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Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

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The Effect of Alpha-galactosidase Enzyme with and Without Avizyme 1502 on Performance of Broilers Fed Diets Based on Corn and Soybean Meal[1]

P.W. Waldroup[2], C.A. Fritts, C.A. Keen and F. Yan
Department of Poultry Science, University of Arkansas, Fayetteville AR 72701, USA

Abstract: One experiment in wire-floored batteries and two experiments in litter-floor pens were conducted to evaluate the effects of addition of α-galactosidase enzyme to typical corn-soybean meal based diets for broilers. In two experiments, Avizyme 1502 was fed in conjunction with the α-galactosidase enzyme. In formulating test diets, soybean meal was assigned an ME value beginning at 2440 ME kcal/kg and increased on the assumption that the addition of the enzyme would increase the ME of soybean meal by 10, 20, or 30%. In two experiments, the level of supplemental poultry oil remained constant with increases in apparent ME, while in the third the level of supplemental poultry oil was reduced as the assumed ME level of soybean meal was increased. Male chicks of a commercial broiler strain were used in all experiments. Overall, the results of the three experiments suggest little if any improvement in metabolizable energy of SBM as a result of the addition of an exogenous α-galactosidase enzyme, as indicated by evaluation of body weight gain, feed utilization, calorie conversion, or mortality. No improvements in the above parameters were noted when Avizyme 1502 was added to the diet, alone or in combination with the α-galactosidase enzyme. At the present time, it does not appear that diets based on corn and SBM of average quality would benefit from supplementation with these enzymes.

Key words: Broilers, enzymes, Avizyme, α-galactosidase

Introduction

Soybean meal (SBM) is the primary protein source of poultry diets throughout much of the world. In addition to its protein component, SBM contains a significant amount of carbohydrate. A large portion of this carbohydrate is in the form of oligosaccharides such as raffinose and stachyose which have poor digestibility by monogastric animals because they lack α-1,6 galactosidase enzyme in the intestinal mucosa (Gitzlemann and Auricchio, 1965). The NRC (1982) suggests an energy value for SBM of 2455 ME kcal/kg for the chick and 3155 ME kcal/kg for the pig, a difference of approximately 30% indicating the potential value of improving the utilization of the carbohydrate fraction for the chick. However, much of this difference between species may be due to the extensive hind-gut fermentation typical of swine rather than innate galactosidase enzymes in the pig.

Improvements in the metabolizable energy value of SBM to chickens have been obtained by removal of the oligosaccharides by ethanol extraction (Coon *et al*., 1990) and by genetic modification of the soybean (Parsons *et al*., 2000. Coon *et al*. (1990) reported that removal of the oligosaccharides in SBM by alcohol extraction increased the TME_n of SBM by 20%, and Leske *et al*. (1993) reported that by adding 5.36% stachyose to a soy protein concentrate there was a decrease of 17% in the TME_n as compared to that of the soy concentrate. However, not all studies agree that the metabolizable energy content of SBM for chicks is improved by extraction of the oligosaccharides (Irish *et al*., 1995). Others have attempted to improve the nutritive value of solvent extracted SBM by exogenous treatment with α-galactosidase enzymes, alone or in combination with other enzymes, with variable results (Irish *et al*., 1995; Knap *et al*., 1996; Kidd *et al*., 2001a, 2001b; Graham *et al*., 2002; Ghazi *et al*., 2003). In addition to reduced energy content, the presence of these undigested carbohydrates in SBM contributes to the stickiness of the droppings, which can cause problems with footpad disorders (Abbott *et al*., 1969; Jensen *et al*., 1970; Harms *et al*., 1977; Harms and Simpson, 1977).

Many enzymes have been found to be beneficial when added to poultry diets containing carbohydrate or protein sources containing high levels of nonstarch polysaccharides, such as wheat, barley, rye, peas, and lupins (Bedford and Morgan, 1996; Chesson, 2001; Acamovic, 2001). Few studies, however, have consistently demonstrated a response to the addition of enzymes when the diets are composed of corn and SBM, which make up the majority of energy and protein sources in the United States, Brazil, and other major poultry producing countries. Recent studies have suggested that addition of Avizyme, a product containing a mixture of xylanase, protease, and amylase enzymes, may be beneficial in such types of diets (Wyatt *et al*., 1997, 1999; Zanella *et al*., 1999; Douglas *et al*., 2000; Café *et al*., 2002). Use of such a product in combination with a galactosidase enzyme may provide synergistic effects.

Table 1: Composition (g/kg) and calculated nutrient content of diets fed 1 to 14 d with various assumed increases in metabolizable energy of soybean meal as a result of enzyme supplementation (Experiments 1 and 2)

Ingredient	Assumed increase in soybean meal ME[1]			
	0%	10%	20%	30%
Yellow corn	604.33	593.35	581.77	569.33
Soybean meal 48.5%	299.48	309.37	320.17	331.77
Poultry oil	20.00	20.00	20.00	20.00
Meat-bone meal 50%	50.00	50.00	50.00	50.00
Ground limestone	7.66	7.88	8.12	8.38
Dicalcium phosphate	4.63	5.03	5.47	5.94
Iodized salt	4.00	4.00	4.00	4.00
DL methionine 98%	2.59	2.66	2.74	2.83
L Lysine HCl 98%	0.06	0.00	0.00	0.00
Coban 60[2]	0.75	0.75	0.75	0.75
BMD-50[3]	0.50	0.50	0.50	0.50
Vitamin premix[4]	5.00	5.00	5.00	5.00
Trace minerals[5]	1.00	1.00	1.00	1.00
Enzyme/washed sand[6]	0.00	0.46	0.48	0.50
Total	1000.00	1000.00	1000.00	1000.00
Adjusted ME kcal/kg[7]	3028.50	3089.15	3155.80	3227.35
Unadjusted ME kcal/kg[8]	3028.50	3014.94	3002.18	2988.53
CP %	22.57	22.95	23.38	23.84
Ca %	0.91	0.93	0.95	0.97
Available P %	0.43	0.44	0.45	0.46
Met %	0.62	0.63	0.64	0.66
Lys %	1.23	1.25	1.28	1.32
TSAA %	0.93	0.95	0.97	1.00
Trp %	0.25	0.25	0.26	0.26
Thr %	0.89	0.90	0.92	0.94
Na %	0.22	0.22	0.22	0.22

[1] Indicates assumed increase in energy value with enzyme supplementation.
[2]Source of Monensin. Elanco Animal Health division of Eli Lilly & Co., Indianapolis, IN 46825.
[3]Source of bacitracin methylene disalicylate. Alpharma, Inc., Ft. Lee, NJ 07024.
[4]Provides per kg of diet: vitamin A (from vitamin A acetate) 7714 IU; cholecalciferol 2204 IU; vitamin E (from dl-alpha-tocopheryl acetate) 16.53 IU; vitamin B_{12} 0.013 mg; riboflavin 6.6 mg; niacin 39 mg; pantothenic acid 10 mg; menadione (from menadione dimethylpyrimidinol) 1.5 mg; folic acid 0.9 mg; choline 1040 mg; thiamin (from thiamin mononitrate) 1.54 mg; pyridoxine (from pyridoxine HCl) 2.76 mg; d-biotin 0.066 mg; ethoxyquin 125 mg; Se 0.1 mg.
[5] Provides per kg of diet: Mn (from $MnSO_4{\bullet}H_20$) 100 mg; Zn (from $ZnSO_4{\bullet}7H_2O$) 100 mg; Fe (from $FeSO_4{\bullet}7H_2O$) 50 mg; Cu (from $CuSO_4{\bullet}5H_20$) 10 mg; I from $Ca(IO_3)_2{\bullet}H_20$), 1 mg.
[6]Quantity of either enzyme supplementation or washed builders sand.
[7]Energy value from assumed increase in metabolizable energy from soybean meal.
[8]Energy value based on standard soybean meal without improvement from enzyme.

One of the difficulties in attempting to demonstrate the value of enzyme supplementation in broiler diets is deciding how to formulate diets to take advantage of potential improvements in performance. Several methods are used in application of enzymes. One of the most common is known as the “over-the-top” approach in which the enzyme is added to a diet formulated to meet nutrient recommendations without adjustment for potential contribution of the enzyme. If the diet is already adequate in the nutrient in question, this approach often limits the potential for demonstrating a response. The second method is often referred to as “down-specifications” in which the specification for one or more nutrients is adjusted based on some assumed degree of nutrient release by the enzyme. This may involve adding some nutrient value(s) to the enzyme itself or manual adjustment of the nutrient or ingredient specifications in the computer matrix prior to formulation. The most accurate means of formulation should involve some means of adjusting either the ingredient matrix or the nutrient matrix based upon the expected activity of the enzyme(s) in question.

