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EFFECTS OF β-GLUCANASE (ALLZYME BG) ON COMPARATIVE PERFORMANCE OF GROWING RABBITS AND BROILER CHICKS FED RYE, TRITICALE AND HIGH- AND LOW-GLUCAN BARLEY

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Abstract

The effect of a commercial enzyme product (Allzyme BG) on the utilization of diets containing rye, triticale and high- and low-glucan barley was investigated in rabbits and broiler chicks. No adverse effects from feeding these grains to rabbits were noted, and there were no responses to enzyme supplementation, indicating that dietary β-glucan does not have adverse effects in rabbits. In broiler chicks, growth rate and feed conversion were reduced when grains containing glucans were fed. Enzyme supplementation markedly improved performance of chicks fed barley, rye and triticale-containing diets.

Introduction

Barley contains viscous water-soluble gums called β-glucans which adversely affect its utilization by swine and poultry. Rye and triticale also contain glucans, pectins and other poorly digested polysaccharide fractions (Cheeke, 1991). These substances are particularly important in poultry nutrition, causing reduced bird performance and wet litter problems. The addition of commercial enzymes such as β-glucanases to diets containing these grains improves their utilization by poultry (Edney et al., 1989; Gohl et al., 1978; Hasselman et al., 1981, 1982; Petterson and Aman, 1988; Rotter et al., 1989); the degree of response is greater when high β-glucan grain is fed (Froseth et al., 1988). The effects of β-glucans in grains and responses to enzyme supplementation have not been studied in rabbits. Cheeke (1987) speculated that the β-glucans might increase enteritis by promoting excess cecal microbial growth.

The objectives of this study were to compare the responses of weanling rabbits and broiler chicks fed diets containing barley, rye and triticale, with and without supplementation with β-glucanase.

Materials and Methods

Grains used were commercial sources of rye and triticale (cv. Flora), and barley with high (7.5%) and low (3.5%) β-glucan contents. The barley was grown at Washington

State University. The source of β-glucanase was Allzyme BG (Alltech Biotechnology, Inc., Nicholasville, KY).

Ninety 4-5 week old New Zealand White rabbits were randomly assigned to 9 treatments. Each animal was caged individually and fed the experimental diets for 28 days. On day 21, five animals from each treatment were used to measure diet digestibility by the total collection method. Collection trays were placed beneath their cages and feces collected for 7 days. Proximate analyses and bomb calorimetry of feed and feces were conducted using standard techniques. Nutrient composition of ingredients is given in Table 1, diet composition is shown in Table 2 and nutrient content of the diets presented in Table 3. The diets were pelleted. A grain-free high alfalfa pelleted diet was used as a control. Allzyme BG was added at 2.2 g/kg diet.

Table 1. Chemical composition of major ingredients.

		Nutrient Composition (%)					
Ingredient	GE, Kcal/kg	Dry Matter	Neutral Detergent Fiber	Acid Detergent Fiber	Crude Protein	Ether Extract	Ash
High glucan barley	3454	88.8	28.7	10.6	10.4	2.1	2.4
Low glucan barley	3482	88.5	35.6	8.63	11.7	1.7	2.7
Rye	3283	86.9	19.8	3.42	8.3	1.6	2.2
Triticale	3291	87.3	19.9	4.04	9.3	1.6	2.0
Soybean meal	3769	88.5	15.4	8.98	47.2	1.3	6.6
Wheat mill run	3508	86.7	37.3	10.2	17.8	4.5	4.7
Alfalfa	3445	88.7	38.6	28.3	17.4	2.2	10.7

In the broiler experiment, diets were formulated with the test grains completely replacing corn in the control diet. The diets (Tables 4 and 5) were fed in mash form. Each diet was used with and without Allzyme supplementation. Ten 1-week old Peterson X Hubbard broiler chicks (5 of each sex) were assigned to each dietary treatment. The birds were housed in litter floor pens in a naturally ventilated broiler house with wood shaving litter. The experimental period was 28 days.

Data from both experiments was subjected to one-way analysis of variance using general linear models (SAS, 1991).

Table 2. Percentage composition of the rabbit diets.

Ingredient	Control	Test Diets
Alfalfa meal (sun-cured)	56.5	32
Grain[1]	-	40
Wheat mill run	37	10
Soybean meal (44% CP)	-	12
Molasses	3	3
Bentonite	1.25	-
Meat meal	0.82	-
Vegetable oil	-	1.25
Dicalcium phosphate	-	1.0
Salt	0.5	0.5
Vitamin premix[2]	+	0.25

[1] High glucan barley, low glucan barley, triticale and rye.

