Growth performance of broilers consuming wheat- or barley-based diets with or without enzymes

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Introduction Cereal grains, such as wheat, have been regarded as one of the most affordable ingredients to supply dietary energy for fast growing broilers. However, broilers compete with humans for wheat to satisfy their nutritional needs and also they cannot effectively utilise wheat due to the limited ability of their gut enzymes to utilise dietary fibre. The efficiency of wheat utilisation can be increased by adding exogenous enzymes into cereal based diets for these birds (Annison and Choct, 1993). These enzymes can also reduce fermentation in the small intestine and so help maintain the gut health. Therefore, we compared the effect of adding a commercial fibrolytic enzyme to wheat and barley-based diets on the utilisation of either diet by broilers from 0 to 35 days of age.

Materials and methods Two sets of four iso-nitrogenous (213-221 g CP/kg) diets with 12.6-13.6 MJ ME /kg were prepared by mixing (per kg diet) up to 650g coarsely ground wheat (A) or barley (C) with other ingredients in the absence (A and B) or presence of an enzyme (E=β xylanase) (A+E= B and C+E=D). Other ingredients were soybean meal, sunflower oil, sodium chloride, calcium mono phosphate, calcium carbonate and vitamin mineral premix. For the B and D diets, the enzyme was thoroughly mixed first with a portion of the diet which was then remixed with the relevant diet. One hundred and fifty six day old female Ross 308 chicks were transported from a commercial hatchery to the University Farm. The chicks were identified by using leg rings, weighed and divided into 12 experimental units of 13 chicks each where each unit was balanced for initial chick weight. Each chick unit was randomly housed in a circular pen on concrete floors covered with wood shavings in a pre-heated room at 35^{o}C. This room was set for recommended light durations and each pen was equipped with a brooder, feeder and water container. Each of the 4 diets was allocated to 3 pens of 13 chicks each according to a completely randomized design. The brooding temperature was decreased weekly by 3^{0}C until it reached 22^{0}C. These chicks were offered *ad libitum* water and relevant starter diets for 21 days and grower cum finisher diets for another 14 days to the age of 35 days. Weekly body weight per chick and feed consumption per pen was recorded and feed efficiency calculated. Chick health was monitored and feed samples collected for their chemical composition. For this paper, only broiler growth data involving both the starter and finisher diets were analysed using ANOVA on Minitab to compare the effect of these diets on the broiler body weight at each week. The means of these diets in each week were compared by using Tukey test at $P<0.05$.

Results The mean body weights (BW) of broilers at various days of age are summarized in Table 1. The birds continued to increase their diet intake with the increase in their age and so maintained a healthy growth. The BW at day 0 did not differ ($P>0.05$) between diets confirming that the initial bird distribution was uniform across the diets. While the diets caused significant differences in BW at 7, 14, 21 and 35 days of age ($P<0.05$), they did not differ at 28 days of age ($P>0.05$). The impact of wheat and barley based diets was variable depending upon the age of these birds. The mean BW weight of birds consuming wheat based diets was greater than those on barley based diets showing significance at days 7 and 14 ($P<0.0.5$). While, the overall effect of enzymes on BW was non significant at all days of age, the broilers had greater BW for the presence than the absence of enzyme in barley-based diets at 21 to 35 days of age ($P<0.05$ for diet C v D).

Table1 Mean body weight (g) of broilers fed wheat or barley based diets with or without enzymes at different days

Diets \ Days →	0	7	14	21	28	35
A (Wheat)	35.7	164^{ab}	413^{ab}	808^{a}	1309^{a}	1829^{ab}
B (A+E)	36.0	175^{b}	422^{b}	790^{a}	1290^{a}	1819^{a}
C (Barley)	36.5	158^{a}	387^{ac}	746^{b}	1231^{b}	1680^{c}
D (C +E)	36.2	154^{a}	402^{a}	805^{a}	1300^{c}	1849^{b}

E= Enzyme; The figures with different superscripts in each column were significantly different at $P<0.05$

Conclusions The birds had greater body weights for wheat than barley based diets at most days of age. However, enzyme addition appeared to have greater effect on body weights when barley plus enzyme was compared with barley without enzyme at 21, 28 and 35 days of age. The study shows a potential in enzymes to improve the utilisation of barley based diets in order to improve bird performance and so reduce the cost of broiler production.

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Effects of antibiotic and probiotic supplementation to diets containing fat on broiler performance

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Introduction The use of supplementary fat in commercial poultry diets has been wide-spread since the 1960s. In addition to their value as a dense source of energy, supplemental fats are an excellent source of essential fatty acids and enhance the absorption of fat soluble vitamins. The efficiency of nutrient digestion in poultry largely depends on the microorganisms which live naturally in its digestive tract (Apajalahti *et al*. 2003). It has been reported that intestinal microflora influences the absorption of fats (Pesti, 2002).Today, antibiotics and probiotics are used for manipulating the gut microflora in poultry production and act as growth-promoting agents. Thus, using these growth promoters (GP) will probably affect nutrients absorption, especially of dietary fats. The aim of this study was to evaluate the effects of supplementary antibiotics and probiotics in diets containing different levels of fat on broiler performance

Materials and methods Three hundred and sixty one-day old Ross broiler chicks were used in a 2×3 factorial arrangements with 2 levels of soy oil (3 and 6% of diet) and 3 levels of growth promoter (No-GP, antibiotic and probiotic), with 4 replicates and 15 birds per replicate in a randomized complete block design. Flavomycin (400g/t) and protexin (500g/t) were added to diet as growth promoter. Diets were iso-energetic and iso-nitrogenous and sand were used as inert to diets containing high level of oil to adjust their metabolisable energy. Feed and water were provided ad-libitum and a 24h lighting program was followed throughout the 42 days experiment. Feed intake and Body weight gain were recorded weekly and feed consumption ratio was calculated. Blood samples were collected randomly from two birds per each replicate at 35days of age. The blood samples were assayed for cholesterol, HDL, LDL, VLDL and triglycerides. All collected data were analysed using General Linear Models procedure of SAS (SAS, 2004), and means were compared by Duncan multiple range test.

Results The effects of fat levels, growth promoters on broiler performance and blood biochemical properties are presented in Table 1. Addition of probiotics to diets decreased feed intake and weight gain ($P<0.05$). Birds fed diets supplemented with probiotics had the lowest blood cholesterol and LDL. The probiotic effectiveness on broiler performance was related to levels of fat in diets and diets containing probiotic + 6% fat resulted the lowest weight gain ($P<0.05$).

Table 1 The effects of treatments on performance and blood biochemical properties of broiler chicks

	Performance			Blood biochemical properties(mg/dl)				
Variables	FI(g)	WG(g)	FCR	TG	Cholesterol	HDL	LDL	VLDL
Fat (%)								
3	3815.3^{a}	2203.1^{a}	1.75^{b}	71.9	162.1^{b}	85.2^{b}	66.8^{b}	14.2
6	3674.6^{b}	2022.6^{b}	1.82^{a}	74.1	197.7^{a}	94.4^{a}	86.7^{a}	14.8
SE	24.7	43.6	0.02	4.4	2.2	1.6	1.4	0.9
GP								
No-GP	3840.6^{a}	2110.0^{b}	1.76	71.6	179.8^{b}	60.3^{ab}	72.8^{b}	14.2
Antibiotic	3893.4^{a}	2221.5^{a}	1.81	69.0	195.3^{a}	96.0^{a}	91.4^{a}	13.7
Probiotic	3500.9^{b}	2007.0^{c}	1.79	78.4	164.6^{c}	82.9^{b}	66.1^{c}	15.6
SE	53.5	30.3	0.02	5.3	2.8	1.9	1.7	1.1
Fat(%) × GP								
3 × No-GP	4028.6^{a}	2233.9^{a}	1.77^{b}	74.2^{ab}	164.6^{d}	87.1^{b}	60.4^{d}	14. 7^{ab}
3 × Antibiotic	3883.9^{a}	2216.4^{a}	1.75^{b}	77.2^{ab}	174.8^{cd}	93.3^{ab}	83.0^{b}	15.3^{ab}
3 × probiotic	3533.5^{b}	2159.1^{a}	1.73^{b}	64.3^{b}	146.9^{e}	75.2^{c}	57.0^{d}	12.8^{b}
6 × No-GP	3652.6^{b}	1986.1^{b}	1.8^{b}	68.9^{b}	195.1^{b}	93.6^{ab}	85.2^{b}	13.8^{ab}
6 × Antibiotic	3902.7^{a}	2226.7^{a}	1.77^{b}	60.8^{b}	215.9^{a}	98.8^{a}	99.8^{a}	12.1^{b}
6 × probiotic	3468.4^{b}	1854.9^{c}	1.89^{a}	92.4^{a}	182.2^{c}	90.7^{ab}	75.2^{c}	18.5^{a}
SE	75.7	42.9	0.03	7.5	3.9	2.7	2.4	1.6

$^{a-d}$ Mean values with different superscripts on same column are significantly different ($P<0.05$).

Conclusions It was concluded that the supplementing diets containing fat with probiotics may have negative effects on broiler performance.

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Can medicinal plants with antimicrobial properties be replacement for antibiotics in broiler production?

