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Effects of a Mix of Carbohydrases on Live Performance and Carcass Yield of Broilers Fed All Vegetable Diets Based on Corn and Soybean Meal

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Abstract: A study was conducted to compare live performance and the yield of carcass and commercial cuts of broiler chickens fed all vegetable diets supplemented with a mix of enzymes targeting the carbohydrate fraction of soybean meal. All vegetable diets, antibiotic free, were formulated with corn and soybean meal as major ingredients. Treatments were a dietary Control without enzymes and diets composed by the supplementation to produce the other treatments with a xylanase (EC 3.2.1.8), a pectinase (EC 3.2.1.15) and a alpha-galactosidase (EC 3.2.1.22) in the amount of 100 grams per Ton each. These enzymes were included in the feeds over the top at the expense of corn individually, on a two by two basis, or the three altogether, in a total of 8 treatments. Two thousand eight hundred and eighty one-d-old Ross X Ross 308 male broiler chicks were placed in 2.30 X 1.75 m floor pens, 40 birds in each, 7 replicates per treatment. Results demonstrated an overall absence of response for enzyme inclusion in live performance, carcass and cuts. However, data evaluated on a weekly basis demonstrated significative differences in the period of 28 to 37 d of age for the Xylanase inclusion. No response in the most of bird responses for the three enzymes added in combination may be related to inefficacy of the enzymes in the doses included. Other interferences; however, cannot be discharged.

Key words: All vegetable diets, broiler, carbohydrase, enzyme

Introduction

Using all vegetable diets have become a mandatory practice to produce animal products destined to humans in the European Union and other countries, such as Saudi Arabia which is a major broiler chicken importer (CEC, 2000). In addition, there is an increasing trend in marketing broilers as non-traditionally fed or raised, in an attempt to meet a new perception of value to some customers. One of these non-traditionally-grown broiler is fed diets exclusively formulated with plant based ingredients, and therefore it is some times advertised as an "all-veg" broiler.

Irrespective of its reasoning, feeding chickens only with ingredients of plant origin is a practice that does not resemble their eating habits in the wild. The chicken is not expected to be entirely herbivore because it lacks anatomic adaptations to support processes of fermentation, which would support their nutrient needs from forages, such as those placed in ruminants or even in the omnivorous swine. In the adult chicken, the ceca are the only place where digestion of plant fibers takes place and where the major concentration of intestinal microorganisms and volatile fatty acids are found in mature birds (Johansson *et al.*, 1948; Annison *et al.*, 1968). Besides, the ceca are only a small part of the entire gastrointestinal tract and is located at its end (McNab, 1973), which leaves reduced time for the eventual absorption of the fermentation products. It has also being shown that no more than 25 % of the total dry matter passing through the intestines enters the ceca (Son *et al.*, 2002). Therefore, the chicken cannot rely entirely on nutrients originated from high fiber ingredients or other plant components that need microbial fermentation to its production. This justifies its natural habit of eating seeds and insects.

One major alteration in feed formulation to feeds entirely based on plant ingredients is related to a greater inclusion of plant proteins, which in the majority of the cases is soybean meal. Soybean meal dry matter is composed of low digestible carbohydrates, such as oligosaccharides, but also more complex ones such as pectins, hemicelluloses (Eldridge *et al.*, 1979; Honig and Rackis, 1979; Knudsen, 1997).

Enzymes have been used in animal nutrition for decades. However, most of the research conducted with non phytase enzymes have been targeting on barley and rye-based diets (Bedford, 2002). Research focusing on enzymes targeting soybean non starch oligo and polysaccharides is scarce, even though alpha galactosides, pectins and xylans add up to 30 of the soybean meal dry matter. Enzyme limitation is probably involved in the reduced amount of energy released from soybean meal for poultry when compared to swine (NRC, 1994; NRC, 1998).

The present study was conducted to compare live performance and the yield of carcass and cuts of broilers fed all vegetable feeds supplemented with enzymes targeting its non starch low digestible carbohydrate fraction.

