Effect of NSP Degrading Enzyme Supplement on the Nutrient Digestibility of Young Chickens Fed Wheat with Different Viscosities and Triticale

M. D. Shakouri¹ and H. Kermanshahi ¹*

ABSTRACT

To study the effect of cell-wall degrading enzymes on the nutrient efficiency of young chickens fed different grains, an *in vitro* experiment was conducted to determine the range of viscosities of seven local wheat varieties. From these, the highest (Flaat) and the lowest (Ghods) were selected for an *in vivo* study. 288 day-old Arian chickens were kept in cages and fed one of four grains (Flaat, Ghods, Triticale, and Corn) with or without a dietary NSP degrading enzyme in a 4×2 factorial arrangement with six replicates per treatment. An indigestible marker (chromic oxide) was used for digestibility measurements. Feed and water were provided *ad libitum*. Excreta samples were collected from 18-21 days of the experiment. Apparent metabolizable energy corrected for nitrogen (AMEₙ) was improved (*P<0.05*) in all diets by enzyme supplementation except the corn diet. The apparent lipid digestibility (ALD) and apparent crude carbohydrate digestibility (ACCD) of all treatments were significantly improved by adding an enzyme (*P<0.01*). This improvement was highest in the Flaat variety (highest viscosity) of wheat. The results of this experiment clearly indicate the positive effects of supplemental NSP degrading enzymes on nutrient digestibilities and on AMEₙ especially for the grains with the highest viscosity (wheat cultivar Flaat and triticale).

Keywords: Broilers, NSP degrading enzymes, Nutrient digestibility, Viscosity.

INTRODUCTION

Young birds have a gastrointestinal tract with a limited capacity. In order to maximize the growth rate of young broilers at the starter period, diets with high energy and protein contents are recommended (NRC, 1994). The main sources of providing energy in such diets are grains like corn and wheat (Friesen et al., 1992). Wheat can supply up to 70% of metabolizable energy and 40% of the protein requirements of broilers. Compared to other grains, there is a wider variability in wheat composition (Hew et al., 1998). The variability in wheat energy (AMEₙ) for broiler chickens and the lack of relationship between the amount of starch and the AMEₙ of wheat has been reported (Rogel et al., 1987). A negative correlation between AME and the amount of soluble non starch polysacharides (NSP) of wheat has been reported (Annison, 1991). The addition of wheat NSP to a diet containing sorghum decreased the AME (Choct and Annison, 1990, 1992). However, adding xylanase enzyme to a diet containing wheat improved its AME (Annison, 1992). These data suggest that a lower AME in wheat is related to its NSP content.

Smits and Annison (1996) studied the physico-chemical properties of NSP and suggested that the measurement of soluble NSP and the viscosity of ingredients in *in vitro* conditions would be important and can be used for their nutritional evaluation. Dif-

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different methods for the measurement of extract viscosity of wheat by water or buffers have been suggested (Fengler et al., 1990; Scole et al., 1993; Van der Klis et al., 1995a). However, it seems methods that mimic the GIT conditions of the young birds, can be more practical to evaluate nutritional values of different wheat varieties. The two phase method of Bedford and Clasen (1993) is a practical method but it is time-consuming and expensive.

The addition of commercial enzymes to the diets containing high levels of wheat can improve AME, lipid, protein (Friesen et al., 1992; Steenfeld et al., 1998), and other nutrient digestibility (Friesen et al., 1992; Hew et al., 1998). There is little research published on broiler chickens fed triticale that has more protein and lysine than either wheat, sorghum and corn (McGinnis et al., 1985). Triticale like its parents, wheat and rye, contains pentosans that reduce its nutritional value (Pettersson and Aman, 1988). The addition of pentosanase enzymes to diets containing this grain and fed to young broiler chickens can increase the performance of the birds (Flores et al., 1994; McGinnis et al., 1985). Therefore, the objective of this experiment was to determine the effect of a NSP degrading enzyme supplement on AMEn, and nutrient digestibilities of diets containing wheat with different viscosities and triticale in young broiler chickens.

MATERIALS AND METHODS

Seven wheat varieties and one triticale sample from local sources (three replicates of each) were prepared and their viscosities measured by water (Van der Klis et al., 1995a) and acetate buffer, pH=5, 0.1M extraction (Scole et al., 1993) using a Hopler BH2 viscometer. Varieties with the highest and the lowest viscosities, Flaat and Ghods, along with triticale were selected for further studies.

