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Effect of carbohydrase supplementation to broilers fed with reformulated diets based on corn-soybean meal

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Abstract. The study determined the effects of feeding reformulated diets with carbohydrase on broilers growth performance, carcass yield, gut parameters and income over chick and feed cost. A total of 180 day-old Cobb straight run broiler chicks were randomly assigned to: Treatment 1 as standard diet with local industry nutrient specifications, Treatment 2 as reformulated diets (-93kcal/kg and -1.5% digestible amino acids) and Treatment 3 as reformulated diets (-93kcal/kg and -1.5% digestible amino acids) with carbohydrase, each treatment diets had six replications with 10 birds. Results showed that birds fed with treatment 3 supported their growth and feed conversion as it was comparable to birds fed with treatment 1. Carcass yield of birds fed with diet 3 were comparable also with birds fed with other treatment diets. Feeding treatment diet 2 on birds caused an increase in relative weight of ceca but, a remarkable decrease in birds fed with treatment diet 3. Moreover, feeding reformulated treatment diets (diet2 and 3) resulted in lower relative size of the large intestine compared with birds fed with treatment diet1. The income over chick feed cost analysis showed the economic benefit of supplementation of carbohydrase in reformulated diets and has the potential for feeding broilers under circumstances that may be favorably influenced raw materials and their cost.

1. Introduction

Poultry feed is composed for the most part of corn and soybean meal, with corn providing most of the energy and soybean meal as source of well-balanced amino acids. These feed ingredients naturally contain non-starch polysaccharides [1], in which significant amounts of potential sources of nutrients are not properly accessed by endogenous enzymes, due to their complex chemical structures. There are two types of non-starch polysaccharides (NSPs) according to their properties; the water soluble and the water insoluble. Both NSPs are concern in monogastric animals feeding due to their anti-nutritional properties. The water insoluble NSPs in the cell walls exert encapsulating effects to nutrients and water soluble NSPs create viscous condition of the digesta. There are no substantial endogenous enzymes of monogastric animals for effective degradation of NSPs.

In recent years, the nutritional contribution of the feed enzymes has been translated in terms of nutrient specifications in formulating diets. One way of incorporating enzymes is to change the



nutrient density of the feed to reduce the cost per ton of feed and then, by adding enzymes to restore the nutritional value of feed [2]. Formulating diets using enzymes through nutrient matrixes would efficiently maximize digestion of feed through extraction and assimilation of nutrients.

The study focused on the effects of feeding broilers with Standard (STD) and Reformulated (RFD) diets supplemented with a cocktail-type of carbohydrase in a matrix on an add-on basis. It specifically assessed the broilers' responses in terms of growth performance, carcass yield, gut parameters and its economic efficiency using income over chick feed cost (IOCFC).

2. Materials and Methods

2.1. Experimental diets and their preparation

The broiler diets were corn-soybean based formulated to provide standard amount of metabolizable energy (ME) and digestible amino acids (DAA) and reformulated diets to contain less than 93 kcal ME/kg and 1.5% DAA, with or without carbohydrase supplement (Table 1). The carbohydrase is a commercial preparation (Rovabio™ Excel AP) produced from a non-genetically modified strain of *Penicillium funiculosum* (*Talaromyces versatilis* sp. nov.). It contains compatible enzymes that synergistically work on various feedstuffs. It was recommended for use at 500 g per ton of feeds. The diets were mixed on a weekly basis using an electrically operated mixer. All diets were in mash form.

2.2. Care and management of the birds

The birds were housed in three-tier battery-type cages in an open-sided poultry shed. Each cage had a floor space of 1.08 m² (0.90 m x 1.2 m) and welded wire flooring. These were cleaned and disinfected a week before the arrival of the birds.

The birds were fed with booster, starter and finisher diets at 1 to 14, 15 to 28 and 29 to 38 days of age, respectively. Except during the first three days when controlled feeding was practiced, the birds were fed *ad libitum*. The birds were vaccinated against Infectious Bursal Disease at 7 days of age and Avian Pest at 10th day.