Materials and Methods

Two thousand eight hundred and eighty one-day-old male broiler chicks (Ross X Ross 308) were placed in floor pens (2.30 X 1.75 m), 40 birds per pen. Broilers were fed a starter from placement to 21 d and a grower to 37 d. Feeds were formulated exclusively with plant originated ingredients to meet or exceed NRC (1994) recommendations (Table 1) and had no antibiotic growth promoter. Treatments were a Control feed without enzyme and the other treatments were composed by the inclusion of a xylanase (EC 3.2.1.8), a pectinase (EC 3.2.1.15) and a alpha-galactosidase (EC 3.2.1.22) in the amount of 100 grams per Ton each. These enzymes were included at the exchange of corn individually, on a two by two basis, or the three altogether. Experiment was conducted in a Complete Randomized Design, composed of 8 treatments with 7 replicates each.

Prior to preparing the experimental feeds, each ingredient was analyzed for protein, Ca and P. Amino acid profile and other nutrients used in the feed formulation were based on the ingredient supplier's data bank (Avipal, Porto Alegre, Brazil), which is frequently updated. Feed as mash and water were provided *ad libitum* with bell drinkers and tube feeders and overall management was as in a commercial operation with normal environmental conditions for temperature and ventilation.

Birds in each replicate were weekly group weighed to 37 d-of-age, and the other live performance responses were also weekly recorded. Feed conversion was corrected for the weight of dead birds. After the final weighing at 37 d, 6 birds per pen with body weights close to pen average were selected, individually tagged, and sacrificed by cervical dislocation after a 10-hour feed removal period. Each bird was bled for 3 minutes having the feathers and viscera removed manually. Carcasses were chilled in slush ice for three hours and then taken for abdominal fat removal. A team of deboners from a commercial integrator processed the carcasses on the following commercial parts: breast fillets (major and minor muscles), wings, thighs, drumsticks, cage as well as abdominal fat. Cuts were related to the carcass weight and expressed in percentage.

All data collected were analyzed using the ANOVA procedure of SAS (1998) and treatment means were considered statistically different when the main effect F-test was equal or lower than 5%. Mortality data was analyzed after arc-sin transformation.

Table 1: Composition of basal feeds provided from 1 to 37 day of age

Ingredient, %	Starter	Grower
Corn	49.06	52.33
Soybean Meal 45%	14.61	7.80
Toasted soybean	29.47	32.40
Soybean Oil	1.50	2.00
Limestone	1.79	1.78
Dicalcium Phosphate	1.77	1.60
Salt	0.37	0.45
Sodium bicarbonate	0.27	-
DL-Methionine	0.32	0.32
L-Lysine HCl	0.25	0.19
L-Threonine	0.03	-
Choline Chloride	0.09	0.06
Vitamin and mineral premix[2]	0.40	1.00
Enzyme mix[1]	0.07	0.07
TOTAL	100.00	100.00
Energy and Nutrients [3]		
ME_n, kcal/kg	3,100	3,200
CP	21.0	19.70
Met + Cys	0.94	0.90
Lys	1.26	1.17
Thr	0.82	0.76
Ca	1.0	1.00
Av. P.	0.50	0.45
Na	0.24	0.20
Choline	1,800	1,600
DEB ($Na^+ + K^+ - Cl^-$), mEq/kg	250	193

[1]Enzyme-corn mix supplemented in the feeds at the expense of corn: xylanase (EC 3.2.1.8), pectinase (EC 3.2.1.15) alpha-galactosidase (EC 3.2.1.22), 100 grams per Ton each, added individually, on a two by two basis or the three altogether. [2]Supplemented per kg of feed: Fe 40 mg, Zn 80 mg, Mn 80 mg, Cu 10 mg, I 0.7 mg, Se 0.3 mg., vitamin A 8,000 UI, vitamin D_3 2,000 UI, Vitamin E 30 mg, vitamin K_3 2.0 mg, vitamin B_1 2.0 mg., vitamin B_2 6.0 mg, vitamin B_6 2.5 mg, vitamin B_{12} 0.012 mg, pantothenic acid 15 mg, niacin 35 mg, folic acid 1.0 mg, biotin 0.08 mg. [3]As a percentage or else noted.

