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ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

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Impact of Supplemental Feed Enzymes, Condiments Mixture or Their Combination on Broiler Performance, Nutrients Digestibility and Plasma Constituents

M.A. Al-Harthi
Faculty of Meteorology Environment and Arid Land Agriculture, King Abduaziz University, Saudi Arabia

Abstract: An experiment was conducted to study the effect of adding three types of feed additives avizyme, phytase, a mixture of condiments at two levels or their combination to corn-soybean meal based diets. Dietary treatments included feeding a control corn-soybean diet, while in the other diets, the control diet was supplemented with 1g. avizyme/ kg diet, 1000 FTU Natuophos phytase/ kg diet and a mixture (1:1:1:1) of cardamom, cumin, hot and black pepper at 2 or 4 g/kg, or a combination of avizyme and phytase, Avizyme and mixture of condiments at 2 or 4 g/kg and combination of phytase and condiments mixture at 2 and 4 g/kg and combination of Avizyme, phytase and 2 or 4 g of condiments mixture/ kg diet. Diets were iso-caloric and iso-nitrogenous. A number of 540 unsexed 7-days old Lohman broiler chicks were fed on 12 dietary treatments each contained 5 replicates of 9 chicks each. The experimental period lasted from 7 to 49 d. of age. Growth performance, carcass characteristics, chemical composition of the excrement, digestibility of nutrients and biochemical constituents of blood plasma were studied. The results obtained showed that, diet supplementation with a combination of Avizyme, phytase and 2 g/kg of condiments significantly increased the gain of body weight during the first growth period (7-21 days of age). The average live body weight gain increased significantly on using phytase supplementation alone by 7.6% compared to the un-supplemented control for the whole experimental period. Chicks fed diets supplemented with Avizyme without or with either low or high level of condiments mixture showed similar growth rate to those received the un-supplemented diet. There was no significant effect of adding neither tested enzymes and condiments mixture nor their combination on feed intake and feed conversion all over the experimental periods however, group fed diet supplemented with phytase alone recorded the best feed conversion and this was numerically better than that of the un-supplemented control by 3.6%. Chemical composition of the excrements or nutrient digestibility at 49 days of age showed no significant effect of using studied feed additives. However, groups feed on phytase diets showed a numerically better crude protein, fiber, ether extract and organic matter digestibility compared with those of the control. Neither tested enzymes and condiments mixture nor their combination had any significant effects on some blood constituents such as plasma total protein, its fractions, total lipids, cholesterol and liver functions as measured by AST and ALT enzymes. Accordingly, it can be recommended to use a combination of Avizyme, phytase and 2g/kg of condiment mixture in broiler diets during the first growth period, 7-21 days of age, to achieve a satisfactory performance. Also, phytase supplementation also has a pronounced effect on the biological responses associated with the performance at the rest of the growth period.

Key words: Feed additives avizyme, corn-soybean, phytase diets

Introduction

It has increasingly apparent that intensive production systems inflicts considerable stress on poultry, adversely affecting meat and egg production efficiency. So, growth promoters, digestion and absorption enhancer are important feed additives for improving growth rate, feed efficiency and their prevention of intestinal infections (Mohan *et at.*, 1996). In the past, antibiotics played an important role in curing diseases in human and animals as well as sub therapeutic doses of antibiotics could increase feed efficiency and growth of animals (Doyle, 2002 and Wages, 2002). On the other hand, the negative effect of antibiotics on the environment such as cross-resistance and carry over effect has gotten more concern from human health standpoint. It is published that two or three antibiotics derived from micro-organisms are launched each year as well as scientists realize that the effective life span of any antibiotics is limited (Clark, 1996).

Nowadays, scientists are working to better define the most useful herbs and plant extracts to quantify what reliable effects they can have in poultry production (Gill, 1999) as well as gain great popularity to control the negative effect of antibiotics on the environment (Damme, 1999 and El-Husseiny *et al.*, 2002). Along the same line, Afifi (2001); Al-Harthi (2002a,b); Tollba, (2003); Tollba and Hassan (2003), El-Deek *et al.* (2003) and Hassan *et al.* (2004) carried out some experiment to investigate the efficiency of herbs, edible plants and some plant seeds as a natural tonic, restorative and

