EFFECT OF DIETARY SUPPLEMENTATION OF NON-STARCH POLYSACCHARIDE DEGRADING ENZYMES ON GROWTH PERFORMANCE OF BROILER CHICKS

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ABSTRACT

An experiment was conducted to study the performance and carcass parameters of broilers chicks fed diets with and without supplementing non-starch polysaccharide degrading enzymes (NSPDE) at the rate of 0.5 g/kg diet. A total of 300 day-old broiler chicks were randomly divided into 12 sets (replicates) each comprising 25 chicks and three sets per treatment group, reared on deep litter from 1-42 days post-hatch. Group A was fed diets without NSPDE supplementation, while group B was fed diets supplemented with NSPDE (0.5 g/kg). Group C was fed diets containing 50 kcal/kg less metabolizable energy (ME) without NSPDE and group D was fed diets having 50 kcal/kg less ME with NSPDE (0.5 g/kg) supplementation. Feed and water were provided *ad libitum*. Feed intake and feed conversion ratio (FCR) from 1-28 days and 1-42 days was significantly ($p<0.05$) improved in chicks fed NSPDE supplemented diets (groups B and D) compared to non-supplemented diets (groups A and C). However, during 29-42 days of growing period enzymes supplementation did not influence feed intake and FCR. Body weight gain, dressing percentage and relative weights of heart, gizzard and shank at 42 days of age was found to be non-significantly different among all groups. However, liver weight reduced significantly ($p<0.05$) in NSPDE supplemented groups. The study suggested that NSPDE supplementation was beneficial in enhancing feed utilization during the starter phase, while its effects on weight gain, dressing percentage and weights of organs, except liver weight, were found to be non-significant.

Key words: Non-starch polysaccharides, broiler chicks, performance, carcass traits.

INTRODUCTION

Poultry diets are commonly composed of feedstuffs of plant origin (Jacob *et al*., 2000) having anti-nutrition factor, non-starch polysaccharides (NSP). Majority of coarse cereals in poultry diets contains high fibre and low energy (Rama-Rao *et al*., 2004). It is recognized that poultry diets contain variable levels of poorly digested NSP including arabinoxylans, glucons and pectin (Campbell and Bedford, 1992) that possess chemical cross-linking between them and are not well digested by poultry (Adams and Pough, 1993). Subsequently, water intake increases and undesirable ileal microbial fermentation starts, thus increasing moisture in the excreta and resulting in potential diarrhea (Fengler and Marquard, 1988; Dunn, 1996). However, the most detrimental effect is the reduced access of endogenous enzymes to feed particles and nutrients trapped in this carbohydrate water matrix, decreasing feed digestibility.

Poultry produce a number of enzymes, including amylases to digest starch, proteases to digest protein and lipases to digest fats. However, they do not produce enzymes to digest fibres in feeds. The main potential of enzyme addition to feed appears for digestion of substances that an animal is intrinsically incapable of digesting (Cheeke, 1991). These enzymes can open up the complex feed cell walls, allowing the animals own enzymes to digest the enclosed nutrients. Soluble high molecular weight fibre polysaccharide complexes are responsible for high digesta viscosity. These complexes are only a fraction of the polysaccharides present in the digesta, and are made up of a number of different components. High digesta viscosity can lead to reduced feed intake, slower digesta passage rate and impaired nutrient digestion (Austin *et al*., 1999; Naqvi and Nadeem, 2004). The inclusion of appropriate multi-enzyme systems can lower digesta viscosity and improve chick's performance. For common poultry diets, the enzymes of the digestive system cause normal hydrolysis of the dietary proteins, carbohydrates and fats. Thus, no benefit may be expected from the use of enzyme preparation as feed additives unless feed composed of higher amounts of barley, wheat, sunflower, rice bran or oat grains are fed to chickens (Banerjee, 1992).

In the recent past, exogenous feed enzymes have been developed to degrade these anti-nutritive factors and ameliorate their negative effects. Non-starch polysaccharide degrading enzymes (NSPDE) have been the subject of very considerable research as evidenced by the report of Annison (1991), Bedford (1995), Marquardt *et al*. (1996), Bedford and Schulze (1998) and Bedford and Partridge (2001).