Three experiments were conducted in the present study, involving chicks grown in both wire-floored battery brooders and litter-floor pens. The objective of the experiments was to evaluate the potential use of an

Table 2: Composition (g/kg) and calculated nutrient content of diets fed 14 to 35 days with various assumed increases in metabolizable energy of soybean meal from enzyme supplementation (Experiments1 and 2)

Ingredient	Assumed increase in soybean meal ME[1]			
	0%	10%	20%	30%
Yellow corn	652.87	644.65	635.63	626.29
Soybean meal 48.5%	253.11	260.76	269.01	277.67
Poultry oil	20.05	20.01	20.13	20.10
Meat-bone meal 50%	50.00	50.00	50.00	50.00
Ground limestone	6.58	6.75	6.93	7.13
Dicalcium phosphate	3.13	3.44	3.79	4.15
Iodized salt	3.64	3.73	3.83	3.94
DL methionine 98%	2.55	2.62	2.68	2.75
L Lysine HCl 98%	0.44	0.40	0.35	0.30
Coban 60[2]	0.75	0.75	0.75	0.75
BMD-50[2]	0.50	0.50	0.50	0.50
Vitamin premix[2]	5.00	5.00	5.00	5.00
Trace minerals[2]	1.00	1.00	1.00	1.00
Enzyme/washed sand[3]	0.38	0.39	0.40	0.42
Total	1000.00	1000.00	1000.00	1000.00
Adjusted ME kcal/kg[4]	3082.00	3135.00	3192.00	3252.00
Unadjusted ME kcal/kg[5]	3082.00	3072.47	3062.92	3052.08
CP %	20.79	21.09	21.41	21.74
Ca %	0.83	0.84	0.86	0.88
Available P %	0.40	0.41	0.42	0.42
Met %	0.59	0.60	0.61	0.62
Lys %	1.12	1.14	1.16	1.18
TSAA %	0.88	0.89	0.91	0.92
Trp %	0.22	0.23	0.23	0.24
Thr %	0.78	0.82	0.84	0.85
Na %	0.21	0.21	0.21	0.22

[1] Indicates assumed increase in energy value with enzyme supplementation. [2]See Table 1.
[3]Quantity of either enzyme or washed builders sand. [4]Energy value from assumed increase in metabolizable energy from soybean meal. [5]Energy value based on standard soybean meal without improvement from enzyme.

exogenous α-galactosidase enzyme, fed with or without Avizyme, on improving the nutritional value of corn-SBM based diets. Effective use of a α-galactosidase enzyme should improve the overall energy value of the SBM, resulting in diets with greater nutrient density, and produce less viscous droppings which may reduce leg disorders.

Materials and Methods

Experimental diets: Experiments 1 and 2 In all experiments, corn and soybean meal of known moisture and crude protein content was used to prepare the diets. Test diets were formulated for 1 to 14, 14 to 35, and 35 to 49 d of age. The diets were formulated to meet nutrient standards for amino acids and minerals of the average broiler producer in a leading agricultural survey[3]. These diets were formulated for optimum nutrient density (metabolizable energy and related nutrients in proportion) commensurate with an inclusion rate of 2% poultry oil. One potential advantage of obtaining greater energy from SBM is the ability to formulate and feed higher energy diets while maintaining similar levels of fat supplementation; therefore we chose to maintain a fixed level of poultry oil and allow energy to increase while maintaining amino acids, calcium, and phosphorus in relation to the anticipated energy increase. A similar approach was utilized in our laboratory in evaluating the use of high oil corn in broiler diets (Adams *et al.*, 1994). Modifications in level of poultry oil would also alter the amount of linoleic acid in the diet, which might itself influence the performance of the chick (Hopkins and Nesheim, 1967; Menge, 1970; Carew and Foss, 1973) thus confounding the results.

In formulating the test diets, SBM was assigned a series of different metabolizable energy values based on the premise that the addition of the α-galactosidase enzyme would improve the metabolizable energy value of the SBM by 10, 20, or 30%, beginning with an assigned value of 2440 ME kcal/kg (NRC, 1994). In each case, the diets continued to be formulated to optimum nutrient density commensurate with 2% poultry oil, resulting in a series of diets with increasingly higher nutrient density (Table 1, 2 and 3).

Table 3: Composition (g/kg) and calculated nutrient content of diets fed 35 to 42 d (Experiment 1) or 35 to 47 d (Experiment 2) with various assumed increases in soybean meal energy as a result of enzyme supplementation (Experiment 1 and 2)

Ingredient	Assumed increase in soybean meal ME[1]			
	0%	10%	20%	30%
Yellow corn	719.79	714.41	708.96	702.96
Soybean meal 48.5%	187.94	192.82	197.87	203.31
Poultry oil	20.02	20.07	20.00	20.08
Meat-bone meal 50%	50.00	50.00	50.00	50.00
Ground limestone	5.73	5.85	5.97	6.10
Dicalcium phosphate	1.53	1.74	1.97	2.21
Iodized salt	4.23	4.31	4.39	4.47
DL methionine 98%	2.28	2.32	2.37	2.42
L Lysine HCl 98%	0.92	0.90	0.87	0.84
L Threonine	0.03	0.04	0.05	0.06
Coban 60[2]	0.75	0.75	0.75	0.75
BMD-50[2]	0.50	0.50	0.50	0.50
Vitamin premix[2]	5.00	5.00	5.00	5.00
Trace minerals[2]	1.00	1.00	1.00	1.00
Enzyme/washed sand[3]	0.28	0.29	0.30	0.30
Total	1000.00	1000.00	1000.00	1000.00
Adjusted ME kcal/kg[4]	3151.60	3192.00	3234.00	3279.00
Unadjusted ME kcal/kg[5]	3151.60	3145.00	3139.03	3132.65
CP %	18.25	18.45	18.64	18.85
Ca %	0.75	0.76	0.77	0.78
Available P %	0.36	0.37	0.37	0.38
Met %	0.52	0.53	0.54	0.55
Lys %	0.96	0.98	0.99	1.00
TSAA %	0.77	0.78	0.79	0.80
Trp %	0.19	0.19	0.20	0.20
Thr %	0.71	0.71	0.72	0.73
Na %	0.23	0.23	0.23	0.24

[1] Indicates assumed increase in energy value with enzyme supplementation. [2]See Table 1.
[3]Quantity of either enzyme or washed builders sand. [4]Energy value from assumed increase in metabolizable energy from soybean meal. [5]Energy value based on standard soybean meal without improvement from enzyme.

Each of these diets, including the control diet with no adjustment in the metabolizable energy content of SBM, was fed with and without the α-galactosidase enzyme product[4] [30] at the rate of 1.5 kg enzyme per 1000 kg of SBM used in the diet, as recommended by the supplier of the enzyme, and with or without the addition of Avizyme 1502[5] at a rate of 0.05%. In non-supplemented diets, inert filler (sand) was added at the same quantity as comparable enzyme-supplemented diets. This resulted in a total of sixteen test diets in a 4 x 2 x 2 factorial arrangement (four levels of SBM improvement, plus or minus α-galactosidase enzyme, plus or minus Avizyme 1502).

In order to minimize possible differences due to mixing, a "Least Common Amount" (LCA) basal diet was mixed for each age period. This involved determining the lowest amount of any given ingredient that was common between the four diets representing the different assumed levels of SBM energy. A large batch of the LCA basal was prepared for each age period. Four basal diets representing the different assumed SBM levels were then prepared by mixing the appropriate amount of the LCA diet with the remaining quantity of the various ingredients to make four sub-basals. Each of the sub-basals was then divided into four aliquots that were supplemented with the appropriate combination of enzymes or washed sand to produce the sixteen dietary treatments. In the first experiment, all diets were in mash form. In the second experiment, starter diets were fed as mash and grower and finisher diets were pelleted.

Experiment 3: Chicks were fed test diets formulated for 1 to 14, 14 to 35, and 35 to 49 d of age. The control test diets were formulated to meet nutrient standards for amino acids and minerals of the average broiler producer as previously described. In this experiment, the test diets remained isocaloric. The diets were formulated so that approximately 0.5% poultry oil was

Table 4: Composition (g/kg) and calculated nutrient content of diets fed 1 to14 d with various assumed increases in soybean meal energy as a result of enzyme supplementation (Experiment 3)

Ingredient	Assumed increase in soybean meal ME[1]			
	0%	10%	20%	30%
Yellow corn	584.82	602.53	619.86	636.76
Soybean meal 48.5%	282.41	279.16	275.98	272.88
Poultry oil	47.73	33.21	19.01	5.14
Pro-Pak[2]	50.00	50.00	50.00	50.00
Ground limestone	9.74	9.77	9.80	9.83
Dicalcium phosphate	10.46	10.42	10.38	10.35
Iodized salt	4.00	4.00	4.00	4.00
DL methionine 98%	1.94	1.93	1.91	1.89
L Lysine HCl 98%	0.61	0.68	0.75	0.82
Vitamin premix[3]	5.00	5.00	5.00	5.00
L-Threonine	0.37	0.38	0.39	0.40
L-Tryptophan	0.25	0.25	0.26	0.27
Trace minerals[3]	1.00	1.00	1.00	1.00
Coban 60[3]	0.75	0.75	0.75	0.75
BMD-50[3]	0.50	0.50	0.50	0.50
Enzyme/washed sand[4]	0.42	0.42	0.41	0.41
Total	1000.00	1000.00	1000.00	1000.00
Adjusted ME kcal/kg[5]	3198.00	3198.00	3198.00	3198.00
Unadjusted ME kcal/kg[6]	3198.00	3131.03	3065.58	3001.58
CP %	21.97	21.97	21.97	21.97
Ca %	0.96	0.96	0.96	0.96
Available P %	0.46	0.46	0.46	0.46
Met %	0.59	0.59	0.59	0.59
Lys %	1.29	1.29	1.29	1.29
TSAA %	0.99	0.99	0.99	0.99
Trp %	0.26	0.26	0.26	0.26
Thr %	0.91	0.91	0.91	0.91
Na %	0.21	0.21	0.21	0.21

[1] Indicates assumed increase in energy value with enzyme supplementation.
[2] Blended animal protein. H. J. Baker & Bro., 595 Summer Street, Stamford, CT 06901-1407. [3]See Table 1.
[4]Quantity of either enzyme or washed builders sand. [5]Energy value from assumed increase in metabolizable energy from soybean meal.
[6] Energy value based on standard soybean meal without improvement from enzyme.

added to the diet with the highest "assumed energy value" for SBM. In previous trials we allowed the energy to increase to an optimum nutrient density associated with an inclusion rate of 2% poultry oil. However, this also resulted in higher levels of protein and certain amino acids, making it difficult to determine if the observed responses were due to the change in energy or due to the increased levels of protein and amino acids. In formulating the test diets, SBM was assigned a series of different energy values based on the premise that the addition of the enzyme will improve the energy value of the SBM by 10, 20, or 30%. Amino acid supplements were used to maintain a constant level of crude protein, lysine, threonine, tryptophan, and TSAA in all diets. Diets were mixed using the Least Common Amount approach as previously described with the four SBM levels being prepared by blending the LCA diet with the remaining quantity of the various ingredients. Composition of the diets is shown in Tables 4, 5, and 6. Each of these diets, including the control diet with no adjustment in the metabolizable energy content of SBM, was fed with and without the α-galactosidase enzyme product at the rate of 1.5 kg enzyme per 1000 kg of SBM used in the diet, as recommended by the supplier. In non-supplemented diets, non-nutritive filler (sand) was added at the same quantity as comparable enzyme-supplemented diets. This resulted in a total of eight test diets in a 4 x 2 factorial arrangement (four levels of SBM improvement, plus or minus α-galactosidase enzyme). Starter diets were fed as mash, while grower and finisher diets were pelleted.