Table 1: Composition and calculated analysis of the experimental basal diets

Ingredients	Starter-grower diet, %	Finisher diet, %
Yellow corn	54.00	65.70
Soybean meal (44%cp)	39.25	28.20
Limestone	0.92	0.92
Dicalcium Phosphate	1.57	1.32
Vit + Min mix*	0.25	0.25
NaCl	0.25	0.25
DL-methionine	0.2	0.12
Vegetable oils	3.29	3.24
Total	100.0	100.0
Calculated Values ME Kcal/kg diet	2986	3121
Crude Protein,%	22	18
Methionine	0.54	0.41
TSAA,%	0.91	0.73
Lysine,%	1.22	0.94
Ca,%	0.90	0.80
Available P,%	0.44	0.38

*vitamins and minerals mixture provide per kilogram of diet: Vitamin A (as all-trans-retinly acetate); 12000IU; vitamin E (all rac-α-tocopheryl acetate); 10IU; k_3 3mg; Vit. D_3 ,2200 ICU; riboflavin, 10mg; Ca pantothenate, 10mg; niacin, 20 mg; choline chloride, 500mg; vitamin B_{12}, 10Ug ; vitamin B_6, 105mg.; thiamine (as thiamine mononitrate), 2.2 mg; folic acid, 1mg; D-biotin, 50ug. Trace mineral (milligrams per kilogram of diet): Mn, 55; Zn, 50; Fe, 30; Cu, 10; Se, 1 and Ethoxyquin 3 mg.

antibacterial drugs on improving the productive performance in poultry.

A promising method to accomplish efficiency of feedstuff utilization especially with ingredients current considered inferior is the use of supplementary feed enzymes which increasingly seen as "environmentally responsible" alternative to antibiotics to provide growth and health benefits (Kies *et al*., 2001; sheppy, 2001 and Choct, 2004). So, cereal based poultry diets supplemented with microbial phytase result in increased digestibility of phytate bound phosphorus, calcium, zinc and copper as well as increase the digestibility of crude protein and amino acids (Sebastian *et al*., 1998; Abd El-Hakim and Abd-Elsamee, 2004; Choct, 2004 and Abdo, Zeinab, 2004). Also, Shakmak, (2003) and El-Nagmy *et al*. (2004) observed that Avizyme addition to the chicken diets significantly improved weight gain compared to those un-supplemented. Ghazalah *et al*. (2005) indicated that supplementation of enzyme preparations improved broiler performance and allowed the reduction in the energy formulation of the diets. Recently, there is a trend to use spices to improve nutrient utilization with considerable success (Al-Harthi, 2002 a,b; Abdo Zeinab *et al*., 2003, Choct, 2004).

Hence, the current study was designed to evaluate the effects of the utilization of two types of feed enzymes (Avizyme and phytase) with mixture of some spices or their combination as non-classical feed additives in broiler diets on growth performance, nutrients digestibility and some biochemical constituents of blood plasma.

Materials and Methods

The current experiment was conducted at Faculty of Meteorology Environmental and Arid Land Agriculture, King Abdulaziz University. Tested materials (Avizyme[a] , Phytase[b] and mixture (1:1:1:1) of Cardamom, Cumin, Hot and Black Pepper) were obtained from the commercial supplier.

A total number of 540 unsexed 7-day old Lohman broiler chicks of nearly similar live body weight were maintained in batteries under similar managerial and hygienic conditions. Chicks were wing banded, randomly assigned equally to 12 groups of dietary treatments with 5 replicates each of 9 birds. Two types of basal diets (starter and finisher) were formulated to cover the nutrient requirements of broiler chicks as recommended by NRC (1994). The ingredients and calculated analysis of the experimental basal diets are shown in Table 1. Feed in a dry mash form and water were offered *ad libitum* throughout the experimental periods as well as artificial lighting was provided 24 hrs. daily. The experimental periods lasted for 49 days of age. Each group was fed on one of the following experimental diets:

1 Control diet (without supplementation).
2 Control diet supplied with Avizyme at 1 g./ kg diet.
3 Control diet supplied with 1000 FTU Natuophos phytase / kg diet
4 Control diet supplied with condiments at 2g./ kg diet.
5 Control diet supplied with condiments at 4g./ kg diet.
6 Control diet supplied with Avizyme plus phytase.
7 Control diet supplied with Avizyme plus condiments (2g./kg).
8 Control diet supplied with Avizyme plus condiments (4g./kg).
9 Control diet supplied with phytase plus condiments(2g./kg).
10 Control diet supplied with phytase plus condiments (4g./kg).
11 Control diet supplied with Avizyme, phytase and condiments (2g./kg).
12 Control diet supplied with Avizyme, phytase and condiments (4g./kg).