Results and Discussion

Overall mortality rate was low (2.1%) and death of birds was systematically not correlated with treatments.

Body weight, feed intake and feed conversion weekly measured to 37 days are shown in Tables 2, 3 and 4, respectively. Performance of birds evaluated at the end of the experiment was not affected by the enzyme treatments. Alpha-galactosidase included individually in the diets improved body weight gain at 21 days and feed intake from 28 to 37 days of age, respectively. Pectinase or xylanase individually added to the feeds led to the lowest feed intake between treatments in the last week of age. Including enzymes in a two by two basis, or the three altogether, did not improve any response in live performance. On the contrary, the three enzymes reduced body weight at 21 days of age. Evaluation of processing data also demonstrated similar yields for commercial cuts, but a clear worsening in the yield of carcass when supplementing any enzyme, individually or in conjunct.

Enzymes utilized in this study are not commonly used in animal nutrition. They were chosen because of their orientation to break bonds known to limit utilization of carbohydrates present in soybean meal. Therefore, while the α-galactosidase hydrolyzes bonds of non-reducing alpha - D - galactose residues in alpha - D -

Table 2: Body weight of broiler males fed all vegetable diets supplemented with carbohydrases, g

Enzyme	7 d	14 d	21 d	28 d	37 d
No Enzymes	162.4	443.7	918.8[ab]	1471.4	2340.3
α-galactosidase	161.2	452.1	927.3[a]	1462.4	2324.5
Pectinase	151.8	442.9	915.6[ab]	1456.9	2286.4
Xylanase	157.7	438.6	909.2[ab]	1432.5	2282.0
α- galactosidase + Pectinase	157.9	440.1	895.1[bc]	1415.3	2265.7
α-galactosidase + Xylanase	157.7	437.0	899.3[abc]	1425.6	2254.5
Pectinase + Xylanase	164.0	445.1	918.9[ab]	1432.5	2273.1
α-galactosidase + Pectinase + Xylanase	154.9	425.0	875.2[c]	1418.8	2251.9
P ≤	0.1280	0.2490	0.0270	0.1402	0.0758
Mean	158.5	440.3	907.4	1438.1	2,282.5
C.V., %	4.86	3.95	2.90	2.89	2.43

Means followed by different letters are different using Tukey (P<0.05).

Table 3: Feed intake of broiler males fed all vegetable diets supplemented with carbohydrases, g

Enzyme	1-7 d	7-14 d	14-21 d	21-28 d	28-37 d	1-37 d
No Enzyme	141.3	348.6	641.7	911.3	1391.2[abc]	3607.2
α-galactosidase	136.7	357.2	643.4	911.3	1462.1[a]	3361.9
Pectinase	137.1	351.8	629.5	897.1	1339.3[c]	3490.2
Xylanase	139.6	342.4	628.4	895.9	1345.5[c]	3518.8
α-galactosidase + Pectinase	139.0	344.5	622.6	987.9	1420.6[ab]	3558.5
α-galactosidase + Xylanase	141.6	345.7	629.6	909.8	1379.8[bc]	3547.2
Pectinase + Xylanase	144.2	350.4	644.3	901.8	1375.5[bc]	3571.2
α-galactosidase + Pectinase + Xylanase	139.0	339.1	616.4	905.1	1370.8[bc]	3508.5
P ≤	0.6088	0.5749	0.1984	0.8782	0.0342	0.0668
Mean	137.8	347.3	631.5	902.2	1382.5	3554.3
CV, %	5.17	4.67	3.40	3.69	4.18	2.61

Means followed by different letters are different using Tukey (P<0.05).