Birds and housing

Experiment 1: Male chicks of a commercial strain[6] were obtained from a local hatchery where they had been vaccinated in ovo for Marek's virus and had received

Table 5: Composition (g/kg) and calculated nutrient content of diets fed 14 to 35 d of age with various assumed increases in metabolizable energy content of soybean meal as a result of enzyme supplementation (Experiment 3)

Ingredients	Assumed increase in soybean meal ME[1]			
	0	10%	20%	30%
Yellow corn	633.04	648.36	663.35	678.02
Soybean meal 48.5%	244.52	241.70	238.95	236.26
Poultry oil	41.68	29.11	16.82	4.81
Pro-Pak[2]	50.00	50.00	50.00	50.00
Ground limestone	8.47	8.50	8.53	8.55
Dicalcium phosphate	8.48	8.45	8.41	8.38
Iodized salt	4.00	4.00	4.00	4.00
DL methionine 98%	1.60	1.59	1.58	1.56
L Lysine HCl 98%	0.37	0.44	0.50	0.56
L-Threonine	0.06	0.07	0.08	0.08
L-Tryptophan	0.16	0.17	0.17	0.18
Vitamin premix[3]	5.00	5.00	5.00	5.00
Trace minerals[3]	1.00	1.00	1.00	1.00
Coban 60[3]	0.75	0.75	0.75	0.75
BMD 50[3]	0.50	0.50	0.50	0.50
Enzyme/washed sand[4]	0.37	0.36	0.36	0.35
Total	1000.00	1000.00	1000.00	1000.00
Adjusted ME kcal/kg[5]	3216.00	3216.00	3216.00	3216.00
Unadjusted ME kcal/kg[6]	3216.00	3158.01	3101.31	3046.02
CP %	20.47	20.47	20.47	20.47
Ca %	0.87	0.87	0.87	0.87
Available P %	0.42	0.42	0.42	0.42
Met %	0.54	0.54	0.54	0.54
Lys %	1.17	1.17	1.17	1.17
TSAA %	0.91	0.91	0.91	0.91
Trp %	0.23	0.23	0.23	0.23
Thr %	0.82	0.82	0.82	0.82
Na %	0.21	0.21	0.21	0.21

[1] Indicates assumed increase in energy value with enzyme supplementation.
[2] Blended animal protein. H. J. Baker & Bro., 595 Summer Street, Stamford, CT 06901-1407. [3]See Table 1.
[4]Quantity of either enzyme or washed builders sand. [5]Energy value from assumed increase in metabolizable energy from soybean meal. [6] Energy value based on standard soybean meal without improvement from enzyme.

vaccinations for Newcastle disease and Infectious Bronchitis post hatch via a coarse spray. They were randomly assigned to compartments in electrically heated battery brooders with raised wire floors. At 14 d the birds were moved to unheated finishing batteries with wire floors. Eight groups of six birds were assigned to each of the test diets and fed from 1 to 42 d of age with feed changes at 14 and 35 d.

Experiment 2: Male chicks of a commercial strain[6] were obtained from a local hatchery where they had been treated as previously described. They were randomly assigned to litter-floor pens in a house of commercial design. New softwood shavings over concrete floors served as litter. Each pen was equipped with two tube feeders and a bell-type automatic water font. Supplemental feeders and waterers were used for the first seven days. Three pens of 60 birds were assigned to each of the test diets and fed from 1 to 47 d. of age with feed changes at 14 and 35 d.

Experiment 3: Male chicks of a commercial strain[6] were obtained from a local hatchery where they had been treated as previously described. They were randomly assigned to litter-floor pens as previously described with new softwood shavings over concrete floors. Six pens of 60 birds were assigned to each of the test diets and fed the test diets from 1 to 42 d of age with feed changes at 14 and 35 d. In all studies, care and management of the birds followed recommended guidelines for animals in agricultural experiments (FASS, 1999).

Measurements

Experiment 1: Birds were group weighed by pen at 1, 14, 35, and 42 d of age and feed consumption measured. Any bird that died or was culled to remove

Table 6: Composition (g/kg) and calculated nutrient content of diets fed 35 to 42 d with different assumed increases in soybean meal energy due to enzyme supplementation (Experiment 3)

Ingredient	Assumed increase in soybean meal ME[1]			
	0%	10%	20%	30%
Yellow corn	700.45	712.33	723.94	735.30
Soybean meal 48.5%	189.44	187.26	185.12	183.04
Poultry oil	33.58	23.84	14.32	5.01
Pro-Pak[2]	50.00	50.00	50.00	50.00
Ground limestone	7.45	7.47	7.49	7.51
Dicalcium phosphate	6.36	6.34	6.31	6.29
Iodized salt	4.00	4.00	4.00	4.00
DL methionine 98%	0.96	0.95	0.94	0.93
L Lysine HCl 98%	0.13	0.18	0.23	0.28
L Threonine	0.03	0.03	0.04	0.04
L Tryptophan	0.07	0.07	0.08	0.08
Vitamin premix[3]	5.00	5.00	5.00	5.00
Trace minerals[3]	1.00	1.00	1.00	1.00
Coban 60[3]	0.75	0.75	0.75	0.75
BMD-50[3]	0.50	0.50	0.50	0.50
Enzyme/washed sand[4]	0.28	0.28	0.28	0.27
Total	1000.00	1000.00	1000.00	1000.00
Adjusted ME kcal/kg[5]	3240.25	3240.25	3240.25	320.45
Unadjusted ME kcal/kg[6]	3240.25	3195.33	3151.45	3108.51
CP %	18.30	18.30	18.30	18.30
Ca %	0.77	0.77	0.77	0.77
Available P %	0.37	0.37	0.37	0.37
Met %	0.45	0.45	0.45	0.44
Lys %	0.99	0.99	0.99	0.99
TSAA %	0.79	0.79	0.79	0.79
Trp %	0.20	0.20	0.20	0.20
Thr %	0.73	0.73	0.73	0.73
Na %	0.21	0.21	0.21	0.21

[1] Indicates assumed increase in energy value with enzyme supplementation.
[2] Blended animal protein. H. J. Baker & Bro., 595 Summer Street, Stamford, CT 06901-1407. [3]See Table 1.
[4]Quantity of either enzyme or washed builders sand. [5]Energy value from assumed increase in metabolizable energy from soybean meal.
[6] Energy value based on standard soybean meal without improvement from enzyme.

possible suffering was weighed to adjust feed conversion. From these data, mean body weight at 14, 35 and 42 d were determined Likewise, feed conversion from 1 to 14, 1 to 35 and 1 to 42 d was determined. From the ME content of the diets, calorie consumption was estimated and calorie conversion ratios calculated (ME kcal/kg gain.). The calorie conversion ratios were calculated in two ways, one using the anticipated ME content of the diet based on the assumption that the α-galactosidase enzyme would improve the ME by 0, 10, 20, or 30%, and the second based on the assumption that no ME increase would result. At 42 d litter trays were subjectively evaluated for stickiness or texture of the droppings.

Experiment 2: Birds were group weighed by pen at 1, 14, 35, and 47 d of age and feed consumption measured. Any bird that died or was culled to remove possible suffering was weighed to adjust feed conversion. From these data, mean body weight at 1, 14, 35 and 47 d were determined. Likewise, feed conversion from 1 to 14, 1 to 35 and 1 to 47 d was determined. From the calculated ME content of the diets, calorie consumption was estimated and calorie conversion ratios (ME kcal/kg gain) calculated as previously described.

Experiment 3: Birds were group weighed by pen at 1, 14, 35, and 42 d of age and feed consumption measured. Any bird that died or was culled to remove possible suffering was weighed to adjust feed conversion. From these data, mean body weight at 1, 14, 35 and 42 d were determined. Likewise, feed conversion from 1 to 14, 1 to 35 and 1 to 42 d was determined. From the calculated ME content of the diets (Table 4), calorie consumption was estimated and calorie conversion ratios (ME kcal/kg gain) calculated as previously described.