For each group of birds, individual body weight at 7, 21, 35 and 49 days of age and feed consumption was recorded biweekly throughout the entire experimental periods . Gain in body weight and feed conversion values were calculated. At 49 days of age, 4 birds of each treatment were randomly taken. Birds were slaughtered by slitting the jugular vein to collect blood samples in heparin zed tubes. Blood samples were centrifuged at 3000 rpm for 10 minutes and plasma was

Table 2: Effect of feeding either Avizyme ®, Phytase , mixture of condiments or their combination on body weight gains of broiler chicks from 7 – 49 days of age

Treatments	Body Weight gains at			
	7 - 21 d.	22 - 36 d.	37 - 49 d.	7 - 49 d.
Control	375.7^{cd}	787.5^{bc}	738.7	1938.8^{bc}
Avizyme	381.2^{cd}	793.2^{bc}	685.7	1897.6^{c}
Phytase	418.9^{b}	899.6^{a}	718.7	2086.1^{a}
Condiments,2g/kg	376.2^{cd}	772.6^{bc}	765.9	1934.1^{bc}
Condiments,4g/kg	376.7^{cd}	780.1^{bc}	715.7	1910.9^{bc}
Avi + Phytase	405.4^{b}	829.9^{abc}	700.0	1978.0^{abc}
Avi + Cond, 2	377.8^{cd}	784.8^{bc}	670.8	1875.9^{c}
Avi + Cond, 4	370.7^{d}	759.2^{c}	729.4	1878.8^{c}
Phy + Cond, 2	416.6^{b}	861.5^{ab}	738.6	2055.5^{ab}
Phy + Cond, 4	420.8^{b}	807.2^{bc}	708.1	1988.0^{abc}
Avi + Phy + Cond, 2	443.7^{a}	766.2^{bc}	654.7	1906.5^{bc}
Avi + Phy + Cond, 4	400.5^{bc}	841.1^{abc}	666.3	1933.6^{bc}
SEM	6.97	74.8	91.1	30.8
P value	0.0001	0.001	NS	0.001

NS, not significant. a,b,... means within the same row not having similar superscripts are significantly different (P<0.05)

stored at -20^{0}. Plasma total protein, albumin, total lipids, Total cholesterol and transaminase enzymes activities (ALT and AST) were determined color-metrically using available commercial kits (Bio-Meraux, France), where globulin concentration was calculated as the difference between total protein and albumin. A digestibility trial was carried out to study the effect of adding the studied feed additives on nutrients digestibility. At the end of the experiment, 4 birds of each group were housed individually in digestion cages. The birds fed the tested diets for four days as an adaptation period. Through the successive 4-days, excreta collection trays were used and the feed intake was calculated.

Dry excreta for each bird was ground and kept for analysis. The analysis of feed and dried excreta were done according to AOAC (1999). Fecal nitrogen was determined according to Jakobson *et al.*, (1960).

Data were analyzed by using one way ANOVA of the GLM procedure of SAS (SAS Institute, 1985). Duncan's multiple range test was used to determine differences among means when treatments effects were significant (Duncan, 1955).

Results and Discussion

Body weight changes: Data of broiler chicks body weight gain are shown in Table 2. Chicks fed diet supplemented with combination of Avizyme, phytase and condiments mixture 2g./kg had significantly superior body weight gains compared with those of other treatment groups. Similar to that, phytase supplementation without or with Avizyme or either the two levels of condimental significantly gained more weight during 7-21 days of age over the control groups. This indicates the synergetic effect of Avizyme, phytase and condiments mixture for improving the growth performance during the first growth period. The improved growth due to phytase supplementation indicate that phytic diet is a growth limiting factor for chicks growth during early age of life (Kies *et al.*, 2001 and Choct, 2004). In connection, the positive effects of phytase, Avizyme and condiments mixture (2g./kg) may be attributed to their biological function that have been essential for growth. Cowieson *et al.*, 2003 and Ghazalah *et al.*, 2005 showed that the improvement in body weight gain obtained upon feeding enzyme mixtures may be attributed to the presence of amylase and NSPs degrading enzymes in enzymes mixture rather than protease that making the nutrients more available to the birds and improve chicks growth performance. Moreover, Choct, 2004 reported that phytase is contributing factor for the observed enhancement in growth performance during early age of chicks life. Along the same line, an earlier finding by Leung and Foster, (1996) indicated that the improvement in growth performance upon feeding condiments may be attributed to its properties that could act not only as antibacterial, anti-protozoa and anti-fungi but also as anti-oxidants. Similarly, Al- Harthi, (2002 a , b), El-Deek *et al.* (2003) and Hassan *et al.* (2004) stated the efficiency of spices in improving the productive performance of poultry.