2.3. Data gathering

The weight of chicks at day one was obtained immediately upon their arrival. The mean initial weights were obtained by dividing the group weight of the birds by the number of the birds weighed. Successive weighings of the birds were obtained at 7 days interval by group weighing. The average daily gain (ADG) were determined by first adding the weight of dead birds with the average group weight of birds in each weighing period, then subtracting their initial group weight and dividing it by the number of birds remaining within that period. Gain in weight was obtained by multiplying the ADG by the feeding period.

The feed allotted per cage was subtracted with feed remaining at the end of the week were recorded and dividing it by the number of birds remaining in that period to obtain the average feed consumption (AFC). This AFC is then multiplied by feeding periods for the mean total feed consumption. The feed conversion ratio (FCR) was determined as the mean total feed consumption divided by gain in weight.

At 38 days of age, 5 sample birds for each per replication were randomly obtained for carcass and cut-up yield determination. Carcass yields were obtained by weighing the carcass weight and were expressed in relative terms (as percentages). Cut-up yields were obtained by weighing the breast, thigh, drumstick, legs and back of each sample bird. The weight of each cut-up part was expressed also in relative terms (as percentages).

Gut parameters were obtained from the sample birds used for carcass and cut-up yields. Only the digestive and accessory organs were collected, cleaned, sectioned and weighed. The weight of each gut portion was expressed in relative terms (as percentages).

The mean IOCFC was determined as the difference of the mean sale value of birds and mean total cost. The mean sale value of the birds was computed as: mean final weight of birds (kg) x farm gate

price (Php) per kg live weight of the birds. The mean cost was the cost of chicks and feed consumed which was computed as: mean feed consumption (kg) x cost/kg of diet (Php).

Table 1. Composition, calculated nutrient content and cost of broiler diets of standard (STD) and reformulated (RFD) diets with and without carbohydrase.

Ingredient	Booster			Starter			Finisher		
	STD	RFD	RFD+	STD+	RFD	RFD+	STD+	RFD	RFD+
Corn	60.11	59.11	59.11	60.11	59.11	59.11	55.37	58.21	58.21
Rice bran (D1)	3.00	5.00	5.00	3.00	5.00	5.00	15.00	15.00	15.00
Coconut oil (Crude)	1.00	-	-	1.00	-	-	3.85	1.95	1.95
Soybean meal (US)	28.63	27.75	27.75	28.63	27.75	27.75	21.42	20.47	20.47
Poultry by-product meal	4.00	4.00	4.00	4.00	4.00	4.00	1.00	1.00	1.00
Limestone (fine)	0.88	1.77	1.77	0.88	1.77	1.77	0.94	0.94	0.94
Monocalcium phosphate	1.36	1.35	1.35	1.36	1.35	1.35	1.29	1.29	1.29
DL-methionine	0.22	0.21	0.21	0.22	0.21	0.21	0.18	0.18	0.18
Lysine HCL	0.09	0.09	0.09	0.09	0.09	0.09	0.13	0.14	0.14
Threonine	0.02	0.02	0.02	0.02	0.02	0.02	0.07	0.07	0.07
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.30	0.30	0.30
Vitamin premix	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Trace Mineral	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Choline Chloride	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Ethoxyquin	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Toxin binder	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Carbohydrase	-	-	0.50	0.50	-	0.50	-	-	0.50
Total	100.01	100.00	100.50	100.06	100.00	100.50	100.50	100.00	100.50
Calculated analysis ('as is basis')									
M.E., kcal/kg	3000	2907	2907	3000	2907	2907	3100	3007	3007
Crude fat, %	4.57	3.80	3.80	4.57	3.80	3.80	8.37	6.60	6.60
Crude fiber, %	2.64	2.67	2.67	2.64	2.67	2.67	2.78	2.82	2.82
Calcium, %	0.92	1.25	1.25	0.92	1.25	1.25	0.81	0.81	0.81
Available phosphorus, %	0.48	0.48	0.48	0.48	0.48	0.48	0.41	0.41	0.41
Crude protein, %	21.39	21.14	21.14	21.39	21.14	21.14	17.19	16.98	16.98
Lysine, %	1.29	1.10	1.10	1.29	1.10	1.10	1.02	0.86	0.86
Methionine, %	0.57	0.52	0.52	0.57	0.52	0.52	0.47	0.43	0.43
Methionine + Cysteine, %	0.92	0.83	0.83	0.92	0.83	0.83	0.77	0.68	0.68
Threonine, %	0.84	0.71	0.71	0.84	0.71	0.71	0.71	0.60	0.60
Tryptophan, %	0.25	0.22	0.22	0.25	0.22	0.22	0.20	0.17	0.17

