Introduction

The primary constituents of poultry diets are plant-based ingredients which come primarily from plant seeds. The non-starch polysaccharides (NSP) in plants including cellulose, pectins, glucans and arabinoxylans affect their nutritive values (Souffrant, 2001). Furthermore, these compounds in solution interact with long polymers resulting in the formation of a viscous digesta in poultry gut (Bedford, 1995). Choct and Annison (1992) in studies with broiler chicks showed that an increase in the viscosity of the intestinal content is closely associated with a decrease in protein, energy and other nutrients digestibility. Moreover, viscous digesta in poultry gut results in an increase in the incidence of sticky droppings and adverse effects on litter quality (Hesselman and Aman 1986). Marsmann *et al.* (1997) reported improvement in the nutritional value of soybeans could be achieved with protease and carbohydrase enzymes supplementation. Multi enzyme feed additives have been found to increase availability of protein / amino acids, energy and minerals for broilers (Aulrich and Flachowsky, 2001; Bedford, 2000; Brufau *et al.,* 2002; Mathlouthi *et al*., 2003; Wang *et al*., 2005; Saleh *et al*., 2006). This makes it necessary to study the effects of protease activities in multi enzyme systems upon performance and carcass traits. The combination of proteases with lysophospholipids should have positive effects on nutrients digestibility and absorption which is reflected on feed efficiency and growth performance. This study was carried out to investigate the effects of the combination of protease with lysophospholipids in multi enzyme mixtures on feed efficiency, broiler chicken growth performance, dressing weight and breast muscle yield.

Materials and Methods

A total number of 2000, 1-d-old male meat-type chickens (Hubbard) were raised in floor pens and randomly divided into 4 main groups (500 chicks per group). Each main group was further divided into 5 sub-groups having 100 chicks (5 replicates of 100 chicks per group). Group 1 consumed the diets (starter, grower and finisher) without enzyme supplementation and served as control group (Table 1). The experimental diets were the same as the control diets but supplemented with 0.05% of either Nutrikem Dry®, Kemzyme Plus® or Kemzyme MS® for experimental groups 2, 3 and 4 respectively. Diets were formulated according to the recommendations of the Hubbard breed and all the feed formulae were calculated by Kemin Europa N.V. Company. The diets in the form of mash and water were provided *ad- libitum* during the entire experimental period (42 d). Body weight as well as the rest of feed was recorded weekly. Body weight gain and feed conversion ratio were calculated.

The enzyme mixtures used illustrated in table (2) were produced by Kemin Europa N.V. Company. At the end of the experimental period (d 42 of age), 100 chickens randomly selected (20 from each replicate) from control and each experimental treatment were slaughtered and examined for dressing and breast muscle weights. All data were statistically analyzed using SPSS® version 11.0 software for personal computer (2005). Means were compared by one-way ANOVA ($P<0.05$) Sendecor and Cochran (1980).

Results and discussion

Table 3 summarizes the average weekly live body weight of the control and the experimental treatments. Enzyme mixtures supplementation improved significantly ($P<0.05$) the live body weight compared with the control group at day 28 of age and at the end of the experimental period as well. However, there was no significant difference observed between the treated groups. Enzyme supplementation improved live body weight at the end of the experimental period by 5.90, 7.09 and 7.1% for group 2, 3 and 4 respectively. Zanella *et al.* (1999) also reported that enzyme supplementation improved body weight and feed conversion ratio by 1.9 and 2.2%, respectively. Marsmann *et al.* (1997) suggested that an improvement in the nutritional value of soybeans could be achieved with protease and carbohydrase enzymes supplementation. Douglas *et al.* (2000) evaluated twelve commercial soybean meal samples in a 2-week broiler assay with or without enzymes addition.

They found that the ileal digestible energy (DE) of the diets was significantly improved by the enzymes addition and this was reflected on the live body weight and feed conversion.