During the second interval (22-36 d. of age), birds of the experimental group fed diet supplemented with phytase alone had a significantly higher growth rate compared with those of the other treatments groups. Meanwhile, no significant difference was recorded between phytase treatment group and those received basal diet supplemented with Avizyme plus phytase without or with condiments mixture (4g./kg) or phytase plus condiments (2g./kg). With the progress of age to 49 days, no significant differences were detected among studied treatments. This may indicate that nutrient requirements were met by the experimental diets as control group showed comparable or superior growth to any feed

Table 3: Effect of feeding either Avizyme ®, Phytase , mixture of condiments or their combination on Feed intake of broiler chicks from 7-49 days of age

Treatments	Feed intake, g/period			
	7-21 d.	22-36 d.	37-49 d.	7-49 d.
Control	644.6^{b}	1491.1^{b}	1238.2	3373.9
Avizyme	646.7^{b}	1526.7^{ab}	1221.4	3394.7
Phytase	664.4^{ab}	1702.1^{a}	1212.2	3578.6
Condiments,2g	644.0^{b}	1511.1^{b}	1164.5	3319.6
Condiments,4g	663.4^{ab}	1567.8^{ab}	1223.3	3405.5
Avi+ Phytase	687.7^{ab}	1518.9^{ab}	1254.5	3510.0
Aviz+ Cond,2g	656.4^{b}	1545.6^{ab}	1188.4	3390.3
Aviz+ Cond,4g	667.4^{ab}	1584.9^{ab}	1175.5	3391.8
Phy + Cond,2g	701.7^{ab}	1622.2^{ab}	1262.7	3586.6
Phy + Cond,4g	687.8^{ab}	1610.0^{ab}	1190.2	3488.0
Avi + Phy + Cond,2g	722.1^{a}	1568.9^{ab}	1146.1	3437.1
Avi + Phy + Cond,4g	685.5^{ab}	1614.4^{ab}	1135.1	3435.0
SEM	14.1	39.3	51.3	83.7
P value	0.004	0.03	NS	NS

NS, not significant. a,b. means within the same row not having similar superscripts are significantly different. (P< 0.05)

Table 4: Effect of feeding either Avizyme ®, Phytase, mixture of condiments or their combination on feed conversion of broiler chicks from 7-49 days of age

Treatment	Feed conversion ratio at			
	7-21d	22-36d	37-49d	7-49d
Control	1.72^{ab}	1.89	1.68	1.77
Avizyme®	1.70^{ab}	1.93	1.79	1.83
Phytase	1.44^{b}	1.89	1.72	1.71
Condiments,2g	1.72^{ab}	1.97	1.53	1.73
Condiments,4g	1.76^{ab}	1.95	1.71	1.82
Aviz+ Phytase	1.70^{ab}	1.89	1.79	1.82
Aviz+ Cond,2g	1.73^{ab}	1.97	1.77	1.85
Aviz+ Cond,4g	1.80^{a}	2.05	1.61	1.83
Phy + Cond,2g	1.58^{ab}	1.89	1.69	1.74
Phy + Cond,4g	1.64^{ab}	1.99	1.67	1.80
Avi + Phy + Cond,2g	1.63^{ab}	2.05	1.76	1.85
Avi + Phy + Cond,4g	1.72^{ab}	1.92	1.71	1.80
SEM	0.07	0.05	0.08	0.04
P value	0.05	NS	NS	NS

NS, not significant. A,b.. means within the same row not having similar superscripts are significantly different (P< 0.05).

additives supplemented group, expect for chicks fed diets plus condiments at level 2g./kg diet which gave the best value of body weight gain by about 3.7% over that of the control (Table2).