¹ Each kg contains, 45,000,000 IU vitamin A, 9,000,000 IU vitamin D₃, 200,000 vitamin E, 15,000 g vitamin K, 150,000 g niacin, 9,000 g vitamin B₁, 30,000 g vitamin B₂, 19,500 g vitamin B₆, 0.15 g vitamin B₁₂, 81,522 g vitamin B₅, 8,000g vitamin B₉, and 0.70 g vitamin H/H₂.

² Each kg contains, 83.33 g copper, 0.998 g iodine, 66.672 g iron, 33.334 g manganese, 0.202 g selenium, 83.34 g zinc, and 0.33 g cobalt.

2.4. Statistical analysis

The data gathered were summarized on a weekly basis. Treatment means were subjected to analysis of variances using SAS (Version 9). Treatment differences were determined using Duncans Multiple Range Test of the same software for parameters where statistical significance was noted. Significance was set at P=0.05.

3. Results and Discussion

3.1. Growth performance

The mean growth performance of broilers grown on STD and RFD diets with and without carbohydrase is presented in Table 2. The birds fed with RFD with carbohydrase have compared well with the control diet (STD) with regards to gain in weight and FCR as observed in all stages. Significant ($P < 0.05$) differences on feed intake was observed at 0-14 days, but not in the other periods.

The result of the study showed that, reformulation of the diet (RFD) as well as carbohydrase supplementation (RFD+) caused reduction in feed intake of the birds within 14 days of age. Supplementation of carbohydrase to diets apparently increased energy metabolized by the birds, which consequently caused the birds to consume less feed.

Low feed intake usually occurs with high energy diet as the birds consume less feed to satisfy their energy requirements [3]. The hydrolysis of the NSP due to carbohydrase could had increased apparent metabolizable energy (AME) of the diet [4, 5].

Table 2. Mean Growth performance of broilers fed with Standard diet (STD) and Reformulated (RFD) diets supplemented with and without carbohydrase.

Parameter	STD	RFD	RFD+	Prob.
Feed intake (g)				
0-14 days	428 ^a	414 ^b	405 ^b	0.0091
0-28 days	1688	1667	1673	0.7849
0-38 days	2986	2933	2972	0.7955
Gain in weight (g)				
Initial weight	43	42	41	0.1506
0-14 days	292 ^a	266 ^b	291 ^a	0.0121
0-28 days	1048 ^a	988 ^b	1035 ^{ab}	0.0618
0-38 days	1678 ^a	1576 ^b	1669 ^a	0.0025
FCR				
0-14 days	1.47 ^b	1.56 ^a	1.39 ^b	0.0002
0-28 days	1.61 ^b	1.68 ^a	1.61 ^b	0.0275
0-38 days	1.77 ^b	1.86 ^a	1.78 ^b	0.0023
Livability (%)	97.22	93.06	98.61	0.57

Note: Means within row with the same superscript are not significantly different ($P = 0.05$).

Reformulated diets caused a decrease gain in weight in almost all periods. However, supplementation of carbohydrase to RFD diet alleviated this decrease as birds fed with RFD+ compared well with broilers fed with STD diet. RFD diets affected gain in weight of broilers indicating adverse effect of reducing ME and AA. Improved gain in weight of broilers fed RFD+ suggested that there was an improvement in energy utilization as more energy nutrients are digested which compensated for the reduced energy contents of RFD diet [6,7] that energy digestibility was significantly improved when enzyme in corn and soybean diet was added resulting in better growth performance.