Mean values of weekly feed consumption, body weight gain and FCR are shown in table 4. Enzymes addition to broiler chicken diets reduced significantly ($P<0.05$) the total feed consumption and improved FCR compared with the control group. Moreover, group 4 fed on diets containing enzyme mixture Kemzyme MS® showed a significant ($P<0.05$) reduction in feed intake and the best feed conversion even when compared with the other enzyme mixtures groups. As Bedford (1996) reported the actions of enzymes supplementation may be improving the overall nutrient digestion and reducing endogenous amino acid losses. A number of research studies have reported positive responses to the addition of exogenous enzymes in terms of reduced diet cost, improved FCR, weight and egg weight (Cook *et al.,* 2000; Gonzales *et al.,* 2001 Mathlouthi *et al*., 2003; Saleh *et al*., 2006). In broilers and ducks fed on diets treated with enzyme mixtures, improvements in FCR, body weight, uniformity and nutrient digestibility were reported (Zanella *et al.,* 1999; Burrows *et al.,* 2002; Wang *et al*., 2005). The combination of xylanase, amylase, Beta-glucanase, Cellulase and protease enzymes has been shown to improve protein, amino acid and energy utilization, which was reflected on performance / uniformity and this impacted microbial population in a beneficial manner in the upper and lower intestine (Douglas *et al.,* 2000). Research focusing on the bird's endogenous enzymes (Krogdahl and Sell, 1989) suggested that the young bird might be limited in the types and amounts of enzymes necessary to utilize a high carbohydrate and vegetable protein diets at an early age, thus affecting nutrient digestibility (Noy and Sklan, 1994). This was confirmed by Choct *et al.* (1996) and Sklan (2002) who found that the ileal digestibility of starch was 90% in 29-day old broilers fed on sorghum-based diets. In conclusion, exogenous multi enzyme mixtures especially those containing protease could improve broiler performance, FCR, dressing weight and the breast muscle weight.

Table 5 shows the results of dressing and breast muscle weights. Dressing and breast weights were improved with all enzyme treatments in a significant way ($P<0.05$). The highest dressing weight and breast yield were obtained with the Kemzyme MS® treatment and these results were statistically significant ($P<0.05$) versus the control and other enzyme supplemented groups.

Table 1. Composition and calculated analyses of starter, grower and finisher diets

Ingredients	Starter (0-14 d)	Grower (15-35 d)	Finisher (36-42 d)
Yellow corn	50.403	57.363	60.495
Corn gluten meal	5.00	5.00	3.00
Soybean meal	38.531	30.919	28.823
Soy oil	2.167	2.856	3.939
Dicalcium phosphate	2.596	2.307	2.119
Lime stone	0.132	0.392	0.534
Common salt	0.331	0.308	0.284
DL-Methionine	0.188	0.169	0.169
L-lysine	0.168	0.248	0.199
Choline chloride	0.184	0.138	0.138
Broiler premix*	0.30	0.30	0.30
Nutrient Profile:			
ME (kcal/kg)	3021.50	3185.30	3279.00
Crude protein%	23.08	20.57	18.71
C / P ratio	130.91	154.85	175.25
Crude fat%	4.79	5.51	6.53
Crude fibre%	4.57	4.03	3.88
Total ash%	5.58	5.08	4.90
Calcium%	0.89	0.89	0.89
Non-phytate phosphorus%	0.50	0.45	0.42
Sodium%	0.16	0.15	0.14
Methionine%	0.58	0.53	0.49
Lysine%	1.29	1.17	1.07
Methionine+Cystine%	0.99	0.89	0.82
Tryptophane%	0.25	0.21	0.19

*Per kg broiler premix: 1,200,000 IU vit. A, 350,000 IU vit. D_3, 4,000 mg vit. E, 250 mg vit. B_1, 800 mg vit. B_2, 600 mg vit. B_6, 3.2 mg vit. B_{12}, 450 mg vit. K_3, 4.5 g nicotinic acid, 1.5 g Ca-pantothenate, 120 mg folic acid, 5 mg biotin, 55 g choline chlorider, 3 g Fe, 2 g Cu, 10 g Mn, 8 g Zn, 120 mg I, 40 mg Co (Vilomix GmbH, Germany).

Table 2. Composition of multi enzyme mixtures

	Nutrikem Dry®	Kemzyme Plus®	Kemzyme MS®
Beta-glucanase (IU/g)	1175	2350	1175
Cellulase (IU/g)	2000	4000	2000
Alpha amylase (IU/g)	200	400	200
Protease (IU/g)	225	450	225
Xylanase (IU/g) Emulsifier	10000	20000	10000
(Lecithin)	+	-	-

Table 3. Effect of the dietary supplementation of enzyme mixtures on weekly body weight (g) in broiler chickens