In an in vivo study, 288 day-old meat type male broiler chickens of the Arian strain were used. In a completely randomized experiment with 4×2 factorial arrangement, treatments using 6 replicates of six birds

Table 1. Chemical composition and calculated metabolizable energy of the selected grains (dry matter basis).

<table>
<thead>
<tr>
<th>Grain</th>
<th>DM%</th>
<th>GE Kcal/kg</th>
<th>CP%</th>
<th>EE%</th>
<th>Ash%</th>
<th>CF%</th>
<th>NFE%</th>
<th>AMEnb Kcal/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flaat wheat</td>
<td>90.54</td>
<td>4000</td>
<td>13.68</td>
<td>2.74</td>
<td>1.84</td>
<td>3.31</td>
<td>78.43</td>
<td>3506</td>
</tr>
<tr>
<td>Ghods wheat</td>
<td>91.83</td>
<td>4030</td>
<td>9.19</td>
<td>3.21</td>
<td>1.54</td>
<td>3.32</td>
<td>82.74</td>
<td>3535</td>
</tr>
<tr>
<td>Triticale</td>
<td>90.92</td>
<td>4090</td>
<td>13.15</td>
<td>2.78</td>
<td>1.87</td>
<td>3.24</td>
<td>78.96</td>
<td>3437</td>
</tr>
</tbody>
</table>

aDM, dry matter; GE, gross energy; CP, crude protein; EE, ether extract; CF, crude fiber; NFE, nitrogen free extract; AMEn, apparent metabolizable energy corrected for nitrogen.
bAMEn (apparent metabolizable energy corrected for nitrogen) for wheat obtained from AMEn= 34.92 × CP + 63.1 × EE + 36.42 × NFE and for triticale obtained from AMEn= 34.49 × CP + 62.16 × EE + 35.61 × NFE (NRC, 1994).
added to each diet and fed to chickens from 18-21 days of the experiment. Performance of the chickens was measured from 1-14 days of age. Samples of excreta were collected for three days, two times per day and kept in a freezer (-20 °C). Feed, and excreta samples were oven dried (60 °C, 72 hours) and ground prior to analysis. Gross energy was measured by a bomb calorimeter (Schi- maszu Calorimeter), protein by Kjeldahl (Kjeltec Auto Analyzer 1030), fat by Sox- elete (Soxtec System HT6) using standard procedures of AOAC (1980) and chromic oxide by the method of Fenton and Fenton (1979). Apparent metabolizable energy corrected for nitrogen (AMEn) was measured by the Sibbald and Slinger formula (1963), digestibility of nutrients by the formula of Saha and Gilbreath (1993), and apparent crude carbohydrate digestibility (ACCD) by the formula suggested by Steenfeldt et al (1998). Date were analyzed using the General Linear Model of SAS (1986) and, when appropriate, the Duncan multiple range test was used to compare means.

RESULTS AND DISCUSSION

The viscosity of extracts from wheat varieties and triticale are shown in Table 3.

Table 3. Viscosity values of extracts from different wheat varieties and triticale with water and acetate buffer, pH=5, 0.1 M (centi poise).

<table>
<thead>
<tr>
<th>Grain varieties</th>
<th>Viscosity with water</th>
<th>Viscosity with acetate buffer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flaat</td>
<td>2.802</td>
<td>2.358</td>
</tr>
<tr>
<td>Roushan</td>
<td>1.860</td>
<td>1.850</td>
</tr>
<tr>
<td>Alamout</td>
<td>1.791</td>
<td>1.823</td>
</tr>
<tr>
<td>Chamran</td>
<td>1.577</td>
<td>1.743</td>
</tr>
<tr>
<td>Nick Nejad</td>
<td>1.659</td>
<td>1.389</td>
</tr>
<tr>
<td>Mahdavi</td>
<td>1.895</td>
<td>1.250</td>
</tr>
<tr>
<td>Ghods</td>
<td>1.334</td>
<td>1.220</td>
</tr>
<tr>
<td>Triticale (wheat * rye)</td>
<td>3.005</td>
<td>2.273</td>
</tr>
</tbody>
</table>
Except for Alamout and Chamran, the viscosity of water extracts was greater than those of the acetate buffer. Due to a constant ratio of wheat to water or acetate buffer (1:2) and similar in vitro conditions, it seems that the higher viscosity values obtained with the water method probably relates to the increased pH of the media (Fengler et al., 1988), greater solubility of viscous compounds in water and higher solubility of specific wheat proteins (gliadins) that increases the viscosity of extracts (Van der Klis et al., 1995b). Since Flaat had a higher protein level than that of Ghods, it is possible that the higher viscosity value of Flaat in comparison to Ghods is related to its protein content. Due to the high positive correlation between the two methods ($r^2 = 0.70$), one method can be chosen (Figure 1). However, there are some other methods (Fengler et al., 1990; Bedford and Classen, 1993) and it seems important that a fast method for assessing the NSP content of grains be established. Measuring grain viscosities under situations that mimic the gastrointestinal conditions of young chickens can be of value.