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Introduction Antibiotics have been used for 50 years to enhance growth performance and to prevent disease in poultry production. Recently, most of the antibacterial growth promoters have been banned because the feeding of antibiotics is risky due not only cross-resistance but also to multiple resistances. Plants (especially herbs) have been used as food and medicinal purposes and some of them have played a significant role in maintaining human health and improving the quality of human life for thousands of years. Herbs or products containing plant extracts, essential oils or main components of the essential oil are among the alternative growth promoters that are already being used in practice. (Acamovic and Brooker, 2005; Ocak *et al*., 2008). There is evidence suggesting that herbs, spices, and various plant extracts have appetizing, digestion-stimulating and antimicrobial properties. But, there is only limited evidence about whether the inclusion as a solid herb material would have the growth promoting effects in live birds. The aim of this study was to evaluate the antibacterial effects of dietary dry peppermint (*Mentha piperita L.),* Cumin *(Cuminum L.*), Milfoil (*Achellia millefolium L.*) and poley (*Teucrium Polium L.*) on the performance of broiler.

Materials and methods Three hundred and sixty one-old broilers (Arbor Acres) were randomly assigned to 6 treatment diets, with 4 replicates and 13 birds per replicate in a completely randomized design. The diets were isocaloric and iso-nitrogenous and contained 15, 3, 2 and 2 g/kg of dried herb of cumin, mint, Milfoil and poley, respectively. Two treatments with (flavomycin, 400g/t) and without antibiotic were considered as control groups. The diets were fed as mash and chicks were permitted free access to feed and water during the 42 days of experimental period. Continuous lighting was provided during the experiment. Body weight gain and feed intake were recorded weekly and feed conversion ratio was calculated on pen weight basis. All collected data were subjected to an analysis of variance, using the General Linear Model procedure of SAS (SAS Institute, 2004) and means were compared by Duncan's multiple range test.

Results The effects of treatments on broiler performance are presented in Table 1. Supplementation diets with antibiotic significantly ($p<0.05$) improved body weight gain, and FCR in broilers during the 42 days rearing period when compared with other treatments.

Table 1 Effects of dietary inclusion medicinal plants and antibiotic on WG (g), FI (g) and FCR of broiler chicks.

Traits		Treatments						
		Control	Antibiotic	Cumin	Mint	Milfoil	Poley	SEM
Starter								
	FI	397.6	404.6	396.1	399.6	387.7	385.5	5.75
	WG	309.1^{ab}	319.1^{a}	308^{ab}	313.6^{ab}	297.2^{bc}	290^{c}	5.76
	FCR	1.28	1.26	1.28	1.27	1.30	1.33	0.026
Grower								
	FI	1196^{c}	1242.3^{a}	1200.7^{bc}	1222^{ab}	1209.3^{bc}	1195.9^{c}	7.53
	WG	760.1^{bc}	776.4^{a}	753.5^{c}	767.4^{ab}	712.4^{d}	712.9^{d}	4.41
	FCR	1.57^{b}	1.60^{b}	1.59^{b}	1.59^{b}	1.69^{a}	1.67^{a}	0.015
Finisher								
	FI	2033.1^{d}	2163.5^{b}	2156.9^{b}	2196.4^{a}	2093^{c}	2157.5^{b}	10.94
	WG	980.6^{c}	1030.1^{a}	982.2^{c}	1005.3^{b}	899^{d}	869.2^{e}	6.41
	FCR	2.07^{d}	2.10^{d}	2.19^{c}	2.18^{c}	2.35^{b}	2.48^{a}	0.013
Total								
	FI	3532.5	3589.8	3570.1	3601.1	3548.2	3504.5	38.15
	WG	1936.7^{c}	2043.6^{a}	1982^{bc}	2008.5^{b}	1857.5^{d}	1821.3^{e}	11.06
	FCR	1.79^{b}	1.75^{b}	1.80^{b}	1.79^{b}	1.91^{a}	1.92^{a}	0.019

$^{a-d}$ Means in each row with different superscripts are significantly different ($P<0.05$).

Conclusions It is concluded that medicinal plants had significant effect on broiler performance, but they can not be replacement for antibiotics. Mint leaves had most positive effects on weigh gain and feed conversion ratio than other studied medicinal plants. Further studies are needed to investigate the effects of different levels of mint, cumin, Milfoil or Poley on colonization and proliferation of microorganisms in the broiler intestine, and its performance**.**

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Effects of enzyme and probiotic supplementation to diets containing wheat on broiler performance

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Introduction Enzymes and probiotics are often used in feeding of poultry in intensive rearing systems. Beneficial effects of probiotics were observed in toxin neutralization, prevention of development and multiplication of specific bacteria, change in microbial metabolism and immunity stimulation. Administration of useful microorganisms as probiotic into diet usually cause enhancement of organic acids production such as lactic acid that in turn can reduce gastrointestinal pH and subsequent prevention of pathogen microorganisms such as salmonella to colonize the alimentary tract(Fuller, 1992). Exogenous enzymes have been shown to alleviate the adverse effects of high viscosity of digesta in the small intestine and to improve digestion (Petersen *et al*. 1999). Pervious studies demonstrate that simultaneously using probiotics and enzymes in broiler diets, improve their growth performance (Midili, and Tuncer, 2001). The objective of the present study was to examine the influence of probiotic (protexin) and enzyme (Natozyme) supplementation on the performance of broilers fed diets containing wheat.

Materials and methods Seven hundred and twenty male broiler chicks (Ross 308) were used in a 2×2×3 factorial arrangements with 2 levels of wheat (0 and 30% of diet), 2 levels of probiotics (0 and 300 g/ton) and 3 levels of enzyme (0, 100 and 200 g/ton), with 4 replicates and 30 birds per each replicate in a completely randomized design. Feed and water were provided ad-libitum and a 23:1 light: dark program was followed throughout the 6-week experiment. Feed intake and body weight gain were recorded weekly and feed consumption to weight gain ratio (FCR) was calculated. At the end of the experiment (week 6), two birds from each replicate were randomly selected, slaughtered and the weights of liver, caeca and abdominal fat were measured. All data were analysed using General Linear Model's procedure in SAS (SAS Institute, 1994) and means were compared by Duncan's test at 5% of probability

Results The effect of wheat, protexin and enzyme on broiler performance are shown in Table 1.The results showed that 30% wheat in diets decreased feed intake and body weight gain, significantly ($P<0.05$). Supplementation diets with Protexin significantly ($p<0.05$) improved feed intake, body weight and FCR, but addition of enzyme to diets had not significant effects on broiler performance. Relative weight of the abdominal fat significantly decreased in bird fed diets containing protexin, but protexin increased caeca weight($P<0.05$). The interaction effect between enzyme × probiotic × wheat on body weight gain and FCR was significant. Supplementation wheat-soy based diets with probiotic and enzyme improved body wheat gain and FCR, significantly ($P<0.05$).

Table1 Effect of different levels of enzyme and probiotic and wheat on the performance of broiler chickens

Factor	FI(g)	BWG(g)	FCR	Abdominal fat%	Liver%	Caeca%
Wheat (%)						
0	4747[a]	2224[a]	2.12[a]	1.05	1.29	0.49
30	4725[b]	2114[b]	2.34[b]	1.10	1.34	0.46
Enzyme(g/ton)						
0	4702	2007	2.33	1.07	1.33	0.47
100	4760	2061	2.21	1.06	1.25	0.45
200	4728	2055	2.27	1.09	1.27	0.51
Probiotic(g/ton)						
0	4677[b]	2007[b]	2.36[b]	1.16[a]	1.31	0.44[b]
300	4798[a]	2131[a]	2.21[a]	0.99[b]	1.32	0.51[a]
SEM	6.01	8.71	4.97	14.47	12.87	19.55

[a, b] Mean values with different superscripts on same column are significantly different ($P<0.05$).

Conclusion It is concluded that the simultaneously using of probiotics and enzyme in wheat – soy based diets is a good way to obtain more economical benefits in broiler production.

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Effect of different levels of digestible lysine on performance, and blood parameters of male and female broilers in the starter period

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Introduction Lysine is the reference amino acid (AA) in the ideal AA ratios for chickens. Feed formulation based on digestible AA has been shown to increase weight gain and feed intake and improve body composition in broilers. Amino acid (AA) in most feed ingredients will not be totally digested, and knowledge of such efficiency is important in formulating diets and will be used to eliminate differences in absorption efficiencies due to feedstuff sources. This study was conducted to evaluate the growth performance and blood parameters of broilers fed various levels of DL (Digestible Lysine) supplemented in diets from day 1 to day 18.