Table 4: Feed conversion of broiler males fed all vegetable diets supplemented with carbohydrases

Enzyme	1 - 7	7-14	14-21	21-28	28-37	1-37
No Enzyme	1.158[a]	1.240	1.382	1.651	1.906	1.680
α-galactosidase	1.192[ab]	1.230	1.359	1.704	1.985	1.718
Pectinase	1.238[bc]	1.219	1.345	1.689	1.995	1.689
Xylanase	1.221[bc]	1.219	1.362	1.714	1.889	1.686
α-galactosidase + Pectinase	1.215[bc]	1.244	1.373	1.709	1.927	1.700
α-galactosidase + Xylanase	1.209[bc]	1.238	1.361	1.730	1.976	1.719
Pectinase + Xylanase	1.198[ab]	1.247	1.374	1.757	1.941	1.716
α-galactosidase + Pectinase + Xylanase	1.246[c]	1.256	1.349	1.694	1.982	1.704
P ≤	0.0322	0.3474	0.4402	0.4370	0.1323	0.0719
Mean	1.211	1.237	1.362	1.707	1.950	1.701
CV, %	3.70	2.63	2.28	4.61	3.97	1.60

Means followed by different letters are different using Tukey (P<0.05).

Table 5: Yield of the carcass (% live weight) and commercial cuts from broilers fed all vegetable diets supplemented with carbohydrases, % carcass

Enzyme	Carcass	Back	Tender	Breast	Drums	Thighs	Wings
No Enzyme	75.4[a]	25.1	4.3	23.3	13.7	19.8	11.8
α-galactosidase	74.3[ab]	24.7	4.1	22.9	14.0	19.7	12.1
Pectinase	73.7[b]	25.4	4.0	22.7	14.0	19.9	12.2
Xylanase	73.3[b]	25.5	4.0	23.0	13.9	20.0	12.2
α-galactosidase+ Pectinase	74.2[ab]	25.3	4.1	22.6	14.1	20.1	12.3
α-galactosidase + Xylanase	73.8[b]	24.9	4.1	22.9	14.0	20.1	12.1
Pectinase+ Xylanase	73.8[b]	24.6	4.1	22.9	14.1	20.1	12.2
α-galactosidase + Pectinase + Xylanase	73.9[b]	25.2	4.0	22.7	14.1	19.9	12.1
P ≤	0.0010	0.0532	0.4610	0.3460	0.2033	0.6954	0.1186
Mean	74.03	25.08	4.08	22.84	13.97	19.95	12.14
CV, %	2.87	6.18	14.69	6.04	5.12	5.64	6.41

Means followed by different letters are different using Tukey (P<0.05).

galactosides, the xylanase is oriented towards the endo hydrolysis of 1,4-β-D-xylosidic bonds present in xylans, whereas the pectinase is oriented to the hydrolysis of 1,4-α-D-galacturonic bonds present in pectic chains

(Expasy, 2006).

In some ways, enzymes can be seen as growth promoter alternatives, since degradation of complex structures are expected to reduce substrate availability for bacterial proliferation. However, most of the studies conducted with enzymes directed to degrade non starch polysaccharides have been done with barley, wheat and rye (Bedford, 2002).

Theoretical reasoning may be used to justify absence of improvements in live performance or processing yields of birds in this study. Enzyme-substrate relationship is very specific and as long as the specific enzyme is added to the right substrate the reaction should follow. Enzyme action, however, may be affected by many factors, including environment, amount of enzyme in the reaction, interactions between enzyme and other substances, among others.