The mean FCR of broilers at different growth stages showed that addition of carbohydrase to RFD diets improved FCR to the level noted for STD at 0-14, 0-28 and 0-38 days. The birds fed with RFD supported the poorest FCR in all periods. The improved FCR values in RFD diets with carbohydrase were associated with the improved gain in weight without concomitant increase in feed intakes. Feed efficiency of birds was improved upon addition of carbohydrase in diets with low and normal nutrient density diets [8]. It was pointed earlier that magnitude of response to enzyme supplementation was high in low nutrient density diet [9].

3.2. Carcass and cut up yield

The carcass yield and cut up parts of broilers fed on STD and RFD diets with or without carbohydrase are presented in Table 3. Significant differences among the treatments ($P < 0.05$) were noted only on carcass yield. Feeding RFD diet resulted in lower carcass yield than its counterpart STD diets. Supplementation of carbohydrase to the RFD diet numerically improved carcass yield as seen in Figure 1.

The findings demonstrated that the decrease in ME and AA in the RFD was a penalizing factor for carcass yield. Apparently, such dietary factors adversely affected body energy and protein retentions. To some extent, carbohydrase supplementation ameliorated the problem which allowed for some increase in carcass yield.

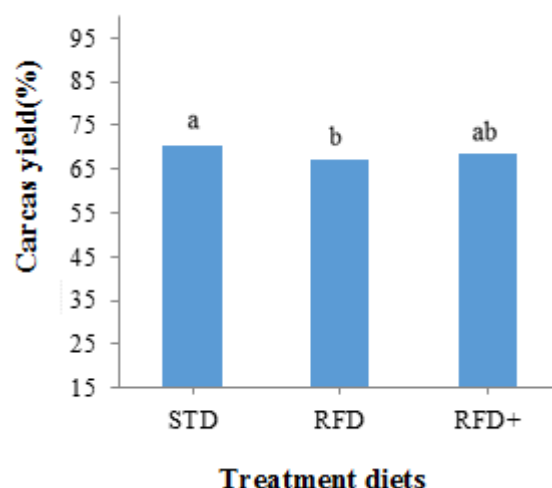


Figure 1. Mean carcass yield of broilers fed STD and RFD diets with and without carbohydrase.

Supplementation of exogenous enzymes influences carcass yield in broilers as a result of nutrient availabilities in a diet. Multi-enzyme preparations at different nutrient density concluded that the addition of enzyme influences the carcass percentages on broilers [8, 10].

Table 3. Mean carcass and cut up yield of broilers fed STD and RFD diets with and without carbohydrase.

Parameter	STD	RFD	RFD+	Prob
Live weight	1778	1689	1734	0.134
Fasted weight	1668	1621	1665	0.265
Carcass yield	70.54 ^a	67.38 ^b	68.72 ^{ab}	0.044
Legs/thigh	21.56	20.29	20.28	0.279
Wings	8.47	8.26	7.80	0.394
Back	19.69	19.80	19.68	0.588
Breast	20.56	19.46	20.96	0.340

Note: Means within row with the same superscript are not significantly different ($P = 0.05$).

3.3. Gut parameters

Table 4 presents the gut and accessory organ weight of broilers grown on STD and RFD diets with or without carbohydrase. Significant differences among treatments were observed in terms of the large intestine and ceca of the broilers.

The ceca of broilers fed with RFD diets were higher than those fed STD diets (Figure 2a). With carbohydrase addition (RFD+), the relative weights of ceca decreased and were comparable to birds

fed with STD diet. The relative size of the large intestine was not influenced by carbohydrase addition to the STD diet as seen in Figure 2b.