Materials and methods Arian male and female broilers (1-18 days) by feeding practical diets formulating on digestible amino acids basis. A total of 240 male and female chicks were used (initial weight of 44±1 g). The birds were distributed in a completely randomized design, using six treatments and four repetitions, with 5 chicks per repetitions. These experimental chickens were kept in thermostatically controlled batteries. The experimental treatments consisted of a lysine-deficient basal diet that was supplement with L-lysine-HCl in order to contain six digestible lysine levels (0.68, 0.8, 0.92, 1.04, 1.16 and 1.28%). These diets were isocaloric, isonitrogenous and equal in electrolyte balance. All diets met an the Illinois recommended ideal amino acid ratio for all other amino acids. Feed and water supplied for *ad libitum* consumption. During the experiment feed consumption (FC), weight gain (WG) and feed conversion ratio (FCR) were measured weekly. Also, blood samples were collected at the end of the starter period. Data were analysed with SAS software in proc ANOVA and Duncan's multiple range test were used to compare treatments means. The results were showed this form: Mean ± SD (Standard Deviation)

Table1 Effects of digestible lysine levels on blood parameters

	DL (%)	*Lys (nmol/ml)*	*Albumin (g/dl)*	*Uric Acid (mg/dl)*	*BUN (mg/dl)*	*Creatinine (mg/dl)*
Male	0.68	70±1.10^{e}	0.90±0.02^{e}	15.10±0.07^{f}	6.61±0.07^{e}	0.78±0.00^{c}
	0.80	90±6.35^{d}	1.38±0.35^{d}	15.58±0.08^{e}	6.44±0.08^{e}	0.75±0.02^{b}
	0.92	140±7.34^{c}	1.70±0.00^{c}	16.21±0.09^{d}	5.66±0.17^{d}	0.73±0.01^{b}
	1.04	140±3.77^{c}	1.93±0.01^{b}	16.50±0.18^{c}	5.22±0.15^{c}	0.70±0.01^{a}
	1.16	150±5.23^{b}	2.40±0.01^{a}	17.11±0.17^{a}	4.00±0.20^{b}	0.71±0.01^{a}
	1.28	160±2.82^{a}	2.38±0.01^{a}	16.83±0.07^{b}	3.29±0.06^{a}	0.80±0.01^{c}
	Mean	125.01	1.78	16.22	5.20	0.75
Female	0.68	50±2.00^{f}	0.70±0.01^{f}	12.37±0.10^{a}	5.49±0.10^{f}	0.45±0.01^{d}
	0.80	70±1.09^{e}	1.12±0.01^{e}	12.72±0.17^{b}	5.10±0.14^{e}	0.41±0.01^{c}
	0.92	90±5.21^{d}	1.50±0.01^{d}	13.20±0.10^{c}	4.82±0.05^{d}	0.40±0.01^{bc}
	1.04	110±5.53^{c}	1.96±0.01^{a}	13.62±0.20^{d}	4.47±0.10^{c}	0.36±0.10^{a}
	1.16	120±4.12^{b}	1.90±0.00^{c}	14.10±0.12^{e}	4.00±0.10^{b}	0.49±0.01^{e}
	1.28	140±3.99^{a}	1.92±0.01^{b}	13.90±0.04^{e}	3.53±0.09^{a}	0.39±0.00^{b}
	Mean	96.67	1.52	13.32	4.57	0.42

Results Increase of digestible lysine level to 1.28% due to: maximum body weight, plasma lysine level, minimum feed conversion. There was the best of plasma albumin level and carcass N deposition in 1.16% and 1.04% of digestible lysine diet level for male and female respectively in the starter phases.

Table2 Effects of DE levels on feed intake, BW, FCR and carcass nitrogen

	DL (%)	*Body Weight(g)*	*FCR*	*Feed Intake(g)*	*N.Carcass (g bird-1 day-1)*
Male	0.68	370.71±6.54^{d}	2.08±0.03^{e}	772.92±17.21^{d}	0.86±0.01^{e}
	0.80	380.23±7.62^{d}	2.06±0.17^{e}	782.39±20.10^{d}	1.16±0.01^{d}
	0.92	415.27±12.91^{c}	1.75±0.01^{d}	726.74±23.82^{c}	1.16±0.01^{d}
	1.04	463.10±8.20^{b}	1.51±0.03^{c}	700.30±8.79^{c}	1.19±0.01^{c}
	1.16	485.58±8.14^{a}	1.31±0.03^{b}	637.42±21.50^{b}	1.24±0.02^{a}
	1.28	490.60±9.63^{a}	1.20±0.02^{a}	588.70±12.80^{a}	1.21±0.02^{b}
	Mean	434.25	1.65	701.41	1.37
Female	0.68	342.53±2.87^{f}	2.12±0.01^{f}	724.45±8.23^{c}	0.80±0.01^{f}
	0.80	358.30±8.56^{e}	2.01±0.01^{e}	717.54±18.17^{c}	0.92±0.01^{e}
	0.92	392.66±2.59^{d}	1.86±0.12^{d}	730.35±7.27^{c}	0.98±0.01^{d}
	1.04	405.77±8.47^{c}	1.60±0.02^{c}	649.32±1.73^{b}	1.20±0.01^{a}
	1.16	415.19±3.86^{b}	1.47±0.02^{b}	609.25±4.14^{a}	1.14±0.01^{c}
	1.28	426.02±3.59^{a}	1.41±0.14^{a}	600.68±6.97^{a}	1.16±0.01^{b}
	Mean	390.08	1.743	671.93	1.03

Conclusion This experiment supports the hypothesis that the different digestible lysine levels enhance protein utilization in broilers**.** All parameters as well were also improved with increase of digestible lysine levels and this suggests an effect of the amino acids utilization. Several possible mechanisms may account for the enhanced growth of chickens in response to additional dietary lysine. These include increased availability of lysine for protein synthesis, stimulated secretion of hormones such as glucagon, insulin and growth hormone which may consequently increase protein synthesis and feed intake.

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Dietary digestible lysine immune responses and carcass nitrogen of broiler chickens in starter period

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Introduction lysine is an essential amino acid that promotes normal growth by helping to maintain the proper protein balance in the body. Most vegetable protein sources used in poultry diet formulations are moderate to low in lysine contents; hence supplementation with lysine is inevitable in growing broilers to ensure rapid growth and optimum efficiency of feed utilization. Adequate supply of nutrients during the starter improves gut development and could result in long term improvements in feed utilization. In order to evaluate the effect of different digestible lysine dietary levels on growth and immune response in starter, this experiment was done.

Materials and methods 240 Arbor Acres broiler chicks (1-18 days) were used in a completely randomized design experiment (6 dietary, 4 replicates and 5 birds per each replicate). The levels of digestible lysine dietary were 0.68, 0.8, 0.92, 1.04, 1.16 and 1.28% (feeding practical diets formulating on digestible amino acids basis). All diets were formulated to meet NRC (1994) requirements and were formulated on a digestible amino acid basis with maintained ratios of dietary essential amino acids to lysine content. These diets were isoenergetic, isonitrogenous and equal in electrolyte balance (Na + K – CL).All diets met an ideal amino acid ratio recommended Illinois for all other amino acids. Feed and water supplied for *ad libitum* consumption. During the experiment feed conversion ratio (FCR) were measured weekly. Also, blood samples were collected to determine antibody titer (Titr), white blood cells(WBC), Lymphocyte (L), Hetrophyle (H), immune index (H/L)and the antibody response to a nonpathogenic antigen sheep red blood cell (SRBC) on day 18. A linear model and Duncan's mean test were used to analyze data by applying SAS software.

Results different digestible lysine levels had a significant effect on FCR and nitrogen deposition. Immune response as well was also improved with increase of digestible lysine levels and this suggests an effect of the on amino acids utilization.

Table 1 Effect of different digestible lysine levels on immune response, FCR and nitrogen deposition

	DL(%)	*WBC(×10³/µl)*	*H(%)*	*H/L*	*Titr(log2)*	*SRBC(log2)*	*FCR*	*N Deposition*
Male	0.68	14300±173 ^{f}	15±2.24 ^{f}	0.37±0.04 ^{f}	1.50±0.01 ^{f}	1.54±0.06 ^{d}	2.08±0.03 ^{e}	0.86±0.01 ^{e}
	0.8	15200±189^{e}	19±1.41 ^{e}	0.42±0.02 ^{e}	1.92±0.03 ^{e}	1.70±0.06 ^{c}	2.06±0.17 ^{e}	1.16±0.01 ^{d}
	0.92	19000±124^{d}	22±0.43 ^{d}	0.47±0.01 ^{d}	2.52±0.02 ^{d}	1.78±0.05 ^{c}	1.75±0.01 ^{d}	1.16±0.01 ^{d}
	1.04	25900±90^{c}	27±0.36 ^{c}	0.58±0.01 ^{c}	2.58±0.02 ^{c}	2.10±0.11 ^{b}	1.51±0.03 ^{c}	1.19±0.01 ^{c}
	1.16	28000±184^{b}	33±1.07 ^{b}	0.62±0.02 ^{b}	2.74±0.03 ^{b}	3.12±0.11 ^{a}	1.31±0.03 ^{b}	1.24±0.02 ^{a}
	1.28	41300±160^{a}	39±1.27 ^{a}	0.69±0.02 ^{a}	2.88±0.01 ^{a}	3.22±0.10 ^{a}	1.20±0.02 ^{a}	1.21±0.02 ^{b}
	Mean	23950	25.83	0.52	2.36	2.24	1.65	1.37
Female	0.68	16800±195^{f}	17±1.18 ^{f}	0.38±0.02 ^{f}	1.45±0.01 ^{f}	1.50±0.06 ^{e}	2.12±0.01 ^{f}	0.80±0.01 ^{f}
	0.8	19600±259^{e}	20±1.18 ^{e}	0.41±0.01 ^{e}	1.70±0.01 ^{e}	1.66±0.06 ^{d}	2.01±0.01 ^{e}	0.92±0.01 ^{e}
	0.92	23800±139^{d}	26±0.63 ^{d}	0.52±0.01 ^{d}	2.08±0.01 ^{d}	1.73±0.05 ^{d}	1.86±0.12 ^{d}	0.98±0.01 ^{d}
	1.04	26600±135^{c}	30±0.67 ^{c}	0.59±0.02 ^{c}	2.56±0.03 ^{c}	1.94±0.11 ^{c}	1.60±0.02 ^{c}	1.20±0.01 ^{a}
	1.16	32200±43^{b}	35±0.76 ^{b}	0.66±0.01 ^{b}	2.74±0.02 ^{b}	2.27±0.11 ^{b}	1.47±0.02 ^{b}	1.14±0.01 ^{c}
	1.28	44100±211 ^{a}	42±1.52 ^{a}	0.73±0.01 ^{a}	2.78±0.03 ^{a}	2.40±0.11 ^{a}	1.41±0.14 ^{a}	1.16±0.01 ^{b}
	Mean	27183.33	28.33	0.55	2.22	1.92	1.743	1.03

