Effects of Kemzyme, Phytase and Yeast Supplementation on the Growth Performance and Pollution Reduction of Broiler Chicks

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ABSTRACT : An experiment was conducted to evaluate the effects of dietary Kemzyme, phytase, yeast and a combination of Kemzyme, phytase and yeast (KPY) supplementation on the growth performance, nutrient utilizability and the nutrients excretion in broiler chicks. Experimental diets based on corn-soybean meal were supplemented with 0.05% Kemzyme, 0.1% phytase, 0.1% yeast, 0.25% KPY (0.05% Kemzyme + 0.1% phytase + 0.1% yeast), respectively. Each treatment had six replicates of six male birds each. A total of 180 Arbor Acres broiler chicks were fed these diets for a period of six weeks. Numerically better body weight gain was found in chicks fed Kemzyme, phytase, yeast or KPY supplemented diet. Feed conversion rate was improved by the addition of KPY compared with control group ($p < 0.05$). Mortality was successfully reduced by supplementation of enzymes, yeast or a combination of enzymes and yeast. The excretions of N and P were considerably reduced by supplementation of dietary enzymes, yeast or combination of all three substances, especially for KPY fed group in starting period. The nutrient excretions in the finishing period were not significantly different. It appeared that the use of Kemzyme, phytase and yeast simultaneously had an additive effect on growth rate and nutrient excretion.

(Key Words : Kemzyme, Phytase, Yeast, Broiler Chicks, Growth Performance, Pollution Reduction)

INTRODUCTION

Enzymes are proteins that act as catalysts in metabolism, and are involved in almost every biochemical process in animals. There are many examples in the literature of enzymes being tested in a range of diets containing a variety of ingredients (Anderson et al., 1961; Berg, 1961; Newman and Newman, 1987; White et al., 1983; Han and Min, 1991; Noh et al., 1994; Ryu et al., 1994; Morgan et al., 1993; Samarasinghe and Wenk, 1993; Schutte et al., 1993; Vranjes and Wenk, 1993).

The N and P excreted from monogastric animals are major factors which can cause environmental pollution, because there is incomplete digestion of the protein and the organic phytic compound in feedstuffs, and approximately 70% of phosphorus in feedstuffs exists as a form of phytic acid. The solution of this problem is to add enzymes like phytase so that animal can use unavailable form of phosphorus more efficiently. Simons and Versteegh (1990), and Kwon et al. (1995) reported that phosphorus excretion was reduced by 34%-50% by supplementation with phytase. These results can be explaine by the fact that phytase hydrolyses 97% of the phosphorus compounds of soybean meal (Nelson et al., 1968).

Yeast culture products, which have some fermentation ability, consist of yeast and the media which the yeast grew on (AAFCO, 1986). Kim and Kim (1988) showed that 0.1% yeast added to a diet could reduce animal wastes, and similar results were reported by Park et al. (1994). In monogastric animals, yeast culture greatly improved feed conversion (Chapple, 1981) and produced palatable materials for animals (Peppler, 1982).

Recently, Wenk et al. (1993) investigated the effects of the use of carbohydrase and phytase in a combination with pigs, and found that both had a more or less pronounced effect on the digestibility of organic matter, energy, and N as well as P and zinc. However, they could not find any favourable effect of a combination of carbohydrase with the phytase concerning growth performance and digestibility of the nutrients.

The objective of this study was to investigate if there is an additive effect on growth rate and nutrient utilization when Kemzyme, phytase and yeast (KPY) are used

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simultaneously. Also, this study was expected to make a contribution to the development of low pollution diets.

MATERIALS AND METHODS

A total of 180 male broiler chicks of Arbor Acres strain hatched at Han Il Breeding Farm were randomly alloted to five dietary treatments. The treatments were control, Kemzyme, phytase, yeast and KPY (Kemzyme+phytase+yeast). Each treatments had six replicates with six male chicks in each replicate.

Birds were fed a commercial diet (23%, CP: 3,200 kcal ME/kg) for a period of three days before the feeding trial began. At third day of post-hatching, the chicks chosen to have uniform initial body weight were alloted to treatments and fed the experimental diet for six weeks. For the starting period (1-3 weeks), birds were fed corn-soybean meal based basal diets (control) containing 23% crude protein and 3,200 kcal ME/kg, and supplemented with 0.05% Kemzyme, or 0.10% phytase, or 0.10% yeast, or 0.25% KPY (Kemzyme 0.05%+phytase 0.1%+yeast 0.1%). The experimental diets for the finishing period (4-6 weeks) were formulated to 20% crude protein and 3,200 kcal ME/kg, and supplemented with 0.05% Kemzyme, 0.10% phytase, 0.10% yeast or 0.25% KPY. The composition of the basal diets for the starting and finishing period is shown in table 1, and the specifications of enzymes and yeast are shown in table 2. All the nutrients were included in amounts to meet or exceed the estimated requirements of NRC (1994).

