
<td>2.01 ± 0.01</td>
<td>1.60 ± 0.01</td>
<td>4.11 ± 2.01</td>
<td>3.05 ± 0.59</td>
<td></td>
</tr>
<tr>
<td>Heated 2.53</td>
<td>2.01 2.02</td>
<td>2.01 ± 0.01</td>
<td>3.93 ± 1.92</td>
<td>3.47 ± 0.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dehulled 1.63 ± 0.04</td>
<td>1.92 ± 0.02</td>
<td>1.60 ± 0.01</td>
<td>4.11 ± 2.01</td>
<td>3.05 ± 0.59</td>
<td></td>
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</tr>
<tr>
<td>F-Value</td>
<td>Treatments 0.01 4.11 ***</td>
<td>Treatments 0.01 4.11 ***</td>
<td>Treatments 0.01 4.11 ***</td>
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</table>

Values are average of three replicate groups; ± standard deviation.

Table 3. Overall Performance of broiler chicks as influenced by processed rapeseed meal in the diet

<table>
<thead>
<tr>
<th>Groups</th>
<th>Total feed intake (g/chick)</th>
<th>Final weight gain (g/chick)</th>
<th>Total weight gain (g/chick)</th>
<th>Feed: weight gain ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1940 782.5</td>
<td>712.81</td>
<td>2.72</td>
<td></td>
</tr>
<tr>
<td>Heated</td>
<td>2081 854.65</td>
<td>787.77</td>
<td>2.64</td>
<td></td>
</tr>
<tr>
<td>Dehulled</td>
<td>1915 833.45</td>
<td>769.35</td>
<td>2.49</td>
<td></td>
</tr>
<tr>
<td>F-Value</td>
<td>0.215 ns</td>
<td>0.128 ns</td>
<td>0.145 ns</td>
<td>0.177 ns</td>
</tr>
</tbody>
</table>

Also most of phytates and tannins are concentrated in the seed-coat (hull). Treatments aimed at reducing these compounds have included breeding for reduced seed coat thickness or mechanically removing the seed coat (dehulling). The latter process has been profitably used in France where the hulls may be fed to rabbits (CHONE et al., 1986).

However, processing designed to reduce tannins (in rapeseed meal) are generally ineffective in reducing rapeseed glucosinolates and in fact dehulling increases the relative proportion of glucosinolates in the remaining meal (MASON et al., 1993). This was partially manifested in those studies in which dehusking the seeds significantly increased the energy and protein digestibility of the RSM and the utilisation of digestible protein in an indirect nitrogen balance trial. However, in the feeding trial the feed efficiency of the dehusked RSM diets was lower than that of the untreated RSM diets (VERMOREL and BAUDET, 1987). Also there have been studies which suggest that the antinutritional compounds in rapeseed meal causing increased liver size are not located in the hulls, as the most profound effects were found when dehulled seeds were fed (CHONE et al., 1989).

Among the phenolic esters sinapine (sinapic acid ester of choline) is the most abundant in rapeseed meal (KRYGIER et al., 1982). Most of the sinapine in rapeseed is concentrated in cotyledons and hulls contain only small amounts of it (BILLE et al., 1983). Presence of phenolic compounds in the rapeseed meal may contribute to certain undesirable properties including dark colour, bitter taste, and astringency (KÖZLOWSKA et al., 1990). Dehulling results in significant increase in the concentration of sinapine in the resultant meal (FENWICK et al., 1984a) and the antinutritional effects are not reduced by heating treatments (FENWICK et al., 1984b).

Relatively better performance of the heated and dehulled RSM-diet group over control group in the present study can probably partly be explained by the heat inactivation of myrosinases prior to oil extraction. Myrosinases hydrolyse the intact glucosinolates when they come into contact with the later on rupturing of the cell wall during extraction. It is actually the hydrolysis breakdown products which have the antinutritional properties (TAPPER and READY, 1973; BENN, 1977; UNDERHILL and KIRKLAND, 1980). On inactivation of myrosinases the hydrolysis of
were given dry heat (80°C) prior to dehulling may have, on the other hand, resulted in decreased digestibility of protein and amino acids (Sionek et al., 1994). It seems that a combination of these factors, working in different directions, may have resulted in the marginally better performance of the chicks fed on dehulled RSM diet.

**Dry heating effect**

Dry heating is a normal process in the extraction of oil from rapeseed. It facilitates oil extraction. Beneficial effects of this processing step on the quality of resultant meal have long been reported. However, the heating temperature and length of heating time has been debated in the literature (Woodly et al., 1972; HAEFFERMANN et al., 1993). In view of our previous experiences (ZEB et al., 1994, 1999 and 2000), a relatively low temperature for longer time was selected for the present study. This, although non-significant, resulted in over 7% higher feed intake and about 10.5% higher weight gain as compared to control group.