For the whole experimental period (7-49 d. of age), body weight gain of phytase treatment group significantly increased by about 7.1% over that of the control. It could be also observed, that using phytase with 2g/kg condiments mixture resulted in a significant increase in the gain of body weight by about 6.04% over that of the control group. However, no significant difference was detected among the other treatments and that of the control group. This seems to agree with observation of Ravindran *et al*. (1999 and 2000) and El-Nagmy, (2004) who reported that satisfactory growth of broiler chicks could be achieved by using phytase supplementation. This may be due to the improving in nutrients absorption especially crude protein which complicate with phytate and its inhibitory effects on proteolyses enzymes such as pepsin and trypsin (Zhang *et al*., 1999).

A combination of phytic acid degrading enzyme (phytase) and energy yielding enzyme (Avizyme) showed no beneficial effect over the un-supplemented control group or group supplemented with phytase alone, indicating that phytase alone is adequate feed additives (Table 2). Also, a combination of phytase with condiments did not result in any beneficial impact over that showed by phytase alone, even resulted in a lack of beneficial effect of phytase over the negative control. The improvement in body weight gain of chicks fed phytase-supplemented diets could be attributed to the improvement in availability of protein, essential amino acids, metabolisable energy and minerals for animal growth as reported by (Ravindran *et al*., 2000; Kies *et al*., 2001; Choct, 2004). However, the improved performance of broiler chicks due to phytase addition indicate a marginally dietary deficiency for chicks' growth especially during the fast growing period (7-36 d. of age).

On the other hand, the lack of positive effect of Avizyme (energy yielding enzymes) on performance of broiler chicks in the present work are contrary to the conclusion of Makled (1993); Jeroch *et al*. (1995) and Shakmak (2003). However, the findings of Ravindran *et al*. (1999) and Zyla *et al*. (2000) showed that a combination of phytase plus carbohydrase resulted in further improvement in broiler performance fed wheat-based diets. These contradiction between these results indicates that the effect of enzyme depends on dietary composition as a corn soybean diet was fed herein compared to wheat based diets as well as the composition of the experimental enzyme. So the ability of phytase to improve protein utilization would provide poultry producers a means to further aid in the alleviation of social and environmental concerns presently encompassing large- scale livestock production.

Table 5: Effect of feeding either Avizyme ®, Phytase, mixture of condiments or their combination on chemical composition of the broiler chicks excrement at 49-d. of age

Treatment	Chemical composition of the excrement,%			
	Crude protein	Ether extract	Crude fiber	Crude ash
Control	24.6	9.85	4.70	20.2
Avizyme®	24.5	9.33	4.88	20.1
Phytase	25.1	9.28	4.85	19.7
Condiments,2g	24.4	9.05	4.51	20.4
Condiments,4g	24.6	9.06	5.08	20.0
Aviz+Phytase	23.8	9.01	4.72	20.5
Aviz+Cond,2g	24.3	9.66	4.92	20.1
Aviz+Cond,4g	24.3	9.50	4.67	20.4
Phy +Cond,2g	24.8	9.49	4.52	19.7
Phy +Cond,4g	24.1	8.98	4.91	20.6
Avi+Phy+Cond,2g	24.5	9.80	4.51	20.4
Avi+Phy+Cond,4g	24.5	9.12	5.13	19.9
SEM	0.45	0.38	0.39	0.47
P value	NS	NS	NS	NS

NS, not significant. a,b. means within the same row not having similar superscripts are significantly different (P<0.05)

Feed intake and feed conversion ratio: Feed intake of the experimental groups during the first growth period (7-21 d. of age) showed a significant effect due to feeding diets with either of the studied feed additives or their combination (Table 3). Birds of the experimental groups fed diet supplemented with a combination of Avizyme, phytase and 2g./kg condiments mixture consumed more feed than those of the control by about 12.02% and those of Avizyme without or with the low level of condiments by 0.33% and 1.8% and those received 4g./kg condiments alone by 2.92%. The 12.02 % increase in feed intake of group fed diet supplemented with a combination of Avizyme, phytase and 2g. condiments /kg diet compared to un-supplemented control could explain the improvement growth of this group during the same period (Table 3). The opposite was seen with the other groups which had no significant effect. Similar to the above results, it should be mentioned that feed intake was numerically higher for groups supplemented with phytase alone by about 14.1% over the control during the period 22-36 days of age. The 14.1% increase in feed intake of group fed diet supplemented with phytase compared to un-supplemented control, could explain the superior body weight gain for this group (Table2). However, with feeding the experimental diets to age 49 day, no significant effect of either studied enzymes, their combination or different levels of condiments without or with enzymes on feed intake. It should be mentioned that feed intake was numerically higher of group supplemented with phytase alone during the second growth period (22-36 wk old) and this could partial explain the increase in growth of phytase supplemented group since other experimental group showed similar feed intake with less weight gains than phytase-supplemented group (Table2).