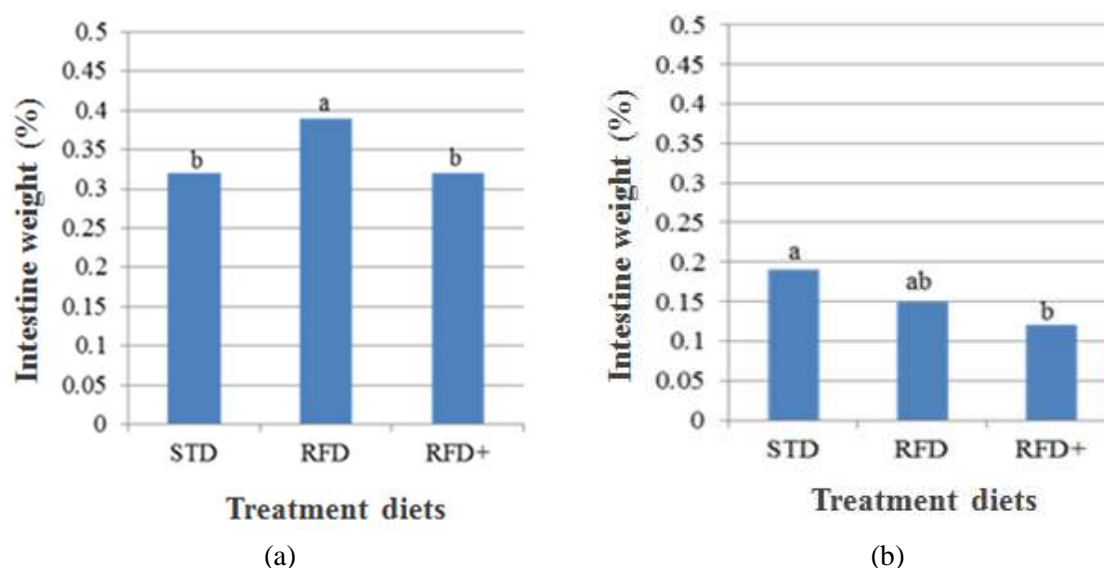


Figure 2. Mean ceca (a) and large intestine weight (%) of broilers fed STD and RFD diets with and without carbohydrase.

Feeding RFD diet increased weight of ceca apparently due to the high crude fiber, especially for the starter and finisher stages than its counterpart. This indicated greater activity of tissues leading to increase in weight resulting from the fermentation of NSP. Such process appeared to be profound as size of the large intestine tended to decrease suggesting lesser undigested material that passed in this gut section. Interestingly, degradation of NSP which was likely due to the carbohydrase caused reduction in relative size of both ceca and intestine. A decrease in cecum weight and length of cecum was observed upon addition of carbohydrases [11].

Table 4. Mean relative gut and accessory organ weight (%) of broilers fed STD and RFD diets with and without carbohydrase

Parameter	STD	RFD	RFD +	Prob
Liver w/ Gall bladder	2.13	2.30	1.99	0.600
Spleen	0.13	0.20	0.14	0.297
Pancreas	0.22	0.20	0.21	0.640
Proventriculus	0.43	0.45	0.43	0.946
Ceca	0.32 ^b	0.39 ^a	0.32 ^b	0.045
Small Intestine	2.73	2.62	2.71	0.794
Large Intestine	0.19 ^a	0.15 ^{ab}	0.12 ^b	0.017
Gizzard	2.45	1.89	2.25	0.368

Note: Means within row with the same superscript are not significantly different ($P=0.05$).

3.4. Income over chick and feed cost

The mean data for income over chick and feed cost are presented in Table 5. Significant differences ($P<0.01$) were observed on values for live weight, sale value as well as for cost of booster diet consumed. The mean live weight of broilers fed RFD diet was the least among the treatments;

supplementation of carbohydrase increased live weight to a level comparable with those fed STD with or without carbohydrase. Such difference was reflected in terms of sale value of the birds.

Table 5. Mean Income over chick and feed cost (IOCFC) of broilers fed STD and RFD diets with and without carbohydrase

PARAMETER	STD	RFD	RFD+	<i>Prob.</i>
Live weight (kg)	1.73 ^a	1.64 ^b	1.71 ^a	0.006
Sale value (Php)	129.75 ^a	123.21 ^b	128.66 ^a	0.007
Chick cost (Php)	24.00	24.00	24.00	
Feed cost	-	-	-	
Booster (Php)	9.14 ^a	8.66 ^{bc}	8.50 ^c	0.001
Starter (Php)	26.08	25.32	25.57	0.650
Finisher (Php)	25.07	23.35	24.77	0.290
Total, (Php)	60.29	57.32	59.02	0.118
IOCFC, Php	45.46	41.90	45.64	0.264

Note: Means within row with the same superscript are not significantly different (P=0.05).