AMEn, apparent lipid (ALD), and crude carbohydrate (ACCD) digestibilities and nitrogen retention (NR) of the experimental diets from 18-21 days of age are shown in Table 4. AMEn of treatments were affected by diet, enzyme (P<0.01) and diet × enzyme (P<0.05). The addition of enzyme to diets containing all grains except corn improved their AMEn values. For Flaat, Ghods and triticale this improvement was 9.24, 3.15 and 3.32% respectively. ALD and ACCD were also improved by the addition of enzyme (P<0.01). This improvement was highest for Flaat followed by triticale. There was no diet/ enzyme interaction for NR, but the addition of an enzyme to the diets significantly improved their NR (P<0.01). Results from other experiments with young broiler chickens indicate that adding enzyme to diets containing high levels of wheat improves AME, ALD (Annison, 1992; Friesen et al., 1992; Van der Klis et al., 1995b), NR (Scott and Hall, 1998), and ACCD (Steenfeldt et al., 1998). Similar to the results of this study, other reports emphasize that enzyme addition to diets containing soluble NSP can improve lipid digestibility more than that of
other nutrients (Friesen et al., 1992; Steenfeldt et al., 1998). Wheats with higher extract viscosity increase the viscosity of the intestinal chyme more than those with lower extract viscosity (Van del Klis et al., 1995a). In this study, addition of an enzyme to the diets containing Flaat wheat with the highest extract viscosity improved the digestibility of ALD more than that of Ghods wheat, which had the lowest extract viscosity (19.32 vs 5.26%). As shown in Table 4, addition of an enzyme to the diets containing Flaat wheat also improved the digestibility of AMEn, ACCD and NR more than those of Ghods wheat (9.24, 3.66, 5.74% vs 3.15, 1.74, and 5.58% respectively). Similar results were obtained when a commercial xylanase enzyme was added to a wheat based diet (Carre et al., 1992). Given the increase in AMEn, they concluded that the improvement in AMEn is mostly related to the increased lipid and starch digestibility. The release of pantose sugars from NSP cannot increase the amount of AMEn as increased by lipid, starch and protein (Carre et al., 1992).

The feed intake, body weight gain, and feed-to-gain ratio of the chickens fed four different grain-based diets, with or without a dietary enzyme, from 1-14 days of age are presented in Table 5 that confirms the other data.

Amongst the several hypothesis relating to the mechanism of enzyme action, the decrease of digesta viscosity by NSP degrading enzymes is more highly validated. Based on this hypothesis, enzymes can hydrolyse the glycoside bonds of large molecules that are responsible for increasing the digesta viscosity. This action alleviates the antinutritional effect of soluble NSP (Bedford and Classen 1992). In addition to the effect of NSP on increasing viscosity, other physico-chemical properties of NSP such as the stirred water layer of the gut, bonding capacity, etc., are involved in digestibility and nutrient absorption (Smits and Annison, 1996).

Under the conditions of this experiment, it was concluded that the addition of this enzyme to diets containing wheat and triticale increases their AMEn, ACCD and especially

### Table 4. Effects of dietary treatments on AMEn (kcal/kg) and nutrient digestibilities (%) in broiler chickens from 18-21 days of age (dry matter basis).

<table>
<thead>
<tr>
<th>Diet</th>
<th>Enzyme</th>
<th>AMEn (kcal/kg)</th>
<th>ALD (%)</th>
<th>ACCD (%)</th>
<th>NR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>-</td>
<td>3211</td>
<td>76.59bc</td>
<td>83.58b</td>
<td>65.43</td>
</tr>
<tr>
<td></td>
<td>+</td>
<td>3276</td>
<td>80.05a</td>
<td>84.68a</td>
<td>68.34</td>
</tr>
<tr>
<td>Ghods wheat</td>
<td>-</td>
<td>3393</td>
<td>70.9f</td>
<td>82.11f</td>
<td>61.27</td>
</tr>
<tr>
<td></td>
<td>+</td>
<td>3500</td>
<td>74.63f</td>
<td>83.54b</td>
<td>64.69</td>
</tr>
<tr>
<td>Flaat</td>
<td>-</td>
<td>3354</td>
<td>65.53f</td>
<td>80.39f</td>
<td>66.43</td>
</tr>
<tr>
<td></td>
<td>+</td>
<td>3664</td>
<td>78.19b</td>
<td>83.33b</td>
<td>70.24</td>
</tr>
<tr>
<td>Triticale</td>
<td>-</td>
<td>3344</td>
<td>69.56d</td>
<td>79.53c</td>
<td>61.44</td>
</tr>
<tr>
<td></td>
<td>+</td>
<td>3455</td>
<td>76.03c</td>
<td>81.13d</td>
<td>66.58</td>
</tr>
<tr>
<td>± SEM</td>
<td></td>
<td>31.3</td>
<td>0.632</td>
<td>0.209</td>
<td>0.378</td>
</tr>
</tbody>
</table>