Conclusion The results of this experiment support the hypothesis that the different digestible lysine levels enhance protein utilization in broilers. The influence of Lys was probably mediated by IGF-I(Conconi,2001) High immune response is possibly due to increased protein availability for liver protein synthesis associated with immune response or antibody production. In the present study, increasing the dietary digestible lysine levels from 0.68 to 1.28% of the NRC-recommended requirement significantly increased immune response and nitrogen retention. These results concur with those previously obtained from chickens (Bons *et al*., 2002). Supplementation of L-lysine also increased their antibody responses, with increasing circulating lymphocytes, monocytes, neutrophils, and humoral response. Understanding the nuances of nutrition and immunity is important for optimizing bird health and productivity, and will be an important contributor towards fulfilling the consumer's conflicting demands for more natural production and better animal welfare. Immune function, especially of lymphocytes, should be monitored when conducting experiments to determine nutrient requirements. Least-cost diets are not usually optimal for immunity because they deliver too much energy and are marginal in some nutrients. Experiments to date indicate that concentrations of some nutrients that give optimal growth and efficiency of feed utilisation are inadequate for immunity. Among amino acids, the dietary concentrations that support maximal growth performance appear to be adequate for immunity for lysine, arginine, isoleucine and valine; but sulphur amino acids may be an exception (Klasing, 2007).

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Effect of prebiotic on performance of broiler chicks in low protein diets

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Introduction In view of the severe restriction or total ban on the use of antibiotics as growth promoters and therapeutic agents in poultry industry, probiotics and prebiotics have been suggested as alternatives to antibiotics (piray *et al*, 2007). Prebiotic are known as "a nondigestible feed ingredient" that beneficially affects the host by selectively stimulating the growth or activity of a limited number of bacteria in the colon (Gibson and Roberfroid, 1995). Prebiotics has a significant effect on body weight gain and feed to gain ratio (piray *et al*, 2007). The objective of this research was to study the effectiveness of adding prebiotic on broiler growth performance in low protein diets.

Materials and methods Two hundred forty day of hatch mixed sex broiler chickens of the Ross strain-308 were housed on litter-floor and allocated randomly to each of 6 treatments with 4 replicates (pens) each in CRD design. The environmental condition was according to the Ross guide book. All groups received starter diet contains 23% crude protein from days 1-10. Three groups received an experimental diet formulated to meet Ross guide nutrient requirements for crude protein (21% in grower diet from days 11-28 and 19% in finisher diet from days 29-42) and other nutrients with three levels of (0.0, 1.5 and 3.0 g /kg into the basal diets) Aspergillus meal prebiotic (Fermacto). It is the feed additive, derived from Aspergillus mycelium. The other 3 groups received a diet deficient in crude protein (19% in grower diet from days 11-28 and 17% in finisher diet from days 29-42) with the same three level of prebiotic. Feed and water were provided ad- libitum. Feed intake and body weight gain of chickens were recorded weekly and feed to gain ratio calculated as the unit of ate feed per unit of body weight gain (g/g). GLM proc of SAS was used for statistical analysis and least square means.

Results In finisher period (29-42 days) supplementation of Fermacto increased feed intake only in diet containing standard protein with 3 g/Kg Fermacto. However, difference between diet containing standard protein with 3 g/Kg Fermacto and three low protein diets was significant ($p<0.05$). Addition of Fermacto into low protein diets did not improved feed intake in comparison to control. Addition of Fermacto into both standard and low protein diets increased weight gain but differences were not significant. Among low protein diets, highest value of weight gain observed in diet with 3 g/Kg Fermacto. Chicks fed low protein diet with 3 g/kg Fermacto did not show significant difference in weight gain in comparison to standard protein diets. Chicks fed low protein diet with 3 g/kg Fermacto had comparable feed conversion ratio (FCR) value with standard protein diets. Using Fermacto in standard protein diet had not significant effect on FCR but addition of 3 g/Kg Fermacto into low protein diet improved FCR significantly ($p<0.05$) .

Table 1 Mean feed intake, weight gain and FCR in chickens fed two levels of protein with three levels of Fermacto in finisher period.

Diets	Feed intake, g	weight Gain, g	FCR	Body weight, g
SP[1]+ 0 g/Kg Fermacto(control)	2000 [ab3]	1126 [abc]	1.78 [bcd]	2711 [ab]
SP+1.5 g/Kg Fermacto	1958 [bc]	11277 [ab]	1.74 [cde]	2614 [bc]
SP+ 3 g/Kg Fermacto	2060 [a]	11583 [a]	1.78 [bc]	2782 [a]
LP[2] + 0 g/Kg Fermacto	1943 [bcde]	1026 [de]	1.90 [a]	2533 [c]
LP+1.5 g/Kg Fermacto	1946 [bcde]	1066 [bcde]	1.83 [ab]	2589 [bc]
LP+ 3 g/Kg Fermacto	1956 [bcd]	1101 [abcd]	1.78 [bcde]	2604 [bc]
SEM	0.0295	0.0271	0.0264	54

[1] Standard protein [2] Low protein
[3]Means in each column with different superscripts differ statistically ($p<0.05$).

Conclusions Generally, using Fermacto at high level (3g/kg) in standard and low protein diets improved weight gain and FCR of chicks numerically and statistically respectively. FCR and weight gain values were more affected in low protein diets containing Fermacto. This findings show potential using of Fermacto in some countries which could not formulate diets at protein level recommended by Ross company**.**

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Effect of prebiotic on lipid profile of broiler chicks

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Introduction Research on poultry genetics, feeding and management for BWG and FCR resulted in fast growth but decreased the quality of poultry products as modern fast growing broilers have been found to contain higher amount of abdominal fat (Chambers *et al*, 1981). Most recently considerable attention has been paid to test the potency of growth promo ants on altering lipid metabolism, because, Word Health Organization suggest that excess fat deposition is undesirable in human body. Recent report suggested that feeding of chicory beta fructans; a prebiotic reduced the serum cholesterol and abdominal fat of broiler chicken. The present study was undertaken to study the effect of Aspergillus meal prebiotic (Fermacto) on abdominal fat, serum total cholesterol, HDL and triglyceride levels in low protein diets.

Materials and methods Two hundred forty day of hatch mixed sex broiler chickens of the Ross strain-308 were housed on litter-floor and allocated randomly to each of 6 treatments with 4 replicates (pens) each in CRD design. Three groups received an experimental diet formulated to meet Ross guide nutrient requirements for crude protein (21% in grower diet from days 11-28 and 19% in finisher diet from days 29-42) and other nutrients with three level of (0.0, 1.5 and 3.0 g /kg into the basal diets) Fermacto. Fermacto is the feed additive, derived from Aspergillus mycelium. The other 3 groups received a diet deficient in crude protein (19% in grower diet from days 11-28 and 17% in finisher diet from days 29-42) with the same three level of Fermacto. A day prior to slaughter, blood samples were randomly collected via wing vein from 5 males of each treatment at 48 days of age. After slaughter, abdominal fat were measured in the dressed carcasses. Serum samples were analyzed for total cholesterol, HDL cholesterol and triglycerides in Imam Reza hospital biochemical lab. GLM proc of SAS was used for statistical analysis and obtaining least square means.

Results In recent study, supplementation of Fermacto decreased total cholesterol in diet containing standard protein with 1.5 g/kg Fermacto significantly ($p<0.05$). With addition of 1.5g/kg Fermacto to standard protein diet, the cholesterol value decreased from 148 to 125.8 mg/dl. However, in the diets containing low protein, addition of Fermacto had no effect on cholesterol level in comparison to control diet. Triglycerides level did not affected by supplementation of Fermacto in diets containing low protein. However, supplementation 3 g/kg Fermacto in standard protein diet decreased triglycerides level in comparison to control diet ($p<0.05$). Decreasing of HDL observed only in diet containing standard protein with 1.5 g/kg Fermacto in comparison to control diet ($p<0.05$), but in other treats did not show significantly differences. These observation show that serum lipids affected by Fermacto in standard protein diets but not in low protein ones. There was decreasing trend in percentage of abdominal fat pad with addition of Fermacto to diets containing standard protein. However, the diets containing low protein, addition of Fermacto with 1.5 g/kg decreased significantly ($p<0.05$) abdominal fat pad in comparison to diet containing low protein without Fermacto.