Table 7: Effect of assumed increase in metabolizable energy of soybean meal, presence or absence of galactosidase enzyme(GSase) and presence or absence of Avizyme 1502 on body weight of male broilers (Experiment 1)[1]

Assumed increase in ME	Without Avizyme			With Avizyme			Mean		
	W/o Gsase	W/ GSase	Mean	W/o Gsase	W/ Gsase	Mean	W/o Gsase	W/ Gsase	Mean
14 d weight (kg)									
0	0.386	0.395	0.391	0.400	0.396	0.398	0.393	0.395	0.394[b]
10%	0.401	0.406	0.404	0.412	0.400	0.406	0.407	0.403	0.405[a]
20%	0.409	0.420	0.415	0.410	0.420	0.415	0.410	0.420	0.415[a]
30%	0.392	0.388	0.390	0.412	0.417	0.414	0.402	0.402	0.402[a]
Mean	0.397	0.402	0.400	0.409	0.408	0.408	0.403	0.405	
35 d weight (kg)									
0	1.911	1.909	1.910	1.853	1.936	1.895	1.882	1.922	1.902[b]
10%	1.932	1.918	1.925	1.960	1.966	1.963	1.946	1.942	1.944[a]
20%	1.995	2.019	2.007	1.961	1.955	1.958	1.978	1.987	1.983[a]
30%	1.977	1.965	1.971	1.950	1.973	1.961	1.964	1.969	1.966[a]
Mean	1.954	1.952	1.953	1.931	1.957	1.944	1.942	1.955	
42 d weight (kg)									
0%	2.472	2.490	2.481	2.365	2.500	2.432	2.419	2.495	2.457
10%	2.489	2.413	2.451	2.484	2.462	2.473	2.486	2.437	2.462
20%	2.517	2.552	2.535	2.525	2.446	2.485	2.521	2.499	2.510
30%	2.490	2.518	2.504	2.474	2.483	2.478	2.482	2.501	2.491
Mean	2.492	2.493	2.493	2.462	2.473	2.467	2.477	2.483	

Source of variance	14 d		35 d		42 d	
	P-value	SEM	P-value	SEM	P-value	SEM
Soybean (Soy)	0.0256	0.005	0.0003	0.014	0.1455	0.019
Galactosidase (GSase)	0.6362	0.003	0.3552	0.010	0.7447	0.013
Soy x Gsase	0.7690	0.007	0.6861	0.021	0.1011	0.028
Avizyme (Avi)	0.0729	0.003	0.5119	0.010	0.1752	0.013
Soy x Avi	0.2644	0.007	0.1842	0.021	0.5100	0.028
GSase x Avi	0.5419	0.005	0.3197	0.014	0.7944	0.019
Soy x GSase x Avi	0.7652	0.010	0.5199	0.031	0.1524	0.043

[1]Means of eight pens of six birds per treatment in battery brooders.
[ab]Within comparisons, means with common superscripts do not differ significantly ($P < 0.05$)

Table 8: Effect of assumed increase in metabolizable energy of soybean meal, presence or absence of galactosidase enzyme (GSase), and presence or absence of Avizyme 1502 on mortality-adjusted feed utilization by male broilers (Experiment 1)[1]

Assumed increase in ME	Without Avizyme			With Avizyme			Mean		
	W/o GSase	W/ GSase	Mean	W/o GSase	W/ GSase	Mean	W/o GSase	W/ Gsase	Mean
1 to 14 d Feed:Gain Ratio (kg:kg)									
0	1.307	1.246	1.277	1.228	1.249	1.239	1.268	1.247	1.258[a]
10%	1.252	1.247	1.249	1.224	1.251	1.237	1.237	1.249	1.243[a]
20%	1.234	1.219	1.226	1.216	1.194	1.205	1.224	1.206	1.215[b]
30%	1.262	1.243	1.253	1.222	1.230	1.226	1.242	1.236	1.239[a]
Mean	1.264[a]	1.239[b]	1.251[a]	1.223[b]	1.231[b]	1.227[b]	1.243	1.235	
1 to 35 d Feed:Gain Ratio (kg:kg)									
0	1.502	1.524	1.513	1.529	1.520	1.525	1.515	1.522	1.519[a]
10%	1.473	1.521	1.497	1.508	1.468	1.488	1.491	1.495	1.493[b]
20%	1.474	1.470	1.472	1.480	1.490	1.485	1.477	1.480	1.478[b]
30%	1.466	1.476	1.471	1.471	1.486	1.478	1.469	1.481	1.475[b]
Mean	1.479	1.498	1.488	1.497	1.491	1.494	1.488	1.494	
1 to 42 d Feed:Gain Ratio (kg:kg)									
0%	1.637	1.649	1.643	1.671	1.654	1.663	1.654	1652	1.653
10%	1.617	1.595	1.606	1.651	1.628	1.639	1.634	1.611	1.623
20%	1.636	1.631	1.634	1.647	1.647	1.647	1.642	1.639	1.640
30%	1.625	1.623	1.624	1.626	1.648	1.637	1.625	1.636	1.631
Mean	1.629	1.624	1.627	1.649	1.644	1.647	1.639	1.634	

Source of variance	1 to 14 d		1 to 35 d		1 to 42 d	
	P-value	SEM	P-value	SEM	P-value	SEM
Soybean (Soy)	0.0009	0.007	0.0006	0.008	0.2163	0.011
Galactosidase (GSase)	0.2514	0.005	0.4191	0.006	0.6739	0.008
Soy x Gsase	0.4074	0.011	0.9751	0.012	0.7565	0.015
Avizyme (Avi)	0.0011	0.005	0.4889	0.006	0.0628	0.008
Soy x Avi	0.6478	0.011	0.7641	0.012	0.9020	0.016
GSase x Avi	0.0246	0.007	0.1287	0.008	0.9895	0.011
Soy x GSase x Avi	0.1918	0.016	0.1155	0.017	0.8543	0.023

[1]Means of eight pens of six birds per treatment. [ab]Within comparisons, means with common superscripts do not differ significantly ($P<0.05$)

Table 9: Effect of assumed increase in metabolizable energy of soybean meal, presence or absence of galactosidase enzyme (GSase), and presence or absence of Avizyme 1502 on mortality-adjusted calorie conversion by male broilers based on assumed increase in ME (Experiment 1)[1]

Assumed increase in ME	Without Avizyme			With Avizyme			Mean		
	W/o GSase	W/ GSase	Mean	W/o GSase	W/ GSase	Mean	W/o GSase	W/ Gsase	Mean
0 to 14 d ME kcal/kg gain based on assumed increase in ME									
0	3959	3774	3866	3720	3783	3751	3840	3778	3809^{b}
10%	3867	3853	3860	3781	3864	3823	3824	3858	3841^{b}
20%	3893	3845	3869	3836	3767	3802	3864	3806	3836^{b}
30%	4073	4012	4043	3944	3969	3957	4009	3991	4000^{a}
Mean	3948^{a}	3871^{b}	3910^{a}	3821^{b}	3846^{b}	3833^{b}	3885	3858	
0 to 35 d kcal/kg gain based on assumed increase in ME									
0	4614	4684	4649	4699	4673	4686	4656	4678	4667^{b}
10%	4607	4758	4682	4717	4592	4654	4662	4675	4668^{b}
20%	4698	4681	4689	4716	4748	4732	4707	4715	4711^{ab}
30%	4763	4795	4779	4777	4783	4780	4770	4789	4780^{a}
Mean	4670	4730	4700	4727	4699	4713	4699	4714	
0 to 42 d kcal/kg gain based on assumed increase in ME									
0%	5068	5105	5087	5172	5122	5147	5120	5114	5117^{b}
10%	5088	5089	5088	5195	5121	5158	5141	5105	5123^{b}
20%	5236	5218	5227	5182	5269	5225	5209	5244	5226^{a}
30%	5291	5287	5289	5296	5367	5331	5294	5327	5310^{a}
Mean	5171	5175	5173	5211	5220	5215	5191	5197	

Source	0-14 d		0-35 d		0-42 d	
	P-value	SEM	P-value	SEM	P-value	SEM
Soybean (Soy)	<0.0001	23	0.0060	26	<0.0001	32
Galactosidase (GSase)	0.2650	16	0.5364	18	0.8378	22
Soy x Gsase	0.4246	34	0.9973	38	0.8291	46
Avizyme (Avi)	0.0012	16	0.6068	18	0.1692	22
Soy x Avi	0.6781	34	0.7380	36	0.8544	46
GSase x Avi	0.0277	23	0.0855	26	0.9396	31
Soy x GSase x Avi	0.2201	52	0.1406	52	0.5772	67

[1]Means of eight pens of six birds per treatment.[ab]Within comparisons, means with common superscripts do not differ significantly ($P<0.05$)

Table 10: Effect of assumed increase in metabolizable energy of soybean meal, presence or absence of galactosidase enzyme (GSase), and presence or absence of Avizyme 1502 on mortality-adjusted calorie conversion by male broilers based on no increase in soybean energy (Experiment 1)[1]

Assumed increase in ME	Without Avizyme			With Avizyme			Mean		
	W/o GSase	W/ GSase	Mean	W/o GSase	W/ Gsase	Mean	W/o GSase	W/ Gsase	Mean
0 to 14 d ME kcal/kg gain based on no increase in soy ME									
0	3959	3774	3866	3720	3783	3751	3840	3778	3809^{a}
10%	3774	3760	3767	3691	3771	3731	3732	3766	3749^{ab}
20%	3704	3658	3681	3650	3584	3617	3677	3621	3648^{c}
30%	3772	3715	3744	3653	3675	3664	3713	3695	3704^{bc}
Mean	3802^{a}	3726^{b}	3765^{a}	3678^{b}	3703^{b}	3691^{b}	3740	3715	
0 to 35 d ME kcal/kg gain based on no increase in soy ME									
0	4614	4684	4649	4699	4673	4686	4656	4678	4667^{a}
10%	4512	4660	4586	4620	4497	4558	4566	4578	4572^{b}
20%	4501	4486	4493	4519	4550	4534	4510	4518	4514^{bc}
30%	4460	4491	4476	4473	4480	4477	4467	4485	4476^{c}
Mean	4522	4580	4551	4578	4550	4564	4550	4565	
0 to 42 d ME kcal/kg based on no increase in soy ME									
0%	5068	5105	5087	5172	5122	5147	5120	5114	5117^{a}
10%	4992	4992	4992	5096	5024	5060	5044	5008	5026^{b}
20%	5036	5018	5027	4984	5068	5026	5010	5043	5027^{b}
30%	4984	4981	4982	4989	5055	5022	4986	5018	5001^{b}
Mean	5020	5024	5022	5060	5067	5064	5040	5046	

Source	0-14 d		0-35 d		0-42 d	
	P-value	SEM	P-value	SEM	P-value	SEM
Soybean (Soy)	<0.0001	22	<0.0001	25	0.0345	31
Galactosidase (GSase)	0.2512	16	0.5368	17	0.8525	21
Soy x Gsase	0.4043	33	0.9969	37	0.8303	45
Avizyme (Avi)	0.0011	16	0.6018	17	0.1688	22
Soy x Avi	0.6424	33	0.7340	37	0.8472	43
GSase x Avi	0.0241	22	0.0814	25	0.9655	31
Soy x GSase x Avi	0.1859	50	0.1359	55	0.5824	66

[1]Means of eight pens of six birds per treatment. [ab] Within comparisons, means with common superscripts do not differ significantly ($P<0.05$)

Statistical analysis: Pen means served as the experimental unit. In Experiments 1 and 2 the data were analyzed as a factorial arrangement of treatments using the General Linear Models option of SAS (SAS Institue, 1991). Main effects of assumed SBM energy level, galactosidase enzyme, and Avizyme were examined along with all possible two-way and three-way interactions. Significant differences among or between means were separated by repeated t-tests using the lsmeans option of SAS. All statements of statistical significance were based on $P < 0.05$. In Experiment 3, data were analyzed as a factorial arrangement of treatments as described in Experiment 1. Main effects of assumed SBM energy level and galactosidase enzyme were examined along with the interaction of assumed SBM energy level and galactosidase enzyme.