Age (day)	Group 1	Group 2	Group 3	Group 4
0	45.04±0.53 [a]	43.27±0.53 [a]	44.09±0.61 [a]	44.87±0.50 [a]
7	141.86±3.03 [a]	138.63±2.58 [a]	139.03±2.96 [a]	140.43±2.85 [a]
14	399.90±4.20 [a]	398.99±3.43 [a]	414.06±3.55 [b]	410.57±3.60 [b]
21	689.52±8.62 [a]	680.53±6.32 [a]	703.35±6.75 [a]	692.31±17.00 [a]
28	1105.00±11.64 [a]	1126.50±10.62 [b]	1155.20±10.48 [b]	1143.30±11.48 [b]
35	1553.60±16.00 [a]	1554.00±16.10 [a]	1567.70±17.68 [a]	1599.70±16.47 [a]
42	1869.30±20.92 [a]	1980.05±14.00 [b]	2002.00±14.91 [b]	2002.60±21.54 [b]

Figures in the same row with different letters are statistically significantly different (P=0.05)

Table 4. Effect of the dietary supplementation of enzyme mixtures on weekly feed intake, body weight gain and FCR in broiler chickens

Age (d)		Group 1	Group 2	Group 3	Group 4
7	Feed Intake (g/bird)	124.34±5.15 [a]	130.54±12.40 [a]	122.82±8.37 [a]	125.10±5.37 [a]
	Body weight gain (g/bird)	96.82±2.54 [a]	95.35±3.32 [a]	94.94±3.40 [a]	95.56±1.96 [a]
	FCR	1.28	1.37	1.29	1.31
14	Feed Intake (g/bird)	377.46±9.67 [a]	389.58±7.50 [a]	379.54±11.23 [a]	384.18±5.76 [a]
	Body weight gain (g/bird)	258.04±11.99 [a]	260.36±8.12 [a]	275.03±10.40 [a]	270.14±5.13 [a]
	FCR	1.46	1.50	1.38	1.42
21	Feed Intake (g/bird)	548.10±5.84 [a]	550.80±2.63 [a]	543.60±10.66 [a]	546.90±6.34 [a]
	Body weight gain (g/bird)	289.62±7.98 [a]	281.54±7.02 [a]	289.29±4.23 [a]	281.74±5.97 [a]
	FCR	1.89	1.96	1.88	1.94
28	Feed Intake (g/bird)	886.60±12.93 [a]	905.70±124.24 [a]	880.90±18.23 [a]	865.60±126.65 [a]
	Body weight gain (g/bird)	415.48±22.34 [a]	445.96±18.60 [a]	451.85±17.02 [a]	450.95±23.87 [a]
	FCR	2.13	2.03	1.95	1.92
35	Feed Intake (g/bird)	784.10±6.62 [a]	734.7±18.42 [b]	785.56±19.66 [a]	736.64±10.56 [b]
	Body weight gain (g/bird)	448.60±38.87 [a]	427.51±20.90 [a]	412.50±33.57 [a]	456.44±42.18 [a]
	FCR	1.75	1.72	1.90	1.61
42	Feed Intake (g/bird)	797.20±1.74 [a]	786.40±4.87 [b]	786.10±3.77 [b]	787.60±1.31 [a]
	Body weight gain (g/bird)	315.70±36.77 [a]	426.05±33.50 [a]	434.30±46.54 [a]	402.90±32.73 [a]
	FCR	2.53	1.85	1.81	1.95
Total	Feed Intake (g/bird)	3517.80±6.99 [a]	3497.72±28.34 [b]	3498.52±11.99 [b]	3446.02±26.00 [c]
	Body weight gain (g/bird)	1824.26±20.08 [a]	1936.77±15.24 [b]	1957.91±19.19 [b]	1957.73±18.64 [b]
	FCR	1.93	1.81	1.79	1.76

Figures in the same row with different letters are statistically significantly different (P=0.05)

Table 5. Effect of the dietary supplementation of enzyme mixtures on dressing and breast muscles weights (g)

	Group 1	Group 2	Group 3	Group 4
Live BW	1869.30±20.92 [a]	1980.05±14.00 [b]	2002.00±14.91 [b]	2002.60±21.54 [b]
Dressing weight	1436.22±24.59 [a]	1485.30±18.72 [b]	1484.80±22.19 [b]	1519.20±23.37 [c]
Breast muscles	321.74±6.79 [a]	356.64±5.91 [b]	354.64±7.83 [b]	369.20±6.02 [c]

Figures in the same row with different letters are statistically significantly different (P=0.05)

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