Table 1 Serum lipid and abdominal fat(% of live weight) content of broiler fed different levels of protein and Fermacto

Diets	Total Cholesterol(mg/dl)	Triglycerides(mg/dl)	HDL(mg/dl)	Abdominal fat	Body weight, g
SP[1] + 0 g/Kg Fermacto(control)	148^{a3}	147.2^{a}	118.8^{a}	2.58^{ab}	2711^{ab}
SP+1.5 g/Kg Fermacto	125.8^{e}	133^{abcde}	108^{cde}	2.25^{abcd}	2614^{bc}
SP+ 3 g/Kg Fermacto	135.4^{bcde}	126.2^{bcde}	117^{abc}	2.14^{bcde}	2782^{a}
LP[2] + 0 g/Kg Fermacto	138.6^{abcd}	145.6^{ab}	113^{abcd}	2.80^{a}	2533^{c}
LP+1.5 g/Kg Fermacto	140^{abc}	142^{abcd}	112^{abcde}	2.12^{bdec}	2589^{bc}
LP+ 3 g/Kg Fermacto	140.2^{ab}	143.4^{abc}	118^{ab}	2.36^{abc}	2604^{bc}
SEM	3.9476	6.8946	3.2660	0.2193	54

[1] Standard protein [2] Low protein [3]Means in each column with different superscripts differ statistically ($p<0.05$).

Conclusions supplementation of Fermacto decreased total cholesterol and abdominal fat pad in broilers fed standard protein diet but at low protein diet, just abdominal fat pad was decreased by Fermacto supplementation; therefore inclusion level of Fermacto and level of protein were important for effectiveness. Use of Fermacto was one of the biological ways to improve economic burden in poultry production with decreasing abdominal fat percentage and improve human health by decreasing cholesterol level in serum.

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Ileal crude protein digestibility, caecal crude protein retention and digesta viscosity in broilers fed enzyme supplemented rice husk

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Introduction Enhanced nutrient digestion and absorption in enzyme supplemented broiler diets could be either through reduced digesta viscosity or weakening of the cage effect elicited by soluble or insoluble Non – Starch – Polysaccharides (NSP) on nutrient digestion and absorption. Inhibitory effect of insoluble NSP on endogenous protease reduces efficient digestion of nutrients embedded in cell wall matrix of grains. Increased amount of undigested and unabsorbed protein reaching the caecum implies available nutrient for fermentation and increased coliform forming units of such bacteria as *clostridium* that ferment proteins, peptides and amino acids. The study aimed to assess the effect of partial replacement of maize with Rice Husk (RH) supplemented with Roxazyme G2 G enzyme on ileal crude protein digestibility, caecal crude protein retention and digesta viscosity in broilers.

Materials and methods Four diets were formulated consisting of a Maize – Soya bean meal (M/SBM) control and 3 treatment diets in which maize was partially replaced with 15 (75g/kg of diet), 30 (150g/kg of diet) and 45% (225g/kg of diet) RH. The RH based diets were supplemented with Roxazyme G2 G at the rate of 200g/tonne. Titanium dioxide (TiO_2) was added as an indigestible marker. Free access to experimental diets was provided to 48 Ross unsexed broilers from day 7 to 35 post hatch. The birds were distributed into 48 cages of 1 bird per cage with two cages representing a replicate. A group of 12 cages were then randomly assigned to each of the experimental diets. The birds were reared in a well ventilated temperature controlled house. Digesta was collected from the ileum (2cm posterior to Merkel's diverticulum and 2cm anterior to the ileal – caecal – colonic junction). Digesta collection, collection of digesta liquid fraction and determination of digesta viscosity was done by the method of Steenfeldt *et al* (1998)with the exception of type of viscometer used. A Roto Visco 1 from HAAKE (Germany) was used instead of the Brookfield type. TiO_2 analysis was determined using the method of Brandt and Allam (1987). Ileal crude protein digestibility coefficient was calculated using the formula as given below. The experiment was arranged as complete randomized design of 6 replicates and 2 birds per replicate. All data collected were subjected to polynomial regression procedure in SAS.

Ileal crude protein digestibility coefficient = $$1 - \frac{(conc.of\ TiO_2\ in\ feed \times conc.of\ nutrient\ in\ digesta)}{(conc.of\ TiO_2\ in\ digesta \times conc.of\ nutrient\ in\ feed)}$$

Results Ileal crude protein digestibility, caecal crude protein retention (unabsorbed protein leaving the ileum less the protein voided in faeces) and digesta viscosity were similar across dietary treatments. Low digesta viscosity (1.71mPa.s) was recorded in broilers fed maize-soya bean meal control diet, with corresponding low caecal crude protein retention (2.55g/kgDM) and a high ileal crude protein digestibility (0.989). A similar trend was observed in broilers fed 15 (2.06mPa.s, 3.62g/kgDM and 0.984), 30 (1.85mPa.s, 2.70g/kgDM and 0.988) and 45% (1.86mPa.s, 3.59g/kgDM and 0.986) enzyme supplemented rice husk-based diets.

Table 1 Enzyme effect on ileal crude protein digestibility, caecal crude protein retention and digesta viscosity in broilers

Parameters	M/SBM	M/SBM+ 75g/kg RH	M/SBM+ 150g/kg RH	M/SBM+ 225g/kg RH	SEM	*P value*
Ileal CP digestibility	0.989	0.984	0.988	0.986	1.54	0.583
Caecal CP retention (g/kgDM)	2.55	3.62	2.70	3.59	0.40	0.161
Digesta viscosity (mPa.s)	1.710	2.060	1.850	1.860	0.17	0.175

mPa.s: millipascal seconds, CP: crude protein

Conclusion The results show a relationship between ileal crude protein digestibility, caecal crude protein retention and digesta viscosity. The amount of protein reaching the caecum is dependent on the amount absorbed in the ileum which can be influenced by ileal digesta viscosity. The inhibitory effect of high amount of insoluble NSP present in rice husk on endogenous protease could have been minimized by the enzyme utilized via disruption of cell wall matrix.

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Immunomodulatory effects of dietary *Allium cepa* in chicken after immunization

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Introduction Although antibiotics treatment has been used as an efficient technique to control infectious diseases in poultry industry, there are intensive studies to decrease the use of antibiotics because of the increase in microbial resistance. Therefore, enhancing protective immunity with immunostimulators by magnifying the capacity of immune response seems to be the most promising and practical approach. *Alliums* have been reported to possess therapeutic properties often attributed to sulphur-containing compounds (Bonaccorsi *et al*., 2005). In addition to these compounds, *Allium cepa* is among the richest dietary flavonoids sources; those flavonoids have shown in mammals *in vitro* antimicrobial and anticarcinogenic activities (Block *et al*., 1992). However, very few studies aimed at examining their effects in poultry have been performed. The objective of this study is to examine if the addition of supplementary *Allium cepa* to a balanced ration enhances the immune response of chickens after immunization.

Materials and methods One-day-old, White Leghorn male chicks were distributed into 3 groups of 8 each. The birds were housed in wire cages, 24 hr light-program and 24℃. After the first week, birds were fed on diets containing powder of *Allium cepa* with 10 or 30 gm/kg of the basal starter diet. Free access to water and feed was allowed. Feed intake and body weight were recorded for growth performance study. On day 14, chickens were immunized intraocularly with Newcastle disease vaccine (NDV-clone 30), and intravenously with *Brucella abortus* (BA), and repeated 14 days later. Blood samples were drawn from wing vein weekly for antibodies determination. Anti-NDV antibody was determined by hemagglutination inhibition (HI) titre whereas anti-BA antibody was determined by agglutination titre. Ratios of $CD4^+$ and $CD8^+$ T-lymphocytes, and $CD4^-CD8^-$ lymphocytes (mostly B-lymphocytes) in splenocytes were studied. Thus, splenocytes were incubated with FITC-labelled anti-chicken CD4 antibody and PE-labelled anti-chicken CD8 antibody; ratios were determined using flow cytometry. To check *in vitro* co-mitogenic properties of *Allium cepa* extract on B-lymphocyte proliferation, bursacytes were resuspended in RPMI-1640 media to 1×10^6 cell/ml, and B-lymphocytes proliferation was induced by phorbol 12-myristate 13-acetate (PMA). After 48 hr incubation (39.5℃ and 5% CO_2), 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) was added, and finally, light absorbance was measured at 570 nm wave length as described by Bao (1998) with some modifications. Proliferation was expressed as stimulation index (SI = proliferation of B-lymphocytes in culture with PMA/proliferation without PMA). Data were analyzed using single factor ANOVA of Microsoft Excel. $P<0.05$ was considered significant for all analysis.

Results Average feed conversion ratios of *Allium cepa*-fed chickens had values of 2.15 for low concentration and 2.17 for high concentration which were significantly improved ($P<0.01$, $P<0.001$, respectively) compared to control (2.70). Feeding low concentration of *Allium cepa* exerted a significant increase in anti-NDV antibody production started in response to primary immunization (Figure 1A). Anti-BA antibody titre was higher with dietary *Allium cepa* in response to secondary immunization; however, low concentration had stronger and prolonged stimulatory effect (Figure 1B). Supplementary high concentration of *Allium cepa* significantly increased the ratio of $CD4^-CD8^-$ cells (48.6%, $P<0.001$), while decreased that of $CD4^+$ (21.0%, $P<0.05$) compared with control (43.0% and 25.6%, respectively). Adding 1.3 ~ 6.5 µg/ml as a final concentration of *Allium cepa* extract had a higher ($P<0.001$) SI of 2.52 compared with that of PMA only (1.86).