In Pakistan, large number of NSP containing feedstuffs are being used for poultry feed preparation. Therefore, this experiment was designed to evaluate the effect of NSPDE (Rovabio) supplementation on growth performance, as well as on the carcass characteristics, of broiler chicks.

MATERIALS AND METHODS

Birds and management

A total of 300 day-old Hubbard broiler chicks of 44g average body weight were randomly divided into 12 sets each comprising 25 chicks and three sets per treatment group, following completely randomized design. The chicks in each set were kept in separate pens measuring 10 feet length and 3 feet width in an open poultry shed, which were disinfected before the start of the experiment. A layer of 3-4 inch saw dust was used as litter in each pen, which was stirred regularly during the experiment to keep it dry. Birds were vaccinated against Newcastle disease, infectious bronchitis, infectious bursal disease and hydro-pericardium syndrome, as per recommended schedule in Pakistan. All the recommended practices for broiler rearing were followed throughout the experimental period. Mash diets and fresh water was offered *ad libitum.* Experiment lasted for 42 days from November to December, 2003 at Animal Nutrition Programme, Animal Sciences Institute, National Agricultural Research Centre, Islamabad, Pakistan.

Diets preparation and feeding

Rovabio, a non-starch polysaccharides degrading enzyme preparation (from non-genetically modified fungus *penicillium funiculosum*) contained β-glucanase, xylanase, cellulase, pecetinase and protease (supplied by Addisseo, France). These enzymes are naturally compatible, stable and more efficient for degrading NSP of feedstuff. Commercial broiler starter (0-28 days of age) and finisher (29-42 days of age) diets were prepared in a local commercial feed mill. Four experimental diets (Table 1) were prepared as follows: A) commercial broiler diet without enzyme supplementation; B) commercial broiler diet with enzyme supplementation (0.5 g/Kg); C) commercial broiler diet having 50 kcal/kg less metabolizable energy (ME) and without enzyme supplementation and D) commercial broiler diet having 50 kcal/kg less ME and with enzyme supplementation (0.5 g/Kg). Chemical composition of diets and feedstuffs used in diets are given in Tables 2 and 3, respectively.

Table 1: Ingredient composition (%) of broiler starter and finisher diets supplemented with or without NSPDE

Ingredients	Diets*							
	A		B		C		D	
	**S	**F	S	F	S	F	S	F
Corn	22.00	20.00	22.00	20.00	22.00	20.02	22.00	20.02
Rice tips	25.99	30.09	25.99	30.09	24.40	23.73	24.40	23.73
Wheat	4.00	-	4.00	-	4.00	5.01	4.00	5.01
Rice polishing	10.00	15.00	10.00	15.00	10.00	15.02	10.00	15.02
Wheat bran	-	-	-	-	-	2.00	-	2.00
Corn gluten meal 60%	0.70	1.00	0.70	1.00	0.70	1.00	0.70	1.00
Corn gluten meal 30%	-	0.50	-	0.50	1.00	0.50	1.00	0.50
Rapeseed meal	3.50	3.00	3.50	3.00	3.50	3.00	3.50	3.00
Canola meal	11.00	9.00	11.00	9.00	11.00	9.01	11.00	9.01
Sunflower meal	2.30	4.20	2.30	4.20	3.00	4.51	3.00	4.51
Guar meal	2.00	2.50	2.00	2.50	2.00	2.30	2.00	2.30
Soybean meal	11.50	7.80	11.50	7.80	11.30	7.01	11.30	7.01
Fish meal (CP 52.5%)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Molasses	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Marble chips	0.70	0.70	0.70	0.70	0.80	0.70	0.80	0.70
Dicalcium phosphate	0.74	0.70	0.74	0.70	0.73	0.65	0.73	0.65
Bone ash	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
L-lysine	0.15	0.12	0.15	0.12	0.15	0.13	0.15	0.13
DL-methionine	0.11	0.08	0.11	0.08	0.11	0.08	0.11	0.08
Sodium chloride	0.12	0.13	0.12	0.13	0.12	0.12	0.12	0.12
Sodium bicarbonate	0.10	0.09	0.10	0.09	0.10	0.09	0.10	0.09
Vitamin premix	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Enzyme (Rovabio)	-	-	0.05	0.05	-	-	0.05	0.05

**S stands for starter (1-28 days) and F for finisher (29-42days) diets

* Diet A: commercial broiler diet without NSPDE; Diet B: commercial broiler diet with 0.05g/Kg NSPDE; Diet C: commercial broiler diet having 50 Kcal/Kg less ME and without NSPDE and Diet D: commercial broiler diet having 50 Kcal/Kg less ME and with 0.05 g/Kg NSPDE.