Results

Experiment 1: The effects of the various dietary treatments on body weight at different ages are shown in Table 7. At both 14 and 35 d, birds fed the diets formulated based on an assumed increase in the metabolizable energy of SBM had significantly greater BW than those fed the diet with no assumed increase in ME of SBM. There was no significant difference in BW of birds fed diets with 20 or 30% assumed increase in ME of SBM compared to those fed diets with 10% assumed increase, although numerically greater at 35 d. No significant differences in BW were observed among birds fed the various assumed SBM diets at 42 d. This improvement in body weight was apparently not due to supplementation with either the α-galactosidase enzyme or to Avizyme supplementation (Table 7). There were no significant effects of either enzyme alone or in combination, and no interaction between or among assumed SBM energy levels and either or both enzymes.

A possible explanation for the increased body weight of birds fed the diets formulated on assumed increase in ME of SBM may be found in observation of the nutrient content of the diets. Because the diets were formulated based on maintaining amino acids and essential minerals in relationship to the assumed increased energy content of the diet, the levels of crude protein, methionine, TSAA, lysine, and other amino acids was increased as the assumed increase in SBM energy increased. For example, in diets fed from 1 to 14 d (Table 1) birds fed diets formulated based on a 30% assumed increase in SBM energy had 1.27% more CP, 0.04% more Met, 0.09% more Lys, and 0.07% more TSAA than those fed the diet with no assumed increase in ME of SBM. Similar but lesser differences were seen in grower (Table 2) and finisher (Table 3) diets. Although these diets were formulated to meet or exceed current industry average values and also current NRC (1992) recommendations, this increase in CP and amino acid levels might have stimulated greater BW gains.

The effects of the various dietary treatments on feed conversion at different ages are shown in Table 8. At 14 d, feed conversion tended to be lower as the assumed increase in ME of SBM increased, but was significantly different from the control group only for those fed diets with 20% assumed increase. At 35 d, the feed conversion of all birds fed diets with an assumed increase in ME of SBM was significantly better than that of birds fed the control group. No significant differences were seen at 42 d related to assumed increase in the ME of SBM. These improvements may also be related to the increased levels of CP and essential amino acids in the diets with assumed increase in ME of SBM.

At 14 d, birds fed diets with Avizyme had significantly lower feed conversion than those fed diets without Avizyme with a significant interaction between Avizyme and galactosidase usage. When no Avizyme was added to the diets, the addition of the galactosidase enzyme significantly improved feed conversion. However, when Avizyme was present, no significant differences were noted between feed conversion of birds fed diets with or without galactosidase. No significant effects of the two enzymes, alone or in combination, were observed at 35 or 42 d. There was no interaction of the enzymes with assumed level of SBM ME at any age.

The poultry industry typically evaluates calorie conversion (ME kcal/kg gain) as a measure of feed utilization as it adjusts for differences in dietary energy level between different companies. Table 9 depicts the calorie conversion calculated on the basis that the ME was improved in the SBM as a result of enzyme supplementation, while Table 10 depicts the same values calculated on the basis that there was no improvement in ME of the SBM. As seen in Table 9, calorie utilization significantly worsened as the assumed ME content of the SBM increased, indicating that the ME content of the mixed feeds was overestimated. Table 10 depicts the calorie conversion calculated on the basis that the ME of SBM was not affected by enzyme supplementation. As seen in Table 10, calorie conversion was generally improved as the level of assumed ME of SBM was increased. This suggests that there might have been some actual improvement in SBM energy content due to enzyme supplementation. Indications of this were seen at 14 d by Avizyme supplementation and by the use of the galactosidase enzyme in the absence of Avizyme for both adjusted and unadjusted calorie conversion. However, this effect did not manifest itself at 35 or 42 d.

No differences in mortality were noted among birds fed the various dietary treatments (Table 11). Brooding temperatures in the starter batteries and room temperature in the battery room were kept at optimum conditions during the study with no heat or cold stress encountered during the study.

Table 11: Effect of assumed increase in metabolizable energy of soybean meal, presence or absence of galactosidase enzyme (GSase), and presence or absence of Avizyme 1502 on mortality by male broilers (Experiment 1)[1]

Assumed increase in ME	Without Avizyme			With Avizyme			Mean		
	W/o Gsase	W/ GSase	Mean	W/o Gsase	W/ GSase	Mean	W/o Gsase	W/ Gsase	Mean
0 to 14 d mortality (%)									
0	4.17	0.00	2.08	2.08	2.08	2.08	3.13	1.04	2.08
10%	2.08	6.25	4.17	4.17	5.56	4.86	3.13	5.90	4.51
20%	4.17	6.25	5.21	4.17	0.00	2.08	4.17	3.13	3.65
30%	7.14	2.08	4.61	4.17	4.17	4.17	5.65	3.13	4.39
Mean	4.39	3.65	4.02	3.65	2.95	3.30	4.02	3.30	
0 to 35 d mortality (%)									
0	6.25	2.08	4.17	2.08	2.08	2.08	4.17	2.08	3.13
10%	4.17	10.42	7.29	4.17	8.33	6.25	4.17	9.38	6.77
20%	6.25	10.42	8.33	4.17	2.08	3.12	5.21	6.25	5.73
30%	9.52	4.17	6.85	6.25	4.17	5.21	7.89	4.16	6.03
Mean	6.55	6.77	6.66	4.17	4.17	4.17	5.36	5.47	
0 to 42 d mortality (%)									
0	6.25	2.08	4.17	2.08	2.08	2.08	4.17	2.08	3.13
10%	4.17	10.42	7.29	10.42	8.33	9.38	7.29	9.38	8.33
20%	6.25	10.42	8.33	8.33	2.08	5.21	7.29	6.25	6.77
30%	9.52	4.17	6.85	6.25	4.17	5.21	7.89	4.17	6.03
Mean	6.55	6.77	6.66	6.77	4.17	5.47	6.66	5.47	

Source of variance	0 to 14 d		0 to 35 d		0 to 42 d	
	P-value	SEM	P-value	SEM	P-value	SEM
Soybean (Soy)	0.6116	1.48	0.5065	1.85	0.2563	1.91
Galactosidase (Gsase)	0.6185	1.02	0.9507	1.28	0.5249	1.32
Soy x Gsase	0.5699	2.20	0.3291	2.71	0.7418	2.69
Avizyme (Avi)	0.6185	1.02	0.1694	1.28	0.5249	1.33
Soy x Avi	0.7965	2.17	0.8474	2.71	0.7820	2.81
GSase x Avi	0.9863	1.48	0.9507	1.85	0.4504	1.91
Soy x GSase x Avi	0.4375	3.28	0.7063	4.10	0.3736	4.25

[1]Means of eight pens of six birds per treatment.

Table 12: Effect of assumed increase in metabolizable energy of soybean meal, presence or absence of galactosidase enzyme(GSase) and presence or absence of Avizyme 1502 on body weight of male broilers (Experiment 2)[1]

Assumed increase in soy ME	Without Avizyme			With Avizyme			Mean		
	W/o GSase	W/Gsase	Mean	W/o GSase	W/Gsase	Mean	W/o GSase	W/Gsase	Mean
14 d weight (kg)									
0%	0.376	0.364	0.370	0.367	0.382	0.374	0.371	0.373	0.372[c]
10%	0.395	0.388	0.392	0.367	0.383	0.375	0.381	0.386	0.384[b]
20%	0.397	0.394	0.396	0.400	0.399	0.399	0.399	0.396	0.397[a]
30%	0.398	0.392	0.395	0.398	0.387	0.393	0.398	0.390	0.394[a]
Mean	0.392	0.385	0.388	0.383	0.388	0.385	0.387	0.386	
35 d weight (kg)									
0%	1.980	1.983	1.981	1.964	2.021	1.992	1.972	2.002	1.987
10%	2.064	2.027	2.046	1.973	2.063	2.018	2.019	2.045	2.032
20%	2.038	2.013	2.025	2.016	2.055	2.035	2.027	2.034	2.030
30%	1.972	2.044	2.008	2.049	2.013	2.031	2.010	2.028	2.019
Mean	2.013	2.017	2.015	2.000	2.038	2.019	2.007	2.027	
47 d weight (kg)									
0%	2.796	2.859	2.827	2.810	2.904	2.857	2.803	2.882	2.842[b]
10%	3.040	2.942	2.991	2.986	2.975	2.981	3.013	2.959	2.986[a]
20%	2.961	2.972	2.966	2.930	2.991	2.961	2.945	2.981	2.963[a]
30%	2.909	2.958	2.933	2.945	2.819	2.882	2.927	2.888	2.908[ab]
Mean	2.926	0.932	2.929	2.918	2.922	2.920	2.922	2.927	