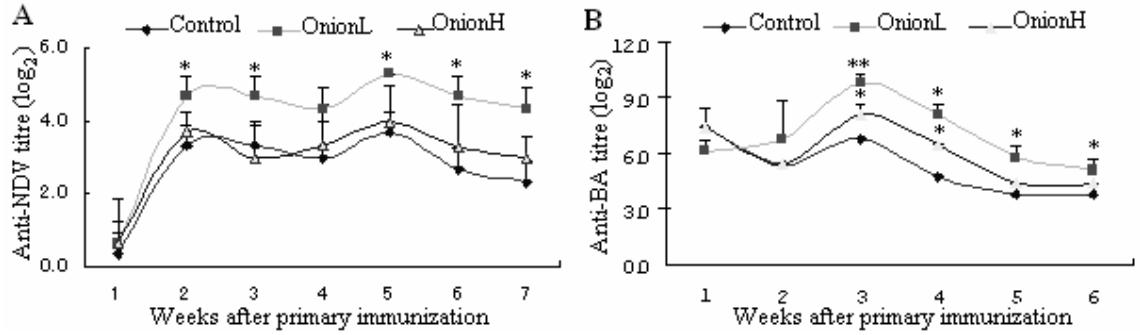

Figure 1 Effect of dietary *Allium cepa* (L, 10 or H, 30 gm/kg diet) on anti-NDV (A) and anti-BA (B) antibody titres (log_2) in chicken. ($^*P<0.05$, $^{**}P<0.01$)

Conclusion The results of this study clearly showed that dietary supplementation of White Leghorn-type chicken with *Allium cepa* stimulated humoral immune response and growth performance. As well, *Allium cepa* had *in vitro* co-mitogenic effect on PMA-induced B-lymphocytes proliferation.

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Nutritive value of poultry by-product meal from Iran in broiler feeding

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Introduction Recently, production of poultry by – product meal (PBPM) has been increased in the northwest of Iran, East Azarbijan. PBPM has a profile of available essential amino acids and is rich in calcium, phosphorus and vitamin B12 (NRC 1994). The chemical composition and mineral content can vary greatly depending on raw material and processing conditions. In our country, fish meal is a common ingredient as animal protein in poultry diets. However, fish meal is imported at high cost. In recent years, there have been attention paid to PBPM supplementation in diets by East Azarbijan poultry feed industry. Therefore, the present study was conducted to determine the chemical composition, mineral content and to study the effects of different dietary concentration (3, 6 and 9%) of PBPM on broiler performance.

Materials and methods The three composed PBPM samples were collected from rendering units of industrial poultry slaughter-house in East Azarbijan province and were chemically analyzed according to AOAC (1992) procedures. For feed evaluation 240 Ross-308 as hatched broiler chickens were used in this experiment. Four different treatments were formed in the study. First treatment was control with no PBPM. The other treatments were 3.0, 6.0 and 9.0% PBPM supplementation, respectively. Experimental diets were formulated as isonitrogenous and isocaloric (based on Ross308 management guide book) and fed from 22 to 49 days of age. Broiler chickens were assigned randomly to four treatment groups (per treatment/5 pens). Fifteen broilers were housed on litter-floor. Feed and water was available on an *ad libitum* basis. Broilers were weighed individually at 22, 42 and 49d of age. For each pen, feed consumption ratio (FCR) and weight gain were measured on a weekly basis. Feed intake was weighed back on the same day that body weights (BW) were determined. Mortality was not observed in this study. The data was analyzed in a completely randomized design using GLM procedure of SAS. Comparison of means was conducted by Duncan's multiple range tests.

Results The average of chemical composition and mineral contents of the PBPM samples are shown in Table 1, and the effects of supplementation PBPM to broiler diets on various live performances is shown in Table 2. Feed intake and weight gain in first stage of experiment with increasing inclusion level of poultry by- product meal, were decreased ($p<0.05$). But feed intake and weight gain in second stage of experiment due to adaptation were not significant difference with control birds ($P>0.05$). Weight gain in total experiment period was less than control birds ($p<0.05$). Feed conversion ratio in two stage and total experiment period were similar to standard feed conversion ratio in Ross308 guide book and non significant difference with control bird ($P>0.05$).

Table 1 Composition of PBPM samples (% as fed)

Composition	DM	CP	EE	TVN*	Ca	P	Na	K	Cu	Zn	Mn	Fe
Average	95.5	62.12	25.28	5.6	1.3	0.43	0.61	0.53	0.061	0.173	0.042	0.821

*Total volatile nitrogen

Table 2 The effects of PBPM inclusion in broiler diets at different levels on growth performance

	22-42d				43- 49 d			22-49d		
Treatments	Feed Intake (gr)	Weight Gain (gr)	Body Weight (gr)	FCR	Feed Intake (gr)	Weight Gain (gr)	FCR	Feed Intake (gr)	Weight Gain (gr)	FCR
Control	2398^{a}	1390^{a}	1919^{a}	1.72^{a}	1159^{a}	570^{a}	2.04^{a}	4037^{a}	2281^{a}	1.76^{a}
3%	2278^{b}	1346^{a}	1800^{b}	1.69^{a}	1118^{a}	552^{a}	2.02^{a}	3875^{a}	2201^{b}	1.76^{a}
6%	2170^{c}	1269^{b}	1664^{c}	1.71^{a}	1172^{a}	599^{a}	1.96^{a}	3785^{b}	2134^{b}	1.77^{a}
9%	2066^{d}	1177^{c}	1561^{d}	1.75^{a}	1133^{a}	569^{a}	2.00^{a}	3629^{c}	1984^{c}	1.82^{a}
SEM	28.7	22.2	26.5	0.025	33.2	16.4	0.08	44.2	22.7	0.025

In the same column differently superscripted are significantly ($P<0.05$) different.

Conclusions In summary, the results showed that composition of studied PBPM samples were different from NRC (1994). Also, under the conditions of this study, using of different levels of poultry by product meal (3, 6 and 9 percent) did not show any detrimental effect on feed conversion ratio but depressed broiler growth rate age of 22 to 49 days.

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Effects of addition of Natuzyme® to broiler diets containing different levels of canola meal

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Introduction Canola meal (CM) is a suitable protein source in poultry diets, although it contains a number of antinutritive factors including non-starch polysaccharides and phytic acid. These factors can limit inclusion rate of canola meal in poultry diets (Kocher *et al*., 2000). The negative correlation between NSP levels and nutritive value of the diet has been demonstrated in poultry (Choct and Annison, 1990). In addition to reducing the availability of phosphorus to birds, phytates are also associated with a number of antinutritional effects, largely because they can chelate divalent cations and reduce protein availability (Ravindran *et al*., 1995). Successful use of enzymes in cereal-based diets has stimulated interest in the application of enzymes to target the vegetable protein components of poultry diets as well. The current study was, therefore, conducted to investigate the effects of a multi-enzyme on performance and serum thyroid hormone concentrations of broilers fed rations in which soybean meal was replaced by CM.

Materials and methods Eight hundred day-old broiler chicks (Cobb) were randomly allocated to 8 dietary treatments in a 4 x 2 factorial arrangement with 5 replicates per treatment and 20 birds per replicate. Experimental diets had different levels of canola meal (0, 100, 200 and 300 g/kg), with or without enzyme (Natuzyme, Sunnybank, Brisbane, Australia). The supplemental enzyme activities reported by the manufacturer were cellolase 6000 units/g, xylanase 10,000 units/g, amylase 700 units/g, glucanase 700 units/g, phytase 500 units/g, pectinase 70 units/g, proteases 3000 units/g and lipase 30 units/g. The diets were isoenergetic and isonitrogenous and were provided *ad libitum* throughout a 42 d experiment. Feed intake and weight gain were determined and feed conversion ratio was calculated. At 42 d age, 2 birds were randomly selected from each replicate and blood samples were collected for measuring T3 and T4 concentrations. T3 and T4 concentrations in the sera were determined by RIA according to the procedure of Kloss *et al*. (1994). Data were subjected to the GLM procedure for ANOVA (SAS, 2001). Mean separation was accomplished using Duncan's multiple range tests.