All the birds were raised in battery cages made of steel wire and housed in a room with 24 hours light and air ventilation. Room temperature was maintained at 30℃, 28℃ and 26℃ for the first, second and third week, respectively. Experimental diets and drinking water were provided *ad libitum* during the entire experimental period. Body weight and feed intake were recorded weekly. Total amount of excreta was recorded weekly. During the feeding trial, mortality was also recorded.

To investigate the nutrient utilizability of the experimental diets, the metabolizability coefficient was calculated by total collection of excreta during seven days at the end of each growth stage (third and sixth week). After four days of adaptation, total excreta were collected four times a day for the three consecutive days to avoid the contamination with foreign materials such as feed, feathers and scales, were pooled, and were dried in an air-forced drying oven at 60℃ for 72 hours to constant weight. All the samples prepared in this way were ground in a 1 mm mesh Wiley mill for chemical analysis.

Experimental diets and excreta were analyzed according to the methods of AOAC (1990). Energy content was measured by Adabatic Oxygen Bomb Calorimeter (Model 1241, Parr Instrument Co., Molin IL).

Statistical analyses for the present data were carried out by comparing means according to Duncan's multiple range test (Duncan, 1955), using the General Linear Model (GLM) Procedure of SAS (1985) package program.

Table 1. Composition of basal diets

Treatments	Starter (1-3 weeks)	Finisher (4-6 weeks)
Ingredient (%):		
Corn	54.92	63.44
Soybean meal	27.22	3.26
Fish meal	5.00	3.05
Corn gluten meal	5.00	4.00
Tallow	5.00	3.78
Limestone	0.72	0.62
Tri-Calcium phosphate	1.60	1.20
Salt	0.10	0.20
Vitamin-Mineral mixture[1]	0.40	0.40
Antibiotics	0.04	0.05
Chemical composition[2]:		
ME (kcal/kg)	3,200.06	3,200.02
Crude protein (%)	23.04	20.06
Lysine (%)	1.20	1.00
Methionine+Cystine (%)	0.91	0.74
Calcium (%)	1.20	0.90
Available P (%)	0.45	0.35

[1] Vitamin and mineral mixture contains as following per 1 kg: Vitamin A, 1,600,000 IU; Vitamin D_2, 300,000 IU; Vitamin K_3, 130 mg; Vitamin B_2, 1,000 mg; Choline chloride, 35,000 mg; Niacin, 2.000 mg; Ca-pantothenate, 800 mg; Folic acid, 60 mg; DL-methionine, 6,000 mg; Mn, 12,000 mg; Zn. 9,000 mg; Fe, 4,000 mg; Cu, 500 mg; I, 250 mg; Co, 100 mg; Ca, 7,140 mg; Butylated hydroxytoluene, 6,000 mg.

[2] Calculated value.

RESULTS AND DISCUSSION

1) Growth performance

The effects of dietary supplementation with Kemzyme, phytase, yeast and KPY on body weight gain, feed intake, feed conversion and mortality are recorded in table 3.

In the first three weeks period, body weight gain, feed intake and feed conversion were not significantly different

Table 2. Specification of enzymes and yeast

Category of supplements	Name	Active compound (kg)		Usage in mixed feed
Enzyme	Kemzyme[2]	α-amylase	2,000,000 IU	0.05%
		β-amylase	2,000,000 IU	
		β-glucanase	33,000 IU	
		Pullulanase	6,900 IU	
		Pectinase	27,500 IU	
		Endoprotease	1,000,000 IU	
		Exoprotease	1,000,000 IU	
		Cellulase	3,750,000 IU	
	Phytase[3]	500,000 FTU[1]		0.10%
Yeast	(CYC)[4]	Saccharomyces cerevisiae cultured on grain media		0.10%
Enzyme and yeast mixture	KPY	Kemzyme	0.05%	0.25%
		Phytase	0.10%	
		Yeast	0.10%	

[1] FTU : The quantity of enzyme which liberates 1 micromole of inorganic phosphorus per minute from 0.0015 mol/l sodium phytate at pH 5.5 and 37℃.
[2] Kemin Korea Co. [3] Alltec Co. [4] Choong Ang Chemical Co.

among treatments. Mortality was significantly different among treatments ($p < 0.05$). The highest mortality was observed in the control group (5.56%), and the lowest was in the Kemzyme, phytase and KPY groups. These results are in agreement with the reports by Kwon et al. (1995), Park et al. (1994) and Noh et al. (1994), but conflict with the reports by Peppler (1982) and Han and Min (1991).