Carbohydrase effects on soybean meal are expected to release energy from substrates normally not available for broilers. Therefore, improvements in feed conversion were expected, since increasing feed energy is known to have this type of effect in broilers (Leeson *et al.*, 1996; Sizemore and Siegel, 1993). In this study, feed conversion was improved when using xylanase but only in the last week, which may indicate an age-enzyme relationship as has been shown by

Effects of enzymes on body weight were seen at 21 days with a significant reduction when adding pectinase with xylanase or both plus alpha-galactosidase compared to the Control and the other dietary treatments. Reduction in performance after supplementing additives may indicate some sort of toxicity. In the case of enzymes, negative effects may result from the influence of substances released after their action. Longstaff *et al.* (1988) described significant decreases in energy digestibility after supplementation of diets with free xylose, arabinose and galacturonic acid. Alteration in the lipid metabolism of rats was observed after feeding free galacturonic acid, which led to reduction in feed intake (Suzuki and Kajuu, 1983). These authors also suggested muscle fat mobilization due an altered insulin functioning, which support the reduction in carcass yield observed with broilers fed pectinase. The current study failed to demonstrate improvements of a mixture of enzymes theoretically oriented to a substrate representing a large fraction of corn-soybean meal feeds. Therefore, amount of enzyme included per unit of diet may be obviously questioned.

References

Annison, E.F., K.J. Hill and R. Kenworthy, 1968. Volatile fatty acids in the digestive tract of the fowl. Br. J. Nutr., 22: 207-216.

Bedford, M.R., 2002. The role of carbohydrases in feedstuff digestion. In: McNab JM, Boorman KN (eds), Poutry Feedstuff: Supply, Composition and Nutritive Value, pp: 319-336. CABI Publishing, London.

CEC, 2000. Council Regulation 2000/766 concerning certain protection measures with regard to transmissible spongiform encephalopathies and the feeding of animal protein. Off. J. Eur. Communities 43: 32-33.

Eldridge, A.C., L.T. Black and W.J. Wolf, 1979. Carbohydrate composition of soybean flours, protein concentrates, and isolates. J. Agri. Food Chem., 27: 799-802.

Expasy, 2006. http://www.expasy.ch/enzyme/

Honig, D.H. and J.J. Rackis, 1979. Determination of the total pepsin-pancreatinin indigestible content (dietary fiber) of soybean products, wheat bran, and corn bran. J. Agri. Food Chem., 27: 1262-1266.

Johansson, K.R., W.B. Sarles and S.K. Shapiro, 1948. The intestinal microflora of hens as influenced by various carbohydrates in a biotin deficient ration. J. Bacteriol., 56: 619-634.

Knudsen, K.E.B., 1997. Carbohydrate and lignin contents of plant materials used in animal feeding. Anim. Feed Sci. Tec., 67: 319-338.

Leeson, S., L. Caston and J.D. Summers, 1996. Broiler response to diet energy. Poult. Sci., 75: 529-535.

Longstaff, M., A. Knox and J.M. McNab, 1988. Digestibility of pentose sugars and uronic acids and their effect on chick weight gain and caecal sizes. Br. Poult. Sci., 29: 379-393.

McNab, J.M., 1973. The avian caeca: a review. World´s Poult. Sci. J., 29: 251-263.

National Research Council - NRC, 1994. Nutrient requirements of poultry. 9th Rev. ed. Natl. Acad. Press. Washington, DC.

National Research Council - NRC, 1998. Nutrient Requirements of swine. 10th Rev. ed. Natl. Acad. Press. Washington, DC.

Potter, L.M. and M. Potchanakorn, 1985. Digestibility of the carbohydrate fraction of soybean meal by poultry. Proceedings of the 3rd World Soybean Conference. Richard Shibles ed. Boulder, pp: 218-224.

Son, J.H., D. Ragland and O. Adeola, 2002. Quantification of digesta flow into de caeca. Br. Poult. Sci., 43: 322-324.

Sizemore, F.G. and H.S. Siegel, 1993. Growth, feed conversion, and carcass composition in females of four broiler crosses fed starter diets with different energy levels and energy to protein ratios. Poult. Sci., 72: 2216-2228.

SAS Institute, 1998. SAS® User's Guide: Statistics. Version 7.0 Edition. SAS Institute Inc., Cary, NC.

Suzuki, M. and T. Kajuu, 1983. Suppression of hepatic lipogenesis by pectin and galacturonic acid orally-fed at the separate timing from digestion-absorption of nutrients in rat. J. Nutr. Sci. Vit., 29: 553-562.