Table 1 Effects of canola meal and multi enzyme on performance and serum thyroid hormone levels of broilers

Item		Feed intake(g)	BW gain (g)	Feed:gain (g/g)	Feed intake(g)	BW gain (g)	Feed:gain (g/g)	Serum T3 (µg/ ml)	Serum T4 (µg /dl)
		1-21 d			1-42 d				
Enzyme	CM								
No	0	924^{b}	688^{ab}	1.34^{c}	3725	2221^{ab}	1.68^{bc}	1.33	0.63
10		921^{b}	606^{c}	1.52^{ab}	3726	2075^{bc}	1.79^{ab}	1.21	1.36
20		952^{ab}	653^{abc}	1.46^{abc}	3711	2039^{bc}	1.82^{a}	1.33	0.4
30		969^{ab}	618^{bc}	1.57^{a}	3696	1935^{c}	1.91^{a}	1.36	0.83
Yes	0	965^{ab}	710^{a}	1.36^{ab}	3690	2268^{a}	1.62^{c}	1.37	1.44
10		991^{a}	637^{abc}	1.55^{a}	3707	2104^{ab}	1.76^{abc}	1.41	0.64
20		971^{ab}	640^{abc}	1.51^{abc}	3705	2103^{b}	1.75^{abc}	1.25	0.48
30		956^{ab}	643^{abc}	1.48^{abc}	3681	2087^{bc}	1.76^{abc}	1.24	0.66
S.O.V									
Enzyme		*	ns	ns	ns	*	*	ns	ns
CM		ns	**	*	ns	**	*	ns	ns
Enzyme × CM		*	*	*	ns	*	*	ns	ns
SEM		14.6	16.2	0.02	37.1	35.3	0.03	0.06	0.23

$^{a-c}$Means with different superscripts are significantly different. ^{ns}non-significant *P<0.05 ** P<0.01

Results Canola meal had no effect on feed intake. Body weight gain was significantly reduced when canola meal was added into the diets (P<0.01). No effect of enzyme addition was observed on BW gain and feed:gain during 1 to 21 d. Enzyme addition significantly increased body weight gain during 1-42 d (P<0.05). Feed conversion ratio was highest from 1 to 42 days when 30 g/kg canola meal was added to the diets. Enzyme supplementation significantly (P<0.05) improved feed conversion ratio during 1- 42 d. The interactions between enzyme and canola meal for body weight gain and FCR were significant. The effect of enzyme addition on weight gain and feed:gain was numerically greater in diets which had higher levels of CM. Different levels of added canola meal and enzyme had no significant effect on concentrations of serum thyroid hormones.

Conclusions The results of this study showed that inclusion of CM at or above 100 g/kg depressed weight gain and FCR without affecting the feed intake. Enzyme supplementation had the potential to reduce the unfavourable effects of canola meal.

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The effects of multi-enzyme addition on performance of broiler chicks

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Introduction Today the use of enzymes is common in practical poultry nutrition. Enzyme supplementation usually result in numerous beneficial effects, such as increased utilization of nutrients (e.g. fat & protein), improved AME values, increased growth rate, improved feed conversion ratio, decreased viscosity of intestinal digesta, reduced incidence of sticky excreta and improved litter conditions (Broz and Ward., 2007). The use of multi enzymes to improve the digestibility of corn-soybean meal-wheat diets for broilers is less well documented than wheat and barely diets. Therefore, the aim of the present study was to examine the effects of a multi-enzyme supplementation on the performance of broiler chicks fed on corn-soybean meal-wheat diets.

Materials and methods A total of 150 one-day-old mixed-sex broiler chicks (Cobb 500) were used in a completely randomized design with 3 replicates with 25 chicks in each replicate. The birds were randomly allocated to 6 pens. The main ingredients of diets included corn, soybean meal and wheat. The amount of corn, soybean meal and wheat in starter (1-10 d) and grower (11-28 d) diets were about 437, 356, 150 and 374, 314, 250 g/Kg diet respectively. Diets were formulated according to Cobb 500 rearing guideline and contained 2950 Kcal/Kg metabolizable energy and 22% crude protein during starter, and 3000 Kcal/Kg metabolizable energy and 21% crude protein during grower period. Feed and water were provided *ad libitum* during the experiment. Temperature was maintained at 32° C for the initial 3 d and then gradually reduced according to normal management practices, until a temperature of 22° C was achieved. The experiment lasted 4 weeks. The experimental diets contained 2 levels of a dietary NSP degrading enzyme (0, 0.05%; Endofeed W produced from *Aspergillus niger*, with minimum activity of 2250 u/g xylanase and 700 u/g Beta-glucanase). According to the manufacturer, the allowance for this enzyme product was 0.05% and it also contained activities of other enzymes, including cellulase, protease, α-amylase and α-galactosidase. The enzyme complex was added to the chicken diet as a dry powder from hatching to the end of the experiment. Chickens were weighed weekly (from 1 to 28 d) to determine their performance. Data were analyzed by analysis of variance using the GLM procedure (SAS institute, 2001). Differences among means were compared by Duncan´s multiple range test (1955).

Results Data obtained from this experiment indicated that enzyme supplementation significantly improved body weight gain and feed conversion ratio (Table 1). These results are in agreement with the findings of previous studies (Wang *et al*., 2005; Gao *et al*., 2007). Adding enzyme to broiler diets may improve performance by two mechanisms: increasing feed intake and improving nutrient digestibility. Both mechanisms might be induced, at least partially, by reduction of gut viscosity which decreased retention time of digesta in the gut, allowing more feed consumption and therefore improving growth and feed conversion ratio (Lázaro *et al*., 2003). The results showed that enzyme supplementation to corn-soybean meal-wheat based diet can improve weight gain whilst maintaining intake, which is suggestive of improved digestibility of a limiting nutrient.

Table 1 Effect of multi-enzyme supplementation on broilers performance during 1 to 28 d of age

Diets	Feed intake (g)	Weight gain (g)	FCR (g:g)	Energy efficiency ratio[1] (%)	Protein efficiency ratio[2] (g:g)	Growth ratio[3]
1 (without enzyme)	2094.44	1389.95[b]	1.51[a]	22.10[b]	3.142[b]	34.74[b]
2 (with enzyme)	2095.05	1435.68[a]	1.46[b]	22.80[a]	3.245[a]	35.89[a]
s.e.m	13.05	7.13	0.008	0.13	0.016	0.18

[ab] Means with different superscripts in each column are significantly different (P<0.05)
[1]Calculated as weight gain×100 divided by total Kcal ME intake. [2]Calculated as weight gain divided by protein intake.
[3]Calculated as BW at 28 d of age – BW at 1 d of age / BW at 1 d of age.

Conclusions Results of the present study indicated that supplementation of enzyme at the level of 50 mg/Kg diet significantly improved feed conversion, energy and protein efficiency and growth ratio of Cobb 500 broiler chicks during starter and grower period of rearing (1 to 28 d of age).

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Enrichment with long chain omega-3 fatty acids and sensory evaluation of chicken meat

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Introduction N-3 fatty acids are essential for normal growth and development, and may play an important role in prevention of coronary artery disease, hypertension, diabetes, arthritis, other inflammatory and autoimmune disorders and cancer in humans (Simopoulos, 1999). Fatty acid profiles of broiler meat may be modified by adding fish oils to the diet (Lopez-Ferrer *et al*., 2001). When meat is enriched with PUFA, particularly n-3 long-chain fatty acids (C≥20), all sources of added vegetable oils seem to be less effective than marine oils (Bou. R *et al*., 2004). The purpose of this experiment was to study the effect of dietary fish oil on fatty acid composition of thigh and breast meat in broiler chickens.

Materials and methods Four hundred and fifty d-old Ross 308 male, broiler chickens were allocated to 6 dietary treatment with 5 replicates of 15 birds each. The birds were reared in a controlled environment house and had *ad libitum* access to water and feed. All dietary nutrients were provided as to meet AVIAGEN recommendations. Khazar Kilka fish oil was added at the levels of 0, 10, 20, 30, 40 and 50 g/kg in diets, fed from 28 to 42d of age. Performance criteria were measured during the experimental period. One bird with an average live body weight of each replicate group was selected and slaughtered on day 42 d The left thigh and left side of the breast were excised and stored at –20 C for later analysis. Samples (including skin) were analyzed for n-3 fatty acids with GC and sensory evaluation after each sample was individually cooked in boiling water. Data were analysed by using GLM procedure of SAS (9.1)

Results Weight gain and Feed Conversion Ratios were similar (P>0.05) for all treatments (table1). The Eicosapentaenoic acid (EPA) and Docosahexaenoic acid (DHA) contents of thigh or breast tissues were increased significantly (P<0.05) as the level of dietary fish oil increased. Effects were not significant for LA(linoleic acid) and ALA(alpha linolenic acid). Sensory evaluation showed that panellists did not identify the fishy smell of cooked thigh or breast meat of birds fed diets with 0, 10 or 20 g/kg fish oil. The concentration of DHA in breast and thigh meat increased from 0.046 (mg/g) and 0.086 (mg/g) to 0.166 (mg/g) and 0.27 (mg/g), respectively, when dietary fish oil increased from 0 to 20 g/kg,. Significant linear relationships were found between the levels of fish oil and EPA in the breast and thigh (R^2 = 0.59 ; R^2= 0.71 respectively) and between the fish oil and DHA in the breast and thigh (R^2 = 0.71 ; R^2 = 0.72, respectively).