[2] See Table 4.

Results and Discussion

The control diet with no cereal grain gave the highest average daily gain (ADG) in the rabbit experiment. Inclusion of grain in the diet gave numerical reductions in ADG which were not statistically significant except for one triticale diet (Table 6). Feed conversion was better ($P<0.05$) for rabbits given the grain-containing diets than for the control, except for the high-glucan barley diets. Mortality and enteritis incidence were low in all treatments. There was no consistent response to enzyme supplementation. The results indicate that rabbits are not adversely affected by β-glucans in grains, and thus no benefit occurs with enzyme supplementation. Presumably, there is adequate microbial β-glucanase produced in cecal fermentation in the rabbit. Alternatively, endogenous β-glucanase in the grain could be activated and there is sufficient time for it to function during cecal fermentation. The digestibilities of dry matter, gross energy and ether extract were significantly higher ($P<0.05$) in the diets containing the grains than in the high alfalfa control diet (Table 7). Dry matter and energy digestibilities were slightly higher with the rye and triticale diets than with barley. There was no effect of enzyme supplementation on digestibility values.

Table 3. Analyzed chemical composition of rabbit diets (dry matter basis).

	Nutrient Composition (%)						
Diets	GE, Kcal/kg	Dry Matter	Neutral Detergent Fiber	Acid Detergent Fiber	Crude Protein	Ether Extract	Ash
Control	3548	88.9	35.2	21.8	14.8	2.42	7.63
High glucan barley + Enz[1]	3518	88.0	29.1	15.7	16.0	3.78	7.10
High glucan barley	3528	87.9	29.8	14.6	15.8	3.47	7.31
Low glucan barley + Enz	3491	87.9	30.1	16.9	15.7	2.95	7.66
Low glucan barley	3592	88.6	30.0	16.4	15.4	3.28	8.01
Rye + Enz	3479	87.2	25.0	13.1	14.8	3.28	6.89
Rye	3491	87.5	26.2	14.6	14.5	3.74	7.42
Triticale + Enz	3436	87.3	26.6	14.5	15.1	3.66	7.79
Triticale	3494	87.5	25.7	13.9	14.0	2.98	7.05

[1] Enz refers to supplementation with Allzyme BG (2.2 g/kg diet).

In the chick trial, the results were much different than for the rabbits (Table 8). With enzyme supplementation, the ADG was lower ($P<0.05$) with rye, triticale and barley as compared to the corn-based control diet. Supplementation with Allzyme increased ADG significantly ($P<0.05$) for both barleys and triticale as compared to the same diets without enzyme supplementation. The improvement with added enzyme ranged from 9.3 to 19.4%. There was also improvement in feed conversion of 3.5-19.8% with the greatest improvement in chicks fed the rye diet and the least with those fed triticale. There were no differences in response between the high and low glucan barleys, and the ADG response to enzyme supplementation was actually greater with the low glucan barley.

Feed conversions for chicks fed diets containing barley, rye or triticale were improved by the addition of Allzyme, but were still 4.4-20.2% poorer than with corn. This infers that these alternate grains, even with enzyme supplementation, would replace corn in least cost diet formulation only when their cost was substantially less than for corn. This probably is a reflection of their lower metabolizable energy, even with enzyme supplementation.

Table 4. Composition of broiler diets.

Ingredient	%
Grain*	59
Soybean meal (47.5% CP)	32.5
Meat and bone meal	5
Animal and vegetable fat	2
Limestone, ground	0.52
Monocalcium phosphate (15% Ca; 21% P)	0.35
Salt	0.25
Vitamin premix[1]	0.20
DL-methionine (98%)	0.13
Trace mineral premix[2]	0.05
Amprol 25% premix[3]	0.05
Baciferm -40 premix[4]	0.05

* Corn in control; other grains were high and low glucan barley, rye and triticale.

[1] Provides per kilogram of diet: vitamin A, 3300 IU; vitamin D_2, 1100 ICU; riboflavin, 3.3 mg; d-pantothenic acid, 5.5 mg; niacin, 22 mg; cholline, 190.9mg; vitamin K, .55 mg; vitamin E, 1.1 IU; vitamin B_{12}, 5.5 mcg; folic acid, .22 mg; ethoxyqyin, 60 mg.

[2] Provides per kilgram of diet: calcium, 97.5 mg; manganese, 60 mg; zinc, 27.5 mg; copper, 2 mg; iron, 20 mg; iodine, 1.2 mg; cobalt, .2 mg.