Feed conversion of the experimental groups during different studied growth periods are shown in Table 4. It is clear that the group of phytase supplementation during the first growth period (7-21 d of age) had a superior feed conversion (1.59) when compared with treatments of Avizyme plus inclusion level (4g./kg) of condiments mixture which was the worst (1.78). The improved feed conversion of phytase-supplemented group is in line with the conclusion by Kies *et al.* (2001) and Choct (2004) and indicating an enhancement in the utilization not only of nutrient complexes to phytate molecule, but also due to elimination of the negative effect of phytic acid on nutrient utilization (Rutherford *et al.*, 1997; Kies *et al.*, 2001 and Choct, 2004).

Meanwhile, from 22 d. of age till the end of the experiment, there were no significant differences in feed conversion due to enzymes and/or 2 or 4g. of condiments/kg diet. However, phytase supplemented groups continue to exhibit better-feed conversion during 22-36 d. of age period (Table 3). During 37-49 d. of age period, the best feed conversion was shown from group supplemented with 2g. condiments/kg diet as a results of high body weight (Table 2) and low feed intake (Table 3) and this contributed mainly to the observed improvement in feed conversion of this group for the whole experimental period. It worth to note that phytase plus Avizyme supplementation and that of condiments (2g./kg) was the best during the periods of (22 to 36) and (37-49) days of age, respectively. Generally, for the whole experimental period, feed conversion of condiments (2g./kg) treatment recorded the best value by about 8.5% over that un-supplemented. However, phytase supplemented group recorded the best feed conversion and this was numerically better that un-supplemented control by 3.6%. These results are similar to those reported by Ravindran *et al.* (2000). Such improvement as a result of condiments mixture was reported by El-Husseiny *et al.* (2002), Al-Harthi (2002b) who found that broiler chicks fed diets supplemented with hot pepper showed improved feed conversion ratio. It may be due to its stimulant, carminative, digestion and anti-microbial properties (Jones *et al.*, 1997 and El-Husseiny *et al.*, 2002).

Composition of excrements and nutrients digestibility: Results obtained from Table (5 and 6) showed that there were no statistical significant effect of either Avizyme, phytase, condiments mixture or their combination treatments on chemical composition (crude protein, crude fiber, ether extract and ash) of excrements as well as apparent digestibility of nutrient substances. It is clear that phytase alone or in a combination with condiments supplementation numerically increased apparent digestibility of nutrients. The increment of

Table 6: Effect of feeding either Avizyme ®, Phytase, mixture of condiments or their combination on digestibility of nutrients at 49d old broiler chicks

Treatments	Apparent digestibility of nutrients, %				
	Organic matter	Crude protein	Ether extract	Crude fiber	Crude ash
Control	76.9	71.1	59.9	26.4	19.0
Avizyme	73.2	71.3	62.4	25.3	19.7
phytase	79.0	75.6	62.1	29.7	25.6
Condiments, 2g.	73.9	71.8	59.4	29.0	18.2
Condiments, 4g.	74.2	72.1	60.0	27.8	17.2
Aviz. + phytase	74.2	70.1	59.9	29.0	19.1
Aviz. + cond., 2g.	74.5	73.3	65.4	25.8	19.6
Aviz. +cond., 4g.	79.0	73.6	63.9	32.2	24.2
Phy. + cond., 2g.	78.7	74.7	66.2	30.6	25.7
Phy. + cond., 4g.	78.7	73.5	61.4	30.9	25.1
Avi.+ phy.+ cond., 2g.	78.0	72.4	62.3	31.0	24.8
Avi. + Phy. + cond., 4g.	78.4	74.7	64.3	31.6	23.3
SEM	2.72	2.76	5.65	6.92	4.69
P value	NS	NS	NS	NS	NS

NS, not significant. A,b.. means within the same row not having similar superscripts are significantly different (P< 0.05)

Table 7: Effect of feeding either Avizyme ®, Phytase, mixture of condiments or their combination on plasma total protein, (g/100ml). Albumin (g/100M), globulin (g/100ml), Total lipids (mg/100ml), total cholesterol (mg/100ml), AST (U/L) and ALT (U/L) of 49 d. old broiler chicks