Birds were fed experimental diets in such a way that each diet was offered to 75 birds distributed to three sets each having 25 chicks. Weekly feed consumption and weights were recorded on per set basis and feed conversion ratio (FCR) was calculated as amount of feed consumed per unit of live body weight gain. Representative feed samples of each diet were collected for proximate composition, Ca, P, and aflatoxin (AOAC, 1990), whereas ME (kcal/kg) was calculated by the method of Wardeh (1981).

Slaughtering of birds

Two birds from each set were selected at random and slaughtered at 42nd day of age. The birds were then immediately eviscerated by removing of skin, head, feathers, lungs, feet and gastro-intestinal tract. The carcass parameters including weights of abdominal fat, liver, gizzard, heart and shank were recorded. These weights were expressed in terms of percentage of live weight.

Statistical analysis

The data obtained through this experiment were analysed by using analysis of variance technique in completely randomized design. Multiple mean comparisons were made by least significant difference test at 5 percent level of probability (Steel and Torrie, 1986).

RESULTS

The effects of dietary supplementation of NSPDE on average daily feed intake, weight gain and FCR during starter (0-28 days), finisher (29-42 days) and overall (0-42 days) growing periods are presented in Table 4. Feed intake of broiler chicks belonging to groups A, B, C and D during starter, finisher and overall growing periods averaged 2200, 2457, 2336 and 2414; 2355, 2443, 2403 and 2491 and 4555, 4900, 4739 and 4905 g/bird, respectively. Significantly ($P<0.05$) more amount of feed intake was noted in NSPDE supplemented groups B and D than non-supplemented groups A and C during starter and overall growing periods. However, there was non-significant difference in feed intake of broiler chicks of all groups during finisher phase.

The average weight gains of broiler chicks of groups A, B, C and D during starter, finisher and overall growing phases were 1002, 1069, 1063 and 1060; 969, 969, 966 and 982; and 1971, 2038, 2029 and 2042 g/bird, respectively. Statistically, there was not significant difference in weight gains of broiler chicks

Table 2: Nutrient composition (%) of starter and finisher diets (as such basis)

Nutrients	Diets*							
	A		B		C		D	
	**S	**F	S	F	S	F	S	F
Crude protein[1]	19.26	18.24	19.26	18.24	19.25	18.25	19.25	18.25
ME (Kcal/Kg)***	2750.00	2770.00	2750.00	2770.00	2700.00	2720.00	2700.00	2720.00
Crud fibre[1]	5.50	5.50	5.50	5.50	5.67	5.50	5.67	5.50
Crud fat[1]	3.26	3.87	3.26	3.87	3.25	3.93	3.25	3.93
Ash[1]	6.70	6.72	6.70	6.72	6.40	6.81	6.40	6.81
Calcium[1]	0.93	0.90	0.93	0.90	0.98	0.98	0.98	0.98
Total phosphorous[1]	0.70	0.69	0.70	0.69	0.71	0.70	0.71	0.70
Aflatoxin (ppb)	20.00	22.00	20.00	22.00	25.00	27.00	25.00	27.00

**S stands for starter (1-28 days) and F for finisher (29-42 days) diets

* Diet A: commercial broiler diet without NSPDE; Diet B: commercial broiler diet with NSPDE; Diet C: commercial broiler diet having 50 Kcal/Kg less ME and without NSPDE and Diet D: commercial broiler diet having 50 Kcal/Kg less ME and with 0.05 g/Kg NSPDE.