Source of variation	14 d		35 d		47 d	
	P-value	SEM	P-value	SEM	P-value	SEM
Soybean (Soy)	<0.0001	0.003	0.2477	0.017	0.0193	0.032
Galactosidase (GSase)	0.7629	0.002	0.2352	0.012	0.8675	0.023
Soy x Gsase	0.5081	0.005	0.9648	0.026	0.4380	0.049
Avizyme (Avi)	0.3969	0.002	0.8171	0.012	0.7733	0.023
Soy x Avi	0.0884	0.005	0.7504	0.026	0.8469	0.049
GSase x Avi	0.0665	0.003	0.3242	0.017	0.9798	0.033
Soy x GSase x Avi	0.1935	0.007	0.1014	0.040	0.4647	0.076

[1]Means of three pens of 60 birds per treatment in litter floor pens.
[ab]Within comparisons, means with common superscripts do not differ significantly ($P < 0.05$)

Table 13: Effect of assumed increase in metabolizable energy of soybean meal, presence or absence of galactosidase enzyme (GSase), and presence or absence of Avizyme 1502 on mortality-adjusted feed utilization by male broilers (Experiment 2)

[1]Assumed increase in soy ME	Without Avizyme W/o GSase	W/ GSase	Mean	With Avizyme W/o Gsase	W/ GSase	Mean	Mean W/o GSase	W/ Gsase	Mean
1 to 14 d g feed:g gain									
0%	1.424	1.460	1.442	1.514	1.419	1.466	1.469	1.439	1.454
10%	1.401	1.480	1.441	1.505	1.444	1.474	1.453	1.462	1.458
20%	1.446	1.383	1.415	1.386	1.374	1.380	1.416	1.379	1.397
30%	1.444	1.390	1.417	1.432	1.440	1.436	1.438	1.415	1.426
Mean	1.429	1.428	1.429	1.459	1.419	1.439	1.444	1.424	
1 to 35 d g feed:g gain									
0%	1.605	1.619	1.612	1.608	1.607	1.608	1.607	1.613	1.610
10%	1.614	1.609	1.611	1.622	1.590	1.606	1.618	1.600	1.609
20%	1.641	1.618	1.629	1.604	1.589	1.596	1.622	1.603	1.613
30%	1.635	1.573	1.604	1.617	1.596	1.606	1.626	1.584	1.605
Mean	1.624	1.605	1.614	1.613	1.596	1.604	1.618	1.600	
1 to 47 d g feed:g gain									
0%	1.780	1.824	1.812	1.829	1.805	1.817	1.814	1.814	1.814
10%	1.788	1.791	1.790	1.810	1.795	1.803	1.799	1.793	1.796
20%	1.813	1.776	1.795	1.803	1.790	1.797	1.808	1.783	1.796
30%	1.802	1.778	1.790	1.803	1.818	1.811	1.803	1.798	1.801
Mean	1.801	1.792	1.797	1.811	1.802	1.807	1.806	1.797	

Source of variation	1 to 14 d P-value	SEM	1 to 35 d P-value	SEM	1 to 47 d P-value	SEM
Soybean (Soy)	0.3989	0.029	0.9767	0.013	0.3638	0.009
Galactosidase (GSase)	0.4654	0.020	0.1632	0.009	0.2910	0.006
Soy x Gsase	0.9336	0.043	0.6108	0.020	0.7288	0.013
Avizyme (Avi)	0.7007	0.020	0.4395	0.009	0.2438	0.006
Soy x Avi	0.8259	0.043	0.7584	0.020	0.8527	0.013
GSase x Avi	0.4769	0.029	0.9378	0.013	0.9428	0.009
Soy x GSase x Avi	0.3875	0.054	0.7952	0.030	0.2548	0.020

[1]Means of three pens of 60 birds per treatment in litter floor pens.

Table 14: Effect of assumed increase in metabolizable energy of soybean meal, presence or absence of galactosidase enzyme (GSase), and presence or absence of Avizyme 1502 on mortality-adjusted calorie conversion by male broilers based on assumed increase in ME (Experiment 2)[1]

Assumed increase in soy ME	Without Avizyme W/o GSase	W/ GSase	Mean	With Avizyme W/o Gsase	W/ GSase	Mean	Mean W/o GSase	W/ GSase	Mean
1 to 14 d ME kcal/kg Gain based on assumed increase in ME									
0%	4313	4422	4367	4569	4296	4433	4441	4359	4400
10%	4327	4573	4450	4648	4461	4555	4488	4517	4503
20%	4564	4365	4465	4374	4338	4356	4469	4351	4410
30%	4660	4485	4572	4621	4646	4634	4640	4565	4603
Mean	4466	4461	4464	4553	4435	4494	4510	4448	
1 to 35 d ME kcal/kg Gain based on assumed increase in ME									
0%	4933	4976	4955	4943	4941	4942	4938	4958	4948[c]
10%	5047	5032	5040	5073	4975	5024	5060	5003	5032[bc]
20%	5228	5154	5191	5110	5064	5087	5169	5109	5139[ab]
30%	5309	5109	5209	5251	5183	5217	5280	5146	5213[a]
Mean	5130	5068	5099	5094	5041	5067	5112	5054	
1 to 47 d ME kcal/kg Gain based on assumed increase in ME									
0%	5586	5662	5624	5676	5602	5639	5631	5632	5631[c]
10%	5639	5647	5643	5707	5658	5682	5673	5653	5663[c]
20%	5811	5692	5752	5780	5736	5758	5795	5714	5755[b]
30%	5874	5797	5836	5879	5927	5903	5877	5862	5869[a]
Mean	5727	5700	5714	5760	5731	5746	5744	5715	

Source of variance	1 to 14 d P-value	SEM	1 to 35 d P-value	SEM	1 to 47 d P-value	SEM
Soybean (Soy)	0.3207	90	0.0002	42	<0.0001	28
Galactosidase (GSase)	0.4815	62	0.1575	29	0.2894	19
Soy x Gsase	0.9387	134	0.5928	62	0.7275	42
Avizyme	0.7255	62	0.4389	29	0.2371	19
Soy x Avi	0.8344	134	0.7530	62	0.8494	42
GSase x Avi	0.5183	90	0.9235	42	0.9697	28
Soy x GSase x Avi	0.4137	208	0.7905	96	0.2567	64

[1]Means of three pens of 60 birds per treatment in litter floor pens.
[abc]Within comparisons, means with common superscripts do not differ significantly ($P < 0.05$)

Table 15: Effect of assumed increase in metabolizable energy of soybean meal, presence or absence of galactosidase enzyme (GSase), and presence or absence of Avizyme 1502 on calorie conversion by male broilers based on no increase in soybean meal energy (Experiment 2)[1]

Assumed increase in soy ME	Without Avizyme			With Avizyme			Mean		
	W/o GSase	W/GSase	Mean	W/o Gsase	W/Gsase	Mean	W/o GSase	W/Gsase	Mean
1 to 14 d ME kcal/kg Gain based on no increase in ME									
0%	4313	4422	4367	4569	4296	4433	4441	4359	4400
10%	4224	4463	4343	4537	4354	4445	4380	4409	4394
20%	4342	4152	4247	4161	4126	4144	4251	4139	4195
30%	4314	4153	4234	4279	4302	4291	4297	4227	4262
Mean	4298	4298	4298	4386	4270	4328	4342	4284	
1 to 35 d ME kcal/kg Gain based on no increase in ME									
0%	4933	4976	4955	4943	4941	4942	4938	4958	4948
10%	4943	4929	4936	4968	4872	4920	4955	4900	4928
20%	5010	4939	4975	4897	4853	4875	4954	4896	4925
30%	4972	4785	4878	4918	4854	4886	4945	4819	4882
Mean	4965	4907	4936	4932	4880	4906	4948	4894	
1 to 47 d ME kcal/kg Gain based on no increase in ME									
0%	5586	5662	5624	5676	5602	5639	5631	5632	5631
10%	5536	5544	5540	5602	5555	5579	5569	5549	5559
20%	5596	5482	5539	5567	5525	5546	5581	5504	5542
30%	5544	5471	5508	5549	5593	5571	5546	5532	5539
Mean	5565	5540	5553	5599	5569	5584	5582	5554	

Source of variance	1 to 14 d		1 to 35 d		1 to 47 d	
	P-value	SEM	P-value	SEM	P-value	SEM
Soybean (Soy)	0.2417	86	0.6598	40	0.0545	27
Galactosidase (GSase)	0.4806	59	0.1648	28	0.2920	19
Soy x Gsase	0.9372	128	0.6073	60	0.7373	40
Avizyme (Avi)	0.7170	59	0.4383	28	0.2422	19
Soy x Avi	0.8317	128	0.7578	60	0.8652	40
GSase x Avi	0.4872	86	0.9409	40	0.9317	27
Soy x GSase x Avi	0.3992	199	0.7965	93	0.2553	62

[1]Means of three pens of 60 birds per treatment in litter floor pens.