Treatments	Plasma constituents						
	Total protein	Albumin	Globulin	Total lipids	Total cholesterol	AST	ALT
Control	4.76	2.43	2.33	6.85	174.1	23.4	11.6
Avizyme	4.72	2.39	2.33	6.90	174.6	24.1	11.9
Phytase	5.00	2.56	2.44	7.02	166.0	22.7	10.6
Condiments, 2g.	4.54	2.43	2.11	7.08	164.0	23.8	11.5
Condiments, 4g.	5.00	2.54	2.46	7.06	165.6	22.7	10.5
Avizyme + phytase	4.70	2.39	2.31	6.91	166.7	24.1	11.5
Aviz. + Condiments, 2g.	4.98	2.52	2.46	7.21	167.4	23.3	10.5
Aviz. + Condiment, 4g.	4.75	2.40	2.35	6.92	172.5	24.0	11.3
Phy. +Condiments, 2g.	4.99	2.53	2.46	7.24	164.8	23.2	11.2
Phy. + Condiments, 4g.	4.66	2.33	2.33	6.82	166.2	22.7	11.6
Avi. + Phy. + cond., 2g.	4.79	2.43	2.36	7.04	169.2	24.0	10.4
Avi. + Phy. + comd., 4g.	4.91	2.48	2.43	6.94	166.0	22.2	11.1
SEM	0.16	0.09	0.09	0.15	4.75	0.76	0.51
P value	NS	NS	NS	NS	NS	NS	NS

NS, not significant. a,b. means within the same row not having similar superscripts are significantly different (P< 0.05).

phytase supplementation represented by 2.7, 6.3, 12.5 and 34.7% for organic matter, crude protein, fiber and ash over that of control, respectively. It is well documented (Farrell *et al*., 1993; Kies *et al*., 1997; Kies and Selle, 1998; Ravindran *et al*., 1999, 2000; Cabahug *et al*., 1999; Kies and Van Hemert, 2000) that protein digestibility and energy utilization were improved by phytase, due to the liberation of nutrients complexes to the phytate molecule. Also, phytase supplementation improved mineral utilization such as P, Ca and Zn (Zanini and Sazzad, 1999). Thereby, livability, growth and FCR were ameliorated (Waldroup *et al*., 2000).

Consequently, it could be concluded that the enhancements in growth and feed conversion ratio of groups supplemented with phytase alone were accompanied with numerical improvement in nutrients digestibility (Table 5 and 6) as well as the increase in feed intake (Table 3). This indicates an increase in nutrients utilization of phytase-nutrient complexes (Sebastian *et al*., 1998; Kies *et al*., 2001 and Choct, 2004). The numerical improvement of other phytase-supplemented groups confirmed these results (Table 6).

Plasma metabolic responses: Biochemical constituents of blood plasma including plasma total protein with their fractions, plasma total lipids, cholesterol and liver enzymes (AST and ALT) were not significantly affected by enzymes and /or low and high level of condiments mixture supplementation. It can be concluded that enzymes and /or condiments supplementation had no adverse impact on plasma constitutes and liver function. These results are in agreement with Qota *et al*. (2002) and Shakmak (2003) who found that cell-wall degrading enzymes and/or phytase supplementation had no adverse effect on

biochemical constituents of plasma and liver function of broiler chicks.

It could therefore be concluded on the basis of this study that it is possible to use a combination of Avizyme, phytase and 2g./kg of condiments mixture in diets as a feed additives during the first growth period (7-21 day of age) since such supplementation achieved a satisfactory performance. During 22-36 d. of age, broiler chicks could be fed diets supplemented with 1000FTU of phytase. Meanwhile, such supplementation had no beneficial effect during 37-49 d. of age. Also, phytase supplemented group improved feed conversion by 3.6% and had numerically better apparent digestibility of nutrients without adverse effect on plasma constituents and liver functions.

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[a]A product of Finn feed international LTD. It is a multi-enzyme product, containing 4000u/g proteases, 300u/g of endo-1,4-β-xylanase and 400 u/g of α-amylase.

[b]A product of DSM Food Specialties, Delft, The Netherlands, marketed in alliance with BASF, Germany. One unit (FTU) is equal to the enzyme activity that liberates 1 umol ortho-phosphate from 5.1 mmol of sodium phytate per minute at 37°C and PH 5.5. Its recommended does of usage in broiler diets is 500 FTU/kg. C until biochemical determinations.