***Calculated values

[1]Analyzed values

Table 3: Percent nutrient contents and aflatoxin of feedstuffs used in experimental diets

Ingredients*	Moisture	CP	EE	CF	Ash	Aflatoxin	Salt
Corn	11.80	8.97	3.33	2.50	1.16	8.00	-
Wheat	8.50	12.03	1.33	3.00	1.67	-	-
Rice polish	10.10	12.40	15.33	11.00	9.50	-	-
Wheat bran	9.70	13.56	-	9.00	4.50	-	-
Soybean meal	10.50	46.27	1.33	5.50	6.16	-	-
Fish meal	8.70	52.50	11.33	-	24.00	-	1.66
Rapeseed meal	7.70	36.09	-	9.50	9.33	-	-
Corn gluten meal 60%	10.40	59.50	3.00	-	1.16	-	810.00
Canola meal	8.70	39.16	-	10.00	7.16	-	-
Sunflower meal	9.00	28.78	2.33	24.00	5.67	-	31.00

***Analyzed values**

of all experimental groups during all feeding periods. These results indicate that dietary supplementation of NSPDE (rovabio) has no significant effect on weight gain of broiler chicks. FCR declined significantly (P<0.05) with NSPDE supplementation during starter and overall growing phases. However, FCR was found to be non-significantly affected among all treated groups during finisher phase.

The slaughtering data including dressing percentage, relative weights of liver, gizzard, heart and shank are presented in Table 5. All these parameters showed non-significant differences between NSPDE supplemented (diets B and D) and non-supplemented diets (diets A and C).

DISCUSSION

In this study from 1 to 42 days of growth period, NSPDE supplementation significantly (P<0.05) improved feed intake. However, the impact of enzyme supplementation was more (P<0.05) pronounced during the starter phase (0-28 days), which was associated with a significant increase in feed consumption. NSPDE did not show significant effect on weight gain during starter, finisher and overall growing periods. These results clearly indicate that younger birds are more vulnerable to the anti-nutritive properties of NSP that may have posed a constraint on voluntary feed intake during the starter phase. This was consistent with the observation of Selle *et al*. (2003) and Rama-Rao *et al*. (2004). Feed intake did not improve between supplemented groups (diets B and D) during starter and overall growing periods. There was a non-significant difference between NSPDE unsupplemented (diet C having 50 Kcal/kg less ME) and supplemented (diet D having 50 Kcal/kg less ME) groups in feed intake, weight gain and feed efficiency.

Results of this study are in accordance with the findings of Jacob *et al*. (2000) and Banerjee (1992), who reported that exogenous enzymes supplementation were particularly useful for diets containing cereals

Table 4: Growth performance of broiler chicks fed diets supplemented with or without NSPDE

Parameters	*Diets			
	A	B	C	D
Starter phase (0-28 days)				
Average initial body weight (g/bird)	44.00 ± 0.03	45 ± 0.08	43 ± 0.07	44 ± 0.06
Average body weight (g/bird)	1002 ± 12	1069 ± 11	1063 ± 14	1060 ± 16
Average feed intake (g/bird)	2200^b ± 5	2457^a ± 7	2336^b ± 5	2414^a ± 4
Feed efficiency	2.20^b ± 0.04	2.30^a ± 0.02	2.20^b ± 0.05	2.28^a ± 0.03
Finisher phase (29-42 days)				
Average body weight gain (g/bird)	969 ± 21	969 ± 22	966 ± 19	982 ± 15
Average feed intake (g/bird)	2355 ± 6	2443 ± 4	2403 ± 8	2491± 9
Feed efficiency	2.43 ± 0.08	2.52 ± 0.07	2.49 ± 0.03	2.54 ± 0.02
Overall (0-42 days)				
Average body weight gain (g/bird)	1971 ± 16	2038 ± 9	2029 ± 15	2042 ± 16
Average feed intake (g/bird)	4555^b ± 5	4900^a ± 3	4739^b ± 9	4905^a ± 8
Feed efficiency	2.31^b ± 0.06	2.40^a ± 0.00	2.33^b ± 0.04	2.40^a ± 0.03

Value (means ± SEM) in rows with different superscripts differ significantly (p<0.05).
* Diet A: commercial broiler diet without NSPDE; Diet B: commercial broiler diet without NSPDE; Diet C: commercial broiler diet having 50 Kcal/Kg less ME and without NSPDE and Diet D: commercial broiler diet having 50 Kcal/Kg less ME and with 0.05 g/Kg NSPDE.