Table 16: Effect of assumed increase in metabolizable energy of soybean meal, presence or absence of galactosidase enzyme (GSase), and presence or absence of Avizyme 1502 on mortality by male broilers (Experiment 2)[1]

Assumed increase in soy ME	Without Avizyme			With Avizyme			Mean		
	W/o GSase	W/ GSase	Mean	W/o GSase	W/ GSase	Mean	W/o GSase	W/ GSase	Mean
1 to 14 d % mortality									
0%	1.67	0.56	1.11	0.00	1.11	0.56	0.83	0.83	0.83
10%	0.00	0.00	0.00	1.67	2.22	1.94	0.83	1.11	0.97
20%	0.56	0.56	0.56	1.11	056	0.83	0.83	0.56	0.69
30%	0.00	0.56	0.28	0.56	1.67	1.11	0.27	1.11	0.69
Mean	0.56	0.42	0.49	0.83	1.39	1.11	0.69	0.90	
1 to 35 d % mortality									
0%	4.17	1.67	2.92	1.67	2.22	1.94	2.92	1.94	2.43
10%	2.22	1.11	1.67	5.00	4.44	4.72	3.61	2.77	3.19
20%	2.78	1.67	2.22	2.78	1.11	1.94	2.77	1.39	2.08
30%	1.67	0.83	1.25	1.11	1.67	1.39	1.39	1.25	1.32
Mean	2.71	1.32	2.01	2.64	2.36	2.50	2.67	1.84	
1 to 47 d % mortality									
0%	5.83	6.67	6.25	5.00	3.33	4.17	5.41	5.00	5.21
10%	4.44	3.33	3.89	6.11	7.22	6.67	5.28	5.28	5.28
20%	5.56	6.11	5.83	5.00	7.22	6.11	5.28	6.67	5.97
30%	6.67	7.50	7.08	3.89	5.83	4.86	5.28	6.67	5.97
Mean	5.63	5.90	5.76	5.00	5.90	5.45	5.31	5.90	

Source of variation	1 to 14 d		1 to 35 d		1 to 47 d	
	P-value	SEM	P-value	SEM	P-value	SEM
Soybean (Soy)	0.9379	0.36	0.3951	0.81	0.9475	1.30
Galactosidase (GSase)	0.5677	0.26	0.2825	0.55	0.6318	0.87
Soy x Gsase	0.7314	0.51	0.9528	1.26	0.9307	2.02
Avizyme (Avi)	0.0929	0.26	0.5280	0.55	0.7995	0.87
Soy x Avi	0.1183	0.51	0.2511	1.15	0.4286	0.84
GSase x Avi	0.3431	0.36	0.4712	0.77	0.7995	1.24
Soy x GSase x Avi	0.6012	0.72	0.8569	1.78	0.9013	2.85

[1]Means of three pens of 60 birds per treatment in litter floor pens.

Table 17: Effect of assumed increase in metabolizable energy of soybean meal, and presence or absence of galactosidase enzyme (GSase) on body weight of male broilers (Experiment 3)[1]

Assumed increase in soy ME	14 d weight (kg)			35 d weight (kg)			42 d weight (kg)		
	W/o GSase	W/GSase	Mean	W/o GSase	W/GSase	Mean	W/o GSase	W/Gsase	Mean
0%	0.366	0.373	0.370[a]	2.126	2.155	2.140[a]	2.781	2.787	2.784[a]
10%	0.372	0.367	0.369[a]	2.172	2.124	2.148[a]	2.797	2.795	2.796[a]
20%	0.367	0.361	0.364[a]	2.147	2.118	2.133[a]	2.820	2.760	2.790[a]
30%	0.347	0.356	0.352[b]	2.061	2.090	2.076[b]	2.684	2.713	2.698[b]
Mean	0.363	0.364	2.126		2.122	2.770	2.764		

Source of variation	14 d P-value	14 d SEM	35 d P-value	35 d SEM	42 d P-value	42 d SEM
Soybean (Soy)	0.0009	0.003	0.0009	0.013	0.0003	0.017
Galactosidase (GSase)	0.6552	0.002	0.7343	0.009	0.6958	0.012
Soy x Gsase	0.2370	0.005	0.0809	0.019	0.2999	0.025

[1]Means of six pens of 60 birds per treatment in litter floor pens.
[ab]Within comparisons, means with common superscripts do not differ significantly (P<0.05).

Table 18: Effect of assumed increase in metabolizable energy of soybean meal and presence or absence of galactosidase enzyme (GSase) on mortality-adjusted feed utilization by male broilers (Experiment 3)[1]

Assumed increase in soy ME	0-14 d g feed:g gain			0-35 d g feed:g gain			0-42 d g feed:g gain		
	W/o GSase	W/GSase	Mean	W/o GSase	W/GSase	Mean	W/o GSase	W/Gsase	Mean
0%	1.344	1.331	1.338[bc]	1.528	1.503	1.516[bc]	1.639	1.626	1.632[c]
10%	1.328	1.342	1.335[c]	1.494	1.506	1.500[c]	1.637	1.616	1.627[c]
20%	1.374	1.367	1.370[bc]	1.531	1.519	1.525[b]	1.645	1.660	1.653[b]
30%	1.406	1.393	1.399[a]	1.543	1.549	1.546[a]	1.693	1.666	1.680[a]
Mean	1.363	1.358		1.524	1.519		1.654	1.642	

Source of variation	0-14 d P-value	0-14 d SEM	0-35 d P-value	0-35 d SEM	0-42 d P-value	0-42 d SEM
Soybean (Soy)	0.0009	0.012	0.0006	0.007	<0.0001	0.007
Galactosidase (GSase)	0.6872	0.009	0.5264	0.005	0.0981	0.005
Soy x Gsase	0.8447	0.018	0.2258	0.010	0.1595	0.010

[1]Means of six pens of 60 birds per treatment in litter floor pens.
[abc]Within comparisons, means with common superscripts do not differ significantly (P<0.05).

Table 19: Effect of assumed increase in metabolizable energy of soybean meal and presence or absence of galactosidase enzyme (GSase) on mortality-adjusted calorie conversion by male broilers based on assumed increase in ME (Experiment 3)[1]

Assumed increase in soy ME	0-14 d ME kcal/kg gain			0-35 d ME kcal/kg gain			0-42 d ME kcal/kg gain		
	W/o GSase	W/ GSase	Mean	W/o GSase	W/ GSase	Mean	W/o GSase	W/ GSase	Mean
0%	4298	4258	4278[bc]	4910	4831	4870[bc]	5278	5236	5257[c]
10%	4248	4291	4270[c]	4801	4840	4820[c]	5274	5207	5241[c]
20%	4393	4371	4382[ab]	4919	4880	4899[bc]	5299	5347	5323[b]
30%	4495	4454	4475[a]	4958	4979	4968[a]	5454	5367	5411[a]
Mean	4359	4343		4897	4882		5326	5289	

Source of variation	0-14 d P-value	0-14 d SEM	0-35 d P-value	0-35 d SEM	42 d P-value	42 d SEM
Soybean (Soy)	0.0009	38	0.0006	23	<0.0001	22
Galactosidase (Gsase)	0.6871	28	0.5252	17	0.0980	16
Soy x Gsase	0.8447	57	0.2258	33	0.1561	33

[1]Means of six pens of 60 birds per treatment in litter floor pens.
[abc]Within comparisons, means with common superscripts do not differ significantly (P<0.05).

No apparent differences were noted in apparent stickiness of the droppings at 42 d of age (data not shown). Abbott *et al*. (1969) and Jensen *et al*. (1970) reported that high levels of SBM in diets of young turkey poults resulted in a high incidence of footpad dermatitis, associated with sticky droppings adhering to the footpad. Jensen *et al*. (1970) reported that the factor associated with the dermatitis was in the non-protein portion of the SBM. It should be noted that SBM inclusion rates in diets for young turkeys is typically much greater

Table 20: Effect of assumed increase in metabolizable energy of soybean meal and presence or absence of galactosidase enzyme (GSase), on mortality-adjusted calorie conversion based on no increase in soybean energy (Experiment 3)[1]

Assumed increase in soy ME	0-14 d ME kcal/kg gain			0-35 d ME kcal/kg gain			0-42 d ME kcal/kg gain		
	W/o GSase	W/GSase	Mean	W/o GSase	W/GSase	Mean	W/o Gsase	W/GSase	Mean
0%	4298	4258	4278	4910	4831	4870[a]	5278	5236	5257[a]
10%	4159	4201	4180	4712	4751	4731[b]	5184	5118	5150[b]
20%	4212	4190	4201	4740	4702	4721[b]	5119	5166	5143[b]
30%	4219	4180	4200	4690	4710	4700[b]	5181	5097	5139[b]
Mean	4222	4207	4763		4748		5190	5154	

Source of variation	0-14 d		0-35 d		0-42 d	
	P-value	SEM	P-value	SEM	P-value	SEM
Soybean (Soy)	0.2568	38	<0.0001	23	0.0005	22
Galactosidase (GSase)	0.6947	27	0.5090	16	0.0966	16
Soy x Gsase	0.8480	56	0.2127	36	0.1555	32

[1]Means of six pens of 60 birds per treatment in litter floor pens.

Table 21: Effect of assumed increase in metabolizable energy of soybean meal and the presence or absence of galactosidase enzyme (GSase) on percent mortality by male broilers (Experiment 3)[1]

Assumed increase in soy ME	0-14 d			0-35 d			0-42 d		
	W/o GSase	W/GSase	Mean	W/o GSase	W/GSase	Mean	W/o GSase	W/Gsase	Mean
0%	1.39	1.11	1.25	3.06	3.61	3.33	4.72	6.39	5.56
10%	1.00	0.83	0.92	2.67	2.50	2.58	5.33	4.17	4.75
20%	0.67	1.11	0.89	1.33	1.94	1.64	6.33	5.56	5.94
30%	0.33	1.19	0.76	1.33	3.10	2.21	4.00	6.19	5.10
Mean	0.85	1.06	2.10	2.79	5.10	5.58			

Source of variation	0-14 d		0-35 d		0-42 d	
	P-value	SEM	P-value	SEM	P-value	SEM
Soybean (Soy)	0.7834	0.36	0.4002	0.70	0.8492	1.02
Galactosidase (GSase)	0.5503	0.26	0.3120	0.51	0.6347	0.74
Soy x Gsase	0.6354	0.54	0.7996	1.04	0.5462	1.50

[1]Means of six pens of 60 birds per treatment in litter floor pens.

than used in broiler diets so this effect might not be observable in broiler diets.

Experiment 2: As seen in the first experiment, an increase in the assumed ME content of SBM resulted in significant improvements in body weight at 14 and 47 d with numerical improvements at 35 d (Table 12). However, this improvement did not appear to be the result of enzyme treatment, as there were no significant effects of either the alpha galactosidase enzyme or the Avizyme enzyme on body weight at any age period, or any interaction between the two enzymes. There were no significant effects of dietary treatments on feed conversion (Table 13).

In agreement with the first experiment, the caloric utilization of diets was significantly worsened by increased assumed ME content of SBM (Table 14) with no significant effects of the two enzymes, alone or in combination, suggesting that there was no actual improvement in ME of the SBM in this study. This is supported by the fact that calorie conversion, based on the assumption that there was no effect of the enzyme treatment on ME of SBM, was not significantly different among treatments (Table 15). Mortality was not significantly influenced by dietary treatments (Table 16).