Kwon et al. (1995) found no difference in weight gain and feed intake when they added phytase to starter broiler diets. The available phosphorus content in the basal diets might be already enough to meet phosphorus requirement for chicks. Park et al. (1994) reported higher weight gain and feed intake with no significant difference when they added 0.1% yeast culture to the starter broiler diets. And Noh et al. (1994) also reported no significant improvement in weight gain, feed intake and feed efficiency with 0.05% Kemzyme or 0.1% yeast culture. In contrast, Peppler (1982) reported higher weight gain with yeast culture supplementation and Han and Min (1991) observed higher weight gain and improved feed efficiency when they supplemented 0.05% Kemzyme to broiler diets. The possible reason for the difference in growth performance between our study and the report by Han and Min (1991) is feed ingredietns used. Han and Min (1991) used 2% of wheat bran which is very high in crude fiber. While in our study the basal diets were formulated on the basis of corn-soybean-corn gluten meal. The favorable effect of enzyme supplemen- tation is known to be more clearly promounced in high fiber diets (Hasting, 1946; Berg, 1959). Noh et al. (1994) used similar diets with ours and found no difference in weight gain when they were examining the effect of Kemzyme supplementation to the broiler diets.

For the finishing period, the highest body weight gain was obtained in KPY group, and the lowest in control group with no significant difference. Also, there was no significant difference in feed intake among treatments. However, feed conversion was significantly different among treatments ($p < 0.05$). The best feed conversion was obtained in the KPY group and the worst was found in the control group. This result was in agreement with the results of Noh et al. (1994), Han et al. (1991), Kwon et al. (1995) and Park et al. (1994) who reported that feed conversion was slightly improved by enzymes or yeast supplementation. The mortality was not observed in finishing period.

Kwon et al. (1995) reported that phytase supple- mentation could improve weight gain and feed efficiency. The satisfactory effect of phytase addition have

Table 3. Effects of Kemzyme, phytase, yeast and KPY on the growing performance of broiler chicks and mortality during the first period (1-3 weeks)

Treatment	Initial weight (g)	Final weight (g)	Weight gain (g)	Feed intake (g)	Feed/gain	Mortality (%)
(1-3 weeks)						
Control	60.10	871.21	811.12	1,258.59	1.55	5.56
Kemzyme	60.11	872.78	812.67	1,231.78	1.51	0.00
Phytase	59.99	874.53	814.54	1,246.17	1.53	0.00
Yeast	60.14	877.18	817.04	1,252.94	1.54	2.78
KPY	60.06	878.82	818.76	1,231.61	1.50	0.00
SE[1]	0.03	3.01	3.01	11.91	0.01	
(4-6 weeks)						
Control	871.21	2,129.80	1,258.59	2,945.2	2.34[a]	0
Kemzyme	872.78	2,150.11	1,277.39	2,857.4	2.24[ab]	0
Phytase	874.53	2,146.19	1,271.67	2,841.8	2.24[ab]	0
Yeast	877.18	2,165.45	1,288.26	2,841.2	2.21[ab]	0
KPY	878.82	2,171.75	1,292.93	2,734.1	2.12[b]	0
SE[1]	3.01	14.93	13.90	35.3	0.03	
(1-6 weeks)						
Control	60.10	2,129.80	2,069.71	4,203.8	2.03[a]	5.56
Kemzyme	60.11	2,150.11	2,090.05	4,089.1	1.96[ab]	0.00
Phytase	59.99	2,146.19	2,086.21	4,088.0	1.96[ab]	0.00
Yeast	60.14	2,165.45	2,105.30	4,094.2	1.95[ab]	2.78
KPY	60.06	2,171.75	2,111.69	3,965.8	1.88[b]	0.00
SE[1]	0.03	14.93	14.92	42.3	0.02	

[1] Pooled standard error, n=30.

[a,b] Figures with different superscripts are significantly different at $p < 0.05$.

been well documented. Park et al. (1994) also reported an improved weight gain, feed intake and feed efficiency when they added 0.01% yeast culture to broiler diets, though there was no significant difference among treatments. Noh et al. (1994) found that Kemzyme significantly improved feed efficiency for the finisher broiler chicks. However, in our study, only KPY group showed significant improvement in terms of feed efficiency and other treatment only showed numerical improvement.