Table 5: Slaughtering parameters of broiler chicks fed diets supplemented with or without NSPDE

Parameters	Diets**			
	A	B	C	D
Dressing percentage	59.76 ± 0.879	61.97 ± 1.245	60.66 ± 1.535	61.81 ± 0.725
Organ weights				
Liver (g/bird)	50.00 ± 2.51^a	45.33 ± 2.60^{ab}	39.00 ± 1.73^b	40.00 ± 0.57^b
Gizzard (g/bird)	36.00 ± 4.51	34.00 ± 2.08	31.00 ± 1.73	34.00 ± 2.08
Shank (g/bird)	97.33 ± 4.91	97.00 ± 10.15	88.00 ± 5.68	88.33 ± 5.69
Heart (g/bird)	16.33 ± 1.45	14.66 ± 0.33	14.00 ± 0.57	12.33 ± 1.33
Liver (% of *LBW)	2.00 ± 0.13^a	1.99 ± 0.09^{ab}	1.83 ± 0.07^b	1.90 ± 0.05^b
Gizzard (% of *LBW)	1.56 ± 0.24	1.49 ± 0.06	1.45 ± 0.04	1.61 ± 0.07
Shank (% of *LBW)	4.19 ± 0.32	4.23 ± 0.28	4.12 ± 0.14	4.19 ± 0.18
Heart (% of *LBW)	0.70 ± 0.05	0.64 ± 0.01	0.66 ± 0.04	0.59 ± 0.08

*LBW= live body weight
Value (means ± SEM) in rows with different superscripts differ significantly (p<0.05).
****** Diet A: commercial broiler diet without NSPDE; Diet B: commercial broiler diet without NSPDE; Diet C: commercial broiler diet having 50 Kcal/Kg less ME and without NSPDE and Diet D: commercial broiler diet having 50 Kcal/Kg less M E and with 0.05 g/Kg NSPDE.

with a high non-starch polysaccharide (NSP) level, such as wheat, barley and oats. Results of this study contradict to the findings of Selle *et al*. (2003), who reported that AME increased by 0.43 MJ by supplementation of xylanase plus phytase enzyme in broiler diets. Probably this might be due to the use of specific enzyme (xylanase) for wheat used in broiler diets whereas, we used various feed ingredients having different kind of NSP. This enzyme supplementation may be incapable of hydrolyzing various NSP. Chesson (1993) has reported that multi-enzyme preparation for break down of cell walls requires a number of different enzymes. Castanon *et al.* (1997) reported that the addition of NSP degrading enzyme reduced the recovery of total NSP of barley by hydrolyzing high molecular weight NSP and sugars, and the extent of hydrolysis depended on the level of enzyme. According to Bedford and Classen (1992), low level of enzyme could in fact accumulate high-molecular weight soluble NSP in the hind gut section of broilers and reduce nutrient absorption. Graham *et al*. (1993) reported that high digesta viscosity blocked the digestive enzyme efficiency in the gut and reduced the absorption of nutrients. However, exogenous enzyme supplementation significantly reduced ($P<0.001$) digesta viscosity.

The results in the literature are highly variable with some studies reporting increased starch (Inborr *et al*., 1993) and nitrogen digestibilities (Bedford and Classen, 1992), while others reported no effect of exogenous enzyme supplementation (Jacob *et al*., 2000; Banerjee, 1992). Supplementation of enzymes might be incapable of reducing viscosity of intestinal contents. This is because of high intestinal viscosity associated with reduced nutrient availability (Bedford and Classen, 1992). Austin *et al*. (1999) reported that NSP leached from the grain might not be the dominant factor in low AME wheat phenomenon. The exact modes of exogenous enzymes are still not completely understood. Ravindran *et al*. (1999), Choct and Annison (1990) and Selle *et al*. (2003) reported that continuous use of exogenous enzymes might increase digestibility of amino acids to a synergistic extent. Furthermore, the present study showed that NSPDE supplementation did not affect the dressing percentage, weights of shank, gizzard and heart. However, liver weight was reduced significantly ($P<0.05$). Weights of shank, heart and gizzard in terms of percent of live weight basis of birds fed diets either supplemented or unsupplemented with NSPDE did not differ. Our traditional poultry diets contain different cereals with different kind of NSP that are not digested properly by broilers. That is why enzyme supplementation does not improve growth performance.

From the results, it can be concluded that supplementation of NSPDE in commercial broiler diets improved the efficiency of feed utilization only during starter phase and failed to do so during finisher phase. NSPDE supplementation did not influence the carcass traits except, relative liver weight.

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