Experiment 3: Diets formulated based on assumed increases in the metabolizable energy content of SBM had a significant effect on body weight of male broilers at 14, 35, and 42 d of age (Table 17). The body weight of broilers fed diets based on 10 or 20% assumed increase in SBM ME did not differ significantly from that of broilers fed diets with no assumed increase in SBM ME; the body weight of birds fed diets based on 30% assumed increase in SBM ME were significantly lighter than all other treatment groups. The presence or absences of the α-galactosidase enzyme had no influence on the response to the assumed increase in SBM ME, in agreement with previous experiments in this study.

The utilization of feed (kg feed per kg gain) was significantly affected by the level of assumed energy increase in SBM ME (Table 18). Feed utilization worsened in almost a linear manner as the assumed change in SBM ME was increased from 0 to 30%. There was no apparent effect of the α-galactosidase enzyme on feed utilization or any indication of an interaction with the assumed increase in SBM ME, suggesting that there was no benefit from addition of the enzyme to the diets. Evaluation of the calorie conversion by broilers (ME kcal per kg gain) based on the assumed increase in SBM ME also suggests that there was no improvement in ME of the SBM by the α-galactosidase enzyme (Table 19). Increasing the degree of assumed increase in SBM ME resulted in a worsening of the calorie conversion ratio, indicating that more calories were required to produce a unit of gain. There was no significant effect of the α-galactosidase enzyme on calorie conversion, although some indication of benefits ($P = 0.09$) were observed at 42 d. When calorie conversion was based on the assumption that no change resulted in the ME of SBM, diets based on the assumed increase in SBM energy had calorie conversion that were equal (14 d) or significantly improved (35 and 42 d) compared to that of diets based on 0% improvement (Table 20). There was no significant effect of the α-galactosidase enzyme on calorie conversion, although again some suggestion that the addition of the enzyme may have improved calorie conversion at 42 d of age ($P = 0.09$).

Mortality during the study was not significantly affected by any of the dietary factors (Table 21), in agreement with previous studies.

Discussion

Studies in which TME determinations were made of soybeans varying in oligosaccharide content due to ethanol extraction or from genetic selection generally show improved digestibility of energy and protein (Coon *et al.*, 1990; Parsons *et al.*, 2000) indicating that chicks do not utilize these fractions well. Coon *et al.* (1990) reported that removal of the oligosaccharides in SBM by alcohol extraction increased the TME_n of SBM by 20%, and Leske *et al.* (1993) reported that by adding 5.36% stachyose to a soy protein concentrate there was a decrease of 17% in the TME_n as compared to that of the soy concentrate. However, trials in which chicks have been fed diets using supplements with α-galactosidase activity in an attempt to improve the utilization of these oligosaccharides have demonstrated variable results.

Irish *et al.* (1995) reported that the addition of a α-galactosidase enzyme to corn-SBM diets had no effect on live weight gain, feed efficiency, protein digestibility, or the digestible energy of the feed when fed to chickens. In a second experiment by these authors, ethanol extraction or incubation of SBM with α-galactosidase decreased the concentration of α-galactosides in the SBM, but no improvements in liveweight gain, feed efficiency, or apparent protein digestibility were noted when the meal was fed to chickens. Knap *et al.* (1996) reported that a significant improvement in bioavailability of energy was observed when an α-galactosidase was added to SBM precision-fed to adult cockerels, with increases of 4.4 and 8.8% in TME from the addition of 1000 and 1500 GALU/kg SBM, respectively. In a subsequent trial by Knap *et al.* (1996), a corn-SBM diet was supplemented with an α-galactosidase at 0, 500, 1000, and 1500 GALU/kg of SBM. At 21 d of age the feed conversion ratio was improved by 2.8% with 1000 GALU/kg SBM and at 42 d was improved 1.7% with 1500 GALU/kg. It should be noted that different authors use different methodology or units to express α-galactosidase activity; however, this suggests that the dosage level of enzyme used in the present trial may not have been sufficient to elicit a response. Kidd *et al.* (2001a) utililized an enzyme that consisted primarily of an alpha-galactosidase but which also contained α-amylase, β-glucanase, protease, xylanase, and cellulase activity. This product was added “over-the-top” post-pelleting to nutritionally complete corn SBM diets in a study where birds were grown to 49 d in hot summer temperatures. Birds fed the enzyme-supplemented diets had significantly improved feed conversion and lower mortality than the birds fed the unsupplemented control diets with no significant difference in live weight, carcass yield, or breast yield. In a second study in which birds were maintained in battery brooders and fed the test diets to 18 d, no significant differences in BW, feed intake, feed conversion, or mortality were noted. In a second report, Kidd *et al.* (2001b) evaluated an enzyme that consisted primarily of α-galactosidase enzyme but which also contained activities of α-amylase, β-glucanase, protease, xylanase, and cellulase. The enzyme was added to diets of broilers reared in thermoneutral and warm weather conditions. The enzyme treatment significantly improved feed conversion in both warm and thermoneutral conditions; oddly enough, however, no differences in calorie conversion were noted.

Graham *et al.* (2002) treated SBM with a α-galactosidase and reported that the enzyme treatment degraded raffinose and stachyose in SBM by 69 and 54%, respectively, compared to untreated SBM. However, when fed to chickens it was found that chick growth performance was not significantly improved by enzyme treatment. Ghazi *et al.* (2003) reported on trials in which tube-fed broiler cockerels were used to measure the effects of different enzyme treatments on true metabolizable energy (TME) and true nitrogen digestibility of a commercial solvent-extracted, heat-treated SBM. In the first experiment, the addition of an α-galactosidase (from A. oryzae) improved TME and TND, with the results similar whether the treatment was applied by pre-incubation of SBM with the enzyme for 2 h and 50 C or by simple mixing of the enzyme with SBM prior to feeding. In a second trial, addition of protease enzymes or the α-galactosidase, alone or in all possible combinations, resulted in significant improvements in the TME and TND when fed to the cockerels. In the third trial, graded levels of the α-galactosidase (0 to 0.25 g/kg SBM) were evaluated. Increases in the TME and TND were nonlinear with the greatest response occurring at the lower levels of enzyme supplementation. In a final experiment, the α-galactosidase was mixed with SBM at levels of 0, 0.025, and 0.25 g/kg of SBM and the treated meals incorporated into semi-purified diets containing 450 g of SBM per kg. These diets were then fed to chicks for 21 d. Similar patterns of increases in nutrient digestibility were observed in this study. These authors concluded that addition of certain proteases and α-galactosidase significantly improved the nutritive value of SBM.

The response of broiler chicks to the addition of Avizyme to the diet has been sporadic. Wyatt *et al.* (1997) reported that the addition of Avizyme to sorghum-SBM based diets improved liveweight-corrected feed conversion by 5 to 16 points over three experiments and allowed for a reduction in diet specifications by 3% without adversely affecting broiler performance. In studies reported by Zanella *et al.* (1999) addition of Avizyme to corn-based diets with SBM, extruded SBM, or roasted soybeans resulted in significant improvements in digestibility of crude protein, starch, and fat as well as a significant improvement in metabolizable energy. Zanella *et al.* (1999) reported that addition of Avizyme significantly improved body weight gain and feed conversion in one trial but showed no significant difference between treatments in a second trial. Douglas *et al.* (2000) reported that Avizyme had no significant effect on body weight gain or feed utilization but resulted in a significant improvement in ileal digestible energy. There was a significant interaction between the source of SBM used in the test diets and the response to Avizyme, with Avizyme increasing the DE of SBM of low ileal DE to a greater extent than that of SBM with a high ileal DE.

Café *et al.* (2002) reported that the addition of 0.1% Avizyme 1500 to corn-SBM diets resulted in significantly improved growth and feed conversion, and stated that the response was probably due to improvement in overall digestibility of crude protein, starch, and fat in the diets although no direct determination of digestibility was undertaken.

Although no response to Avizyme 1502 was observed in the present study, it has been demonstrated that response to Avizyme or other similar enzymes may be influenced by variation in the quality of SBM (Douglas *et al.*, 2000) or corn (Wyatt *et al.*, 1999) used in the study, although no guidelines as to quality were proposed by either author. Analysis of the corn and SBM used in the studies reported herein did not indicate any apparent problems in nutrient content.

Overall, the results of the three experiments conducted in this study suggest little if any improvement in metabolizable energy of SBM as a result of the addition of an exogenous α-galactosidase enzyme, as indicated by evaluation of body weight gain, feed utilization, calorie conversion, or mortality. No improvements in the above parameters were noted when Avizyme 1502 was added to the diet, alone or in combination with the α-galactosidase enzyme. At the present time, it does not appear that diets based on corn and SBM of average quality would benefit from supplementation with these enzymes.

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[2]To whom correspondence should be addressed: waldroup@uark.edu.

[3]Agri-Stats, Fort Wayne, IN.

[4]Loders Croklaan, Channahon IL. The α-galactosidase enzyme was stated to contain a minimum of 30 units/g where 1 gram of αgalactosidase converts 30 micromoles of p-nitrophenyl-α.

[5]Danisco Animal Nutrition, St. Louis MO 63147. Avizyme 1502 is guaranteed by the manufacturer to contain not less than 600 units/g of xylanase (Trichoderma longbrachatum) activity, not less than 8000 units/g of protease (Bacillus subtilis) activity, and not less than 800 units/gram of amylase (Bacillus subtilis) activity. One xylanase unit liberates 1 µmol of reducing sugar (expressed as xylose equivalence) in one minute under the conditions of the assay. One protease unit liberates one µmol of tyrosine per minute under conditions of the assay. One alpha-amylase unite catalyzes 1 µmol of hydrolysis of glycosidic linkages in one minute under the conditions of the assay.

[6]Cobb 500. Cobb-Vantress, Inc., Siloam Springs AR.