[3] Gratuitously provided by MSD AGVET Division, Merck and Company, Rahway, N.J. 07065.

[4] Gratuitously provided by Pitman-Moore, Incorporated, Terre Haute, IN 47804.

Table 5. Analyzed nutrient composition (dry matter basis) of broiler diets (%).

	Nutrient Composition, %						
Diets	GE, Kcal/kg	Dry Matter	Neutral Detergent Fiber	Acid Detergent Fiber	Crude Protein	Ash	Fat
High glucan barley + Enz[1]	2934	94.9	19.5	7.0	25.1	6.9	4.6
High glucan barley	2934	94.9	20.2	6.6	24.3	7.1	4.2
Low glucan barley + Enz	2970	95.5	25.8	8.0	25.7	7.2	3.9
Low glucan barley	2968	95.4	27.0	7.7	23.9	6.8	4.1
Rye + Enz	2814	94.1	14.6	4.1	23.9	6.4	3.8
Rye	2828	94.5	15.7	4.5	23.8	6.8	3.9
Triticale + Enz	2817	94.0	14.6	5.6	24.5	6.2	4.0
Triticale	2826	94.3	13.3	4.1	24.2	6.4	4.4
Corn + Enz	2874	93.9	13.2	3.9	22.8	5.9	4.9
Corn	2873	93.9	15.0	4.2	22.4	6.2	4.8

[1] Enz refers to supplementation with Allzyme BG (2.2 g/kg diet).

Table 6. Performance of rabbits fed grain-containing diets with or without Allzyme supplementation (means ± SE)[1].

Diet	Initial Wt (g)	Avg. Daily Feed Intake (g)	Avg. Daily Gain (g)	Feed/Gain	Mortality (n/10)
Control (high alfalfa diet)	791.1 ± 26.3^{a}[1]	145.4 ± 3.6^{a}	42.0 ± 1.2^{a}	3.47 ± .04^{a}	-
High glucan barley + Enz[2]	715.1 ± 35.2^{ab}	118.7 ± 6.4^{b}	39.0 ± 1.5^{ab}	3.04 ± 0.15^{ab}	-
High glucan barley	715.3 ± 38.2^{ab}	112.0 ± 3.4^{b}	38.1 ± 3.2^{ab}	3.12 ± 0.31^{ab}	1
Low glucan barley + Enz	704.8 ± 35.3^{ab}	117.5 ± 8.3^{b}	41.1 ± 2.1^{a}	2.87 ± 0.13^{b}	1
Low glucan barley	705.5 ± 33.2^{ab}	120.5 ± 4.5^{b}	41.2 ± 2.0^{a}	2.95 ± 0.07^{b}	-
Rye + Enz	698.9 ± 36.4^{b}	107.2 ± 6.4^{b}	37.5 ± 1.4^{ab}	2.88 ± 0.18^{b}	-
Rye	752.0 ± 37.6^{ab}	111.9 ± 6.7^{b}	39.6 ± 1.5^{ab}	2.81 ± 0.10^{b}	2
Triticale + Enz	682.4 ± 31.2^{b}	104.1 ± 2.9^{b}	35.4 ± 0.9^{b}	2.95 ± 0.06^{b}	-
Triticale	717.4 ± 27.4^{ab}	110.9 ± 4.1^{b}	39.4 ± 1.2^{ab}	2.82 ± 0.07^{b}	-

[1] Means within a column with the same superscripts are not significantly different ($P < .05$).

[2] Enz refers to supplementation with Allzyme BG (2.2 g/kg diet).

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Table 7. Digestibilities of rabbit diets containing various grains with and without Allzyme BG[1].