1. +, with enzyme; -, without enzyme.
2. AMEn, apparent metabolizable energy corrected for nitrogen.
3. ALD, apparent lipid digestibility.
4. ACCD, apparent crude carbohydrate digestibility.
5. NR, nitrogen retention.
6. Means with different superscripts in each column are significantly different, NS, not significant.

The feed intake, body weight gain, and feed-to-gain ratio of the chickens fed four different grain-based diets, with or without a dietary enzyme, from 1-14 days of age are presented in Table 5 that confirms the other data.

Amongst the several hypothesis relating to the mechanism of enzyme action, the decrease of digesta viscosity by NSP degrading enzymes is more highly validated. Based on this hypothesis, enzymes can hydrolyse the glycoside bonds of large molecules that are responsible for increasing the digesta viscosity. This action alleviates the antinutritional effect of soluble NSP (Bedford and Classen 1992). In addition to the effect of NSP on increasing viscosity, other physico-chemical properties of NSP such as the stirred water layer of the gut, bonding capacity, etc., are involved in digestibility and nutrient absorption (Smits and Annison, 1996).

Under the conditions of this experiment, it was concluded that the addition of this enzyme to diets containing wheat and triticale increases their AMEn, ACCD and especially
ALD. The greatest improvement can be achieved for those grains with the highest extract viscosities (Flaat and triticale).

**ACKNOWLEDGMENTS**

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**REFERENCES**

Effect of NSP Degrading Enzyme Supplement on Nutrient Digestibility

اثر مکمل آنزیم بر قابلیت هضم مواد غذایی جردها حاوی گندم‌ها با ویسکوزیته متغیر و تریتیکاله در جوجه های کوشا جوان

م. د. شکوری و ح. کرمانشاهی

چکیده

با هدف بررسی اثر آنزیم‌های جرده‌ای گردنه کننده یلی ساکاربیدهای GDPR نشاستهای NSP) خلول موجود در دیواره سلول غلاف بر روز کابیلت بهره‌وری مواد غذایی، ارقام مختلف از آنها به‌شته و ویسکوزیته آنها در آزمایشگاه تعیین گردید. پس از انتخاب ارقام دارای بیشترین و کمترین مقدار ویسکوزیته آزمایشگاهی (فلات و قدس) از پنل ۷ رقم گذم، با منظور پروری اثر مکمل آنزیم بر انرژی قابل متابولیسم ظاهراً نیم‌الحیاتی براي ازت (AMEn) و قابلیت هضم مواد غذای جرده‌های حاوی ۶۰% از ارقام انتخاب شده، تریتیکاله و کارت، آزمایش با ۲۸۸ دوره خورس به‌طور قابل توجهی به عنوان یک آزمایش فاکتوریل با ۶۱ فاکتور در هر تیمار یک‌بار اجرا شدند. به دنبال تغذیه جوجه‌های آزمایشی با جرده‌های حاوی ۳/۰% اکسید کروم، هم آوری گونه‌های AMEn مقدار در روزهای ۱۷ تا ۲۱ دوره کریت. همیشه جرده‌های به جرده‌های حاوی جزت تحت تأثیر مکمل آنزیم افزایش یافت (۵/۰۵< ؛P< ۰/۰۵). قابلیت هضم ظاهری لپید (ALD) همیشه جرده‌ها به خاتم کردن آنها به‌طور مصنوعی ناشان داد. همیشه جرده‌های فلاته و قدس یک مقدار را دارا بود. نتایج موجود نشان داد که آزمایش مثبت AMEn مکمل آنزیم بر قابلیت هضم ظاهری مواد غذایی حاوی جرده‌های گندم‌های بالا (فلات و تریتیکاله) می‌باشد.