It has been reported that birds fed rapeseed meal desolventized at 100°C consumed 6% more feed (P<0.01) and grew 5% faster (P<0.01) than birds fed desolventized at 25°C. This was attributed to the inactivation of myrosinases with 100°C treatment for desolventization. This process, however, had no effect on feed to gain ratio. Also the use of live heat had no further advantage (SittRUS et al., 1983). The heating conditions have to be optimum if enhanced performance is expected. Heating with steam for 30 and 60 minutes had no effect on the nutritive value of the meal except that it decreased digestibility of protein, although this treatment reduced the glucosinolate and sinapine contents in the meal (SioneK et al., 1994). Lack of any effect of various heat treatments of rapeseed meal on performance of broilers has also been frequently reported (LIEE et al., 1991). Studies involving Peking ducklings (KOZLOWSKI and FARUGA, 1989) also did not show large differences in the performance when fed on soybean meal, rapeseed meal or variously heated rapeseed meal diets.

It can be concluded from this study that a milder heat treatment (80°C), for relatively longer time as was adopted in the case of dry heat treatment in present experiment would be preferable to make the seed coat brittle for subsequent dehulling. This will reduce the damage in terms of losses in protein and amino acids digestibility. Of the other hand myrosinases will be inactivated and hence hydrolysis of glucosinolates during the crushing can be prevented. This will preserve the enhancement in the digestibility achieved through removing the hulls.

**Summary**

A five weeks feeding experiment was conducted to study the effect of including rapeseed meal (processed in different ways) in the diet of broiler chicks on their biological performance. Rapeseed meal was prepared in three different ways: 1) Normal procedure was adopted; 2) Seeds were given dry heat (80°C) treatment and were then extracted in the normal way; 3) Seeds were dehulled and the remaining cotyledon part of the seeds was extracted. These meals were included in the diet of broiler chicks at a level so as to provide 25% of the total dietary protein from rapeseed meal. Data on feed consumption and weight gain were recorded weekly. Results showed no significant effects of different treatments. However among the groups, heat treatment resulted (although not significantly) in the highest feed intake (2081 g/chick) followed by control (1940 g/chick) and dehulled rapeseed meal (1915 g/chick). This trend was paralleled by gain in weight and maximum gain was recorded in the case of heat treated rapeseed meal fed group (788 g/chick). Feed to gain ratio ranged from 2.49 (dehulling group) to 2.72 (control group).

**Keywords**

Broiler, rapeseed, dehulling, dry heat treatment, performance

**Zusammenfassung**

Ein fünfwochiger Fütterungsversuch wurde durchgeführt, um den Einfluss von unterschiedlich behandeltem Rapsamenmehl in der Ration auf die biologische Entwicklung von Broilern zu untersuchen. Das eingesetzte Rapsamenmehl wurde nach drei verschiedenen Methoden behandelt: 1. Allgemein übliche Behandlung (Kontrollgruppe); 2. Die Samen wurden einer trockenen Hitze (80°C) ausgesetzt und anschließend auf normalem Wege extrahiert; 3. Die Samen wurden geschält und der zurückbleibende Rest wurde extrahiert. Die aufgearbeiteten Mehle wurden in die entsprechenden Geflügelrationen mengenmäßig so eingemischt, dass jeweils 25% des gesamten Proteins in Form von Rapsamenmehl abgedeckt wurde. Die Datenerfassung (Futterverbrauch, Gewichtszunahme) erfolgte wöchentlich. Die Ergebnisse zeigen keinen signifikanten Einfluss der Aufschlussverfahren auf die untersuchten Parameter. Vergleicht man die Gruppen untereinander, so zeigt sich die höchste Futteraufnahme bei den Tieren, die hitzebehandeltes Rapsamenmehl bekamen (2081 g/Tier), gefolgt von der Kontrollgruppe (1940 g/Tier) und der Gruppe 3 (1915 g/Tier). Der gleiche Trend ist auch bei der Gewichtsentwicklung festzustellen. Die höchste Gewichtszunahme ist in der Gruppe 2 mit 788 g/Tier gegeben. Die Futterverwertung bewegt sich zwischen 2.49 (Gruppe 3) und 2.72 (Gruppe 1).

**Stichworte**

Broiler, Rapssaat, Schälen, Hitzebehandlung, Leistung

**Literature**