Through entire experimental period, the highest body weight gain was found in the KPY group and the lowest was obtained in the control group. Though, feed intake was not affected by supplementation of experimental additives, the chicks fed the control diet showed the highest feed intake. Feed conversion was improved by KPY supplementation compared with that of the chicks fed control diet ($p < 0.05$). Feed efficiency was more improved by feeding enzymes or yeast in the finishing period than in the starting period, which agreed with the report by Noh et al. (1994). Though there are numerous reports that the body weight gain and the feed efficiency were greatly improved in broilers by supplementation of yeast or enzymes (Hesselman et al., 1981, 1982; Lee and Campbell, 1983; Hesselman and Aman, 1986; Newman and Newman, 1987, 1988; Han and Min, 1991; Park et al., 1994; Ryu et al., 1994), in this study, any significanly favarable effect of single supplement of test additive was not found. Only in KPY group, a significant improvement in feed efficiency was found ($p < 0.05$) which suggests that the use of the combination of Kemzyme, phytase and yeast could have an additive effect on animal performance. Since all treated groups showed similar feed intake, it was assumed that the energy level of the diets was not different among treatments. Rather, the available protein and phosphorus contents could possible deficient in the basal diet. The excretion of N and P also reduced when KPY was fed as shown in table 4. Contary to our results, Wenk et al. (1993) reported a negative interaction between carbohydrase and phytase. They suggested that carbohydrase might reduce the analyzed phytase activity in the diets. More study is needed to clarify the interaction when two or more additives were mixed in the diets.

Table 4. Effects of Kemzyme, phytase, yeast and KPY on nutrient excretion of broiler chicks (g/1,000 g)

Treatment	Dry matter	Nitrogen	Phosphorous
Starter period (3rd week)			
Control	232.84	14.92[a]	3.50[a]
Kemzyme	224.89	12.49[b]	3.36[ab]
Phytase	219.50	12.36[b]	3.16[b]
Yeast	230.02	12.93[b]	3.47[a]
KPY	221.57	11.94[b]	3.19[b]
SE[1]	2.55	0.29	0.04
Finisher period (6th week)			
Control	284.17	20.54	4.28
Kemzyme	266.62	19.36	3.97
Phytase	256.01	19.04	3.97
Yeast	259.44	18.85	4.05
KPY	244.59	17.89	3.86
SE[1]	6.11	0.53	0.08

[1] Pooled standard error, n=30.

[a,b,c] Figures with different superscripts are significantly different at $p < 0.05$.

2) Dry matter, nitrogen and phosphorus excretions

Table 4 summarized the effects of Kemzyme, phytase, yeast and KPY on nutrient excretions per 1,000 g body weight gain in broiler chicks. For the starting period, dry matter excretion was not significantly different among treatments. However, N and P excretion was significantly reduced by supplementation of tested additives. All treated groups showed less N excretion ($p < 0.05$) and phytase and KPY group showed significantly less P excretion compared to the control group ($p < 0.05$). Some researchers already reported that phytase could improve N utilization (Jongbloed et al., 1993; Officer and Batterham, 1992; Khan and Cole, 1993) by improve the utilizability of phytate complexes. For the finishing period, though there was no significant difference, all supplemented groups excreted less dry matter than control group. N excretion during finishing period showed no difference among treatments. Phosphorus excretion also showed no difference during the finishing period. These results is in agreement with the previous report by Noh et al. (1994), Han et al. (1991), Kwon et al. (1995), and Park et al. (1994). Data demonstrated that broiler chicks fed Kemzyme, phytase, yeast and KPY excreted considerably less dry matter, nitrogen and phosphorus when expressed in grams per 1,000 grams of body weight gain. Noh et al. (1994) compared the effect of enzyme, antibiotics, yeast, probiotics, and β-agonists supplementation on the nutrient utilization. They reported that enzyme supplementation was the most efficient in improving nutrient utilization.

Present data indicated that the supplementation of Kemzyme, phytase, yeast or combination of enzymes and yeast in the broiler diets resulted in improving growth performance, nutrient utilization and the reducing N and P excretion of broiler chicks. A combination of Kemzyme, phytase and yeast could be more effective in improving the performance of chicks than when those additives used alone. The optimal supplementation of enzymes and yeast was expected to alleviate the environmental pollution by reducing animal wastes, especially nitrogen and phosphorus excretion, therefore to contribute to the development of low pollution diets of broiler chicks.

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