	Nutrient Digestibility (%)					
	Gross Energy, %	Dry Matter	Crude Protein	Acid Detergent Fiber	Neutral Detergent Fiber	Ether Extract
Control	$50.16 \pm .05^{d}$	$52.20 \pm .44^{d}$	$66.56 \pm .69^{ab}$	$8.78 \pm .85^{ab}$	$3.43 \pm .89^{b}$	47.51 ± 2.05^{a}
High glucan barley + Enz[2]	$61.25 \pm .72^{c}$	$63.25 \pm .65^{c}$	$66.65 \pm .46^{ab}$	9.70 ± 1.85^{a}	17.45 ± 1.34^{a}	75.68 ± 0.89^{b}
High glucan barley	$61.52 \pm .87^{c}$	$63.03 \pm .72^{c}$	$68.34 \pm .34^{a}$	0.07 ± 1.07^{c}	$17.39 \pm .77^{a}$	72.62 ± 2.14^{b}
Low glucan barley + Enz	$60.38 \pm .73^{c}$	$62.09 \pm .50^{c}$	67.72 ± 2.36^{ab}	4.95 ± 2.20^{abc}	18.99 ± 1.78^{a}	70.37 ± 3.49^{b}
Low glucan barley	$61.67 \pm .50^{c}$	$62.69 \pm .46^{bc}$	$66.19 \pm .91^{ab}$	6.52 ± 1.85^{ab}	17.92 ± 1.10^{a}	70.16 ± 2.31^{b}
Rye + Enz	$66.02 \pm .58^{a}$	$67.42 \pm .61^{a}$	$66.84 \pm .78^{ab}$	5.04 ± 1.88^{abc}	18.32 ± 1.66^{a}	76.17 ± 57^{b}
Rye	$63.83 \pm .33^{b}$	$65.56 \pm .39^{b}$	62.85 ± 1.37^{b}	2.89 ± 2.47^{bc}	18.55 ± 2.07^{a}	74.69 ± 2.26^{b}
Triticale + Enz	$64.17 \pm .93^{ab}$	$65.93 \pm .83^{ab}$	69.47 ± 1.79^{a}	7.62 ± 1.38^{ab}	15.67 ± 1.28^{a}	77.36 ± 1.29^{b}
Triticale	$65.98 \pm .35^{a}$	$67.23 \pm .39^{ab}$	66.86 ± 1.01^{ab}	7.39 ± 1.69^{ab}	17.99 ± 1.30^{a}	76.90 ± 1.24^{b}

[1] Means within the same column with a different superscript are significantly different ($P < .01$).

[2] Enz refers to supplementation with Allzyme BG (2.2 g/kg diet).

Table 8. Performance of broiler chicks fed diets with various grains with and without Allzyme (Means ± SE)[1].

Diets	Average Daily Gain (g)	Percent Improvement With Allzyme	Average Daily Feed Intake (g)	Feed/ Gain	Percent Improvement of Feed/Gain With Allzyme	Percent Different than Feed/Gain With Corn
Corn + Enz	48.8 ± 2.5^{ab}	-	89.5^{cd}	$1.87 \pm .09^{ab}$	-	-
Corn	50.9 ± 2.3^{a}	-	91.6^{cd}	$1.83 \pm .09^{a}$	-	-
High glucan barley + Enz[2]	46.8 ± 1.5^{abc}	10.6	92.6^{bc}	$1.99 \pm .06^{ab}$	10.8	8.7
High glucan barley	42.4 ± 1.9^{cd}	-	92.8^{bc}	$2.23 \pm .09^{ab}$	-	-
Low glucan barley + Enz	50.7 ± 2.1^{a}	19.4	100.2^{a}	$2.03 \pm .09^{ab}$	8.6	10.9
Low glucan barley	42.5 ± 1.5^{cd}	-	93.3^{bc}	2.22 ± 1.6^{ab}	-	-
Rye + Enz	42.9 ± 1.7^{cd}	11.7	93.1^{bc}	$2.20 \pm .08^{ab}$	19.8	20.2
Rye	38.4 ± 3.0^{d}	-	95.8^{ab}	$2.74 \pm .37^{c}$	-	-
Triticale + Enz	48.1 ± 1.4^{ab}	9.3	91.3^{cd}	$1.91 \pm .05^{ab}$	3.5	4.4
Triticale	44.0 ± 1.8^{c}	-	86.1^{d}	$1.98 \pm .09^{ab}$	-	-

[1] Means within the same column with a different superscript are significantly different ($P < .05$).

[2] Enz refers to supplementation with Allzyme BG (2.2 g/kg diet).

Conclusions

1. Compared to performance of rabbits fed a high alfalfa diet, growth rate of rabbits was not increased when barley, rye or triticale was incorporated into the diet but feed conversion was improved by inclusion of grain.

2. No adverse effect of glucan-containing grains on performance or health of weanling rabbits was observed, indicating that dietary β-glucans are not deleterious to rabbits.

3. No response to supplementation of grain-containing diets with β-glucanase (Allzyme BG) was observed in rabbits.

4. Broiler chicks had lower growth rate and feed conversion when fed β-glucan-containing grains as compared to a corn-based control diet.

5. Supplementation with β-glucanase markedly improved performance of chicks fed barley, rye and triticale-containing diets.

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