Over all, the IOCFC data do not show economic benefit of feeding RFD+. The marked reduction in cost of feeding booster diet with carbohydrase was not shown in other diets and for the total feed cost. The supplementation of enzyme did not show economic advantage when added to any of the three diets with varying nutrient density [10]. The supplementation of NSP enzyme resulted in lower feed cost per kg at 0-3 weeks of age of the birds [12].

4. Conclusion

The result showed that supplementation of carbohydrase to reformulated diets improved the gain in weight and FCR of broilers and were comparable with those fed STD diet. Likewise, carcass yield for such treatment (RFD+) was comparable to STD. IOCFC showed no economic advantage of carbohydrase supplementation statistically, irrespective of diet (RFD or RFD+) despite the savings on feeding booster diet. One possibility is indeed RFD+ can be fed, most especially when cost of raw materials increase without increase cost of the carbohydrase. Hence, it can be used as a supplement in broiler feeds. It must be emphasized that further studies are needed to support the findings in the present work; digestibility trials with morphological assessment on the size of organs associated with carbohydrate digestion with intrinsic intestinal villi's and gut micro-flora habitat evaluation regarding carbohydrase beneficial effects in the gut.

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References

- [1] Cone J W, Van Gelder A H, Meuler J V 1994 Effect of cell wall degradation enzyme preparation on the in vitro solubility of feedstuffs pp 221-225 *pjbs.org*.
- [2] Pack M, Bedford M 1997 Feed enzymes for corn and soybean diets Feed Mix. **9** pp 2.
- [3] National Research Council 2010 Nutrient requirements for poultry 9th Ed. National Academy of Sciences Washington DC USA.

- [4] Dela Cruz N E 2012 Wheat-based diet with phytogenic additive and exogenous xylanase on nutrient digestibility and growth performance in broilers Undergraduate Thesis Central Luzon State University. Science City of Muñoz, Nueva Ecija Philippines.
- [5] Kocher M G, Choct G, Ross J, Broz, Chung T K 2003 Effects of enzyme combinations on apparent metabolizable energy of corn–soybean meal-based diets in broilers *J. Appl. Poult. Res.* **12** 275-283.
- [6] De Avila V S, Krabbe E L, Lopes L D S, Klein C H, Ader P, De Araujo Ruiz J H 2012 Dietary Enzyme Supplementation on Broiler Performance from 1 up to 42 days of Age *World's Poultry Sci. J.* **68** 1-4.
- [7] Maisonnier-Grenier, P, Dalibard P, Geraert P A 2004 Benefit of NSP enzymes on corn soybean meal based diet in poultry XXII World Poultry Congress, June Issue. pp 526.
- [8] Adudabos A M 2012 Effect of enzyme supplementation to normal and low density broiler diets on corn-soybean meal *Asian J. An. Vet. Adv.* **7** 2 139-148.
- [9] Cowieson A J, Ravindran V 2008 Effect of exogenous enzymes in maize-based diets varying in nutrient density for young broilers: growth performance and digestibility of energy, minerals and amino acids *Br. Poult. Sci.* **49** 37-44.
- [10] Selle P H, Huang K H, Muir W I 2003 Effects of nutrient specifications and xylanase plus phytase supplementation of wheat-based diets on growth performance and carcass traits of broiler chicks *Asian-Aust. J. Anim. Sci.* 2003 **16** 10 1501-1509.
- [11] Aryurek H A, Okur A, Samli H E 2009 Impacts of phytase and/or carbohydrase on performance, intestinal organs and bone development in broilers fed wheat based diets containing different levels of phosphorus *J. An. Vet. Adv.* **7** 1432-1437.
- [12] Narasimha J, Nagalakshmi D, Ramana Y, Reddy, Viroji Rao S T 2013 Synergistic effect of non-starch polysaccharide enzymes, synbiotics and phytase on performance, nutrient utilization and gut health in broilers fed with sub-optimal energy diets *Vet. World* 754-760.