Table 1 Broiler chickens performance and concentration of some n-3 FAs in breast and thigh meat (mg/g in meat) of birds given diets including fish oil

Treatments	WG (g/b/d)	FCR	Thigh				Breast				Scores[1]	
			C18:2	C18:3	C20:5	C22:6	C18:2	C18:3	C20:5	C22:6	Thigh	Breast
control	69.8	2.24	5.4	0.35	0.028^{b}	0.086^{c}	0.54^{b}	0.02b	0.014^{b}	0.046^{c}	1.10	1.12
1% fish oil	71.4	2.27	6.2	0.13	0.051^{b}	0.16^{bc}	0.87^{ab}	0.04^{ab}	0.042^{b}	0.145^{bc}	1.27	1.17
2% fish oil	69.2	2.48	6.1	0.42	0.086^{ab}	0.27^{bc}	0.99^{ab}	0.10^{a}	0.04^{b}	0.166^{bc}	1.25	1.25
3% fish oil	72.1	2.29	4.6	0.32	0.16^{ab}	0.38^{ab}	0.67^{ab}	0.03^{ab}	0.04^{b}	0.240^{ab}	2.32	2.25
4% fish oil	67.6	2.53	4.2	0.43	0.23^{a}	0.53^{a}	0.99^{ab}	0.07^{ab}	0.09^{a}	0.340^{a}	3.25	3.87
5% fish oil	68.0	2.44	3.2	0.30	0.16^{ab}	0.58^{a}	1.10^{a}	0.06^{ab}	0.08^{a}	0.290^{a}	4.02	4.25
SEM	1.78	0.04	0.09	0.11	0.05	0.08	0.16	0.04	0.01	0.04		
P value	NS	NS	NS	NS	0.003	0.003	NS	NS	0.006	0.001		

[abc] Values in column with no common superscripts differs significantly (P<0.05)
[1] Flavour scores using a 5 point scale: 5=very poor,4=poor, 3=indifferent, 2=acceptable, 1=typical chicken flavour

Conclusion The levels of long chain fatty acids (EPA and DHA) were linearly increased in the chicken meat as the levels of dietary Khazar Kilka fish oil increased from 0 to 5%. The panellists identified the fishy smell of the meat when more than 20 g/kg fish oil was included in the diet.

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Determination of chemical composition and metabolizable energy of wastes of spaghetti, pasta, biscuit, crisp, chickpea pre-cleaning and chickpea screening plants

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Introduction Based on the official statistics of industries and mines organization about 1000 ton wastes of spaghetti, pasta, biscuit, crisp, and about 7500 ton waste of chick pea pre-cleaning plants are produced annually in East Azerbaijan province of Iran. In our country there is little researches on wastes. In one study, ileal amino- acid digestibility of wheat, autoclaved wheat and spaghetti by-products for broiler chicks was determined (Zaghari 2006). The aim of the present study was to determine metabolizable energy and chemical composition of wastes of spaghetti, pasta, biscuit, crisp, chickpea pre-cleaning and chickpea screening plants.

Materials and methods After classified random sampling from 10% of spaghetti, pasta, biscuit, crisp, chickpea pre-cleaning and chickpea screening plants, the samples were ground and mixed. 24 adult laying-type cockerels (Hy-Line W36, 35-week-old) with mean body weight of 2000 g ± 100 were randomly grouped into six groups of four replicates. All birds were kept in individual battery cages (25 cm × 35 cm × 50 cm in dimension) and fed commercial diets prior to the experiment. The wastes of spaghetti, soup pasta, rice pasta, crisp, biscuit, pre-cleaning chickpea, and chickpea screening were mixed in the ratio of 15% to basal diet. Then, in order to determine metabolizable energy (TME, TMEn) of waste, 30 grams of mixed feed were force-fed to 4 adult Leghorn-type roosters, according to the method described by Sibbald (1986). Excreta voided from each bird following the feeding procedure was collected quantitatively, for 48 h. Birds had free access to water, and when not on experiment, to a commercial diet. All the birds remained healthy and survived the experimental procedure. The chemical analysis of wastes and collected samples of excreta was carried out according to the standard methods of analysis (AOAC,1990). Gross energy of wastes and individual samples of excreta was measured by a bomb calorimetry.

Results Summarized in table1, are data showing chemical composition of studied wastes. Maximal crude protein, ash and crude fiber value was obtained with chickpea pre-cleaning.

Table 1 Chemical composition (g/kg fresh weight) of wastes

wastes	Dry Matter	Ash	Crude Protein	Crude Fat	Crude Fiber	NFE	NDF	ADF	Gross Energy (MJ/kg)
spaghetti	915	12	127	24	2	805	17	1	18.79
pasta	909	7	141	65	2	755	14	3	18.74
biscuit	948	20	90	170	51	649	111	17	20.37
crisp	935	15	92	42	5	826	131	3	18.23
chickpea pre-cleaning	923	73	302	87	178	320	323	224	19.38
chickpea screening	919	60	300	78	78	450	351	96	19.79

Table 2 Metabolizable energy of experimental wastes (MJ/kg)

wastes	AME	AMEn	TME	TMEn
spaghetti	14.41^{d}±0.17	14.8^{c}±0.18	15.77^{d}±0.17	15.23^{c}±0.18
pasta	15.69^{c}±0.19	16.24^{b}±0.25	17.06^{c}±0.19	16.67^{b}±0.25
biscuit	16.26^{a}±0.09	16.78^{a}±0.26	17.26^{a}±0.09	17.22^{a}±0.22
crisp	15.98^{b}±0.13	16.25^{b}±0.20	17.34^{b}±0.13	16.69^{b}±0.20
chickpea pre-cleaning	10.89^{e}±0.13	10.34^{f}±0.16	10.96^{f}±0.22	11.64^{d}±0.17
chickpea screening	9.6^{f}±0.22	10.34^{f}±0.16	10.96^{f}±0.22	10.77^{f}±0.16
SEM	0.088	0.098	0.088	0.098

Among the wastes, biscuit had the highest ME, presumably related to its highest fat content. Statistical analysis showed that there were significant differences ($p<0.05$) between ME types of wastes.

Conclusions These results show that experimental wastes especially chickpea, biscuit and spaghetti are rich sources of protein and energy with some values even exceeding those in corn and wheat. Further work is required to test their suitability in diets for poultry.

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The effect of different lightning programs on reproductive performance of native turkeys

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Introduction Lighting is very important for turkey production, because their life period is longer than poultry (Nixey 1994). One of the important effects of lighting is to change the time of sexual maturity in pullets. Classen *et al.* (1994) concluded that constant light causes an increase incidence of leg problem and metabolic disorders. With lighting programs and lighting intensity, time of sexual maturation can be modified. Because there is little information about lighting programs in native turkey production in Iran, the aim of this research is determining the best lighting program for native turkey production.

Materials and methods The effect of 2 lighting program in growth period and 7 lighting program in production period on native turkey's reproductive performance was surveyed. Turkeys received (7L:17D) and (14L:10D) lighting programs by 36 weeks respectively. 400 female and 80 male turkeys were used on completely randomized design with four repeat, each contain 50 female and 10 male turkeys. The survey of lighting program continued in production period (37- 66 weeks). The groups receiving 7h light during the growth period received 4 different lighting program (12L:12D), (14L:10D), (16L:8D) and intermittent (1L: 3d) for 66 weeks. The group receiving 14h light during the growth period received 3 different lighting programs (14L:10D), (16L:8D) and (1L:3D). This period of experiment was carried on completely randomized design with four repeat, each contain 10 female and 2 male turkeys. Sexual maturity age, egg production, fertility, and hatchability percent and feed intake for every 1day's chick production were recorded.

Results The largest hatchability was in 7L: 17D in growing period and then 14L:10D in production period group, that was significant differences with 14L:10D in growing period and (1L:3D) in production period group ($p<0.05$). The least feed intake for every 1 day's chick production was in 14L:10D in growing and production period group, but there wasn't significant differences between treatments ($p<0.05$). The largest produced chick was in 7 and 14 lights respectively for growth and production period group, but there wasn't significant differences between treatments ($p<0.05$).

Table 1 Number of chicks produced from 100 female turkey, amount of feed intake(kg) for every 1day old chick production and mean of maturity age

Lighting program		Number chicks produced from 100 female turkey in every day	Fertility	Hatchability	Feed intake(kg) for chicken production	FI(kg) for every 1d chick production	Mean of maturity age(day)
Growth period	Production period						
7L:17D	1L:3D[1]	7.05	$64^{c}\pm20$	$77^{ab}\pm18$	54.93	7.79	
7L:17D	12L:12D	9.30	$72b^{c}\pm19$	$80^{ab}\pm14$	30.29	3.27	259.25
7L:17D	14L:10D	11.94	$84^{a}\pm12$	$85^{a}\pm21$	28.32	2.37	
7L:17D	16L:8D	10.55	$77^{ab}\pm12$	$79^{ab}\pm19$	42.52	4.03	
14L:10D	1L:3D	8.19	$72^{bc}\pm26$	$71^{b}\pm15$	22.45	2.74	
14L:10D	14L:10D	10.18	$62^{bc}\pm19$	$85^{a}\pm15$	22.48	2.21	256.67
14L:10D	16L:8D	10.80	$78^{ab}\pm17$	$81^{ab}\pm17$	28.94	2.68	

1-1L:3D=Intermittent program (1h light:3h dark). 2-7L:17D=continuous program(7h lightness:17h dark)

Conclusion The best FCR was for the groups received 14h L in growth period and 14h D in production period and also in the total production period, the highest egg production percent was for the groups received 7h L in growth period and 14h L in production period

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Effects of butyric acid, mannanoligosaccharide (MOS) and avilamycin on performance and small intestine morphology of broiler chickens

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Introduction The subtherapeutic use of antibiotics in animals has been under scientific and public scrutiny as antibiotic growth promoters (AGP) have been linked to the development of antibiotic resistance in bacteria, which poses a threat to human health (Smith *et al*., 2003). Short chain fatty acids such as butyrate are considered as potential alternative to AGP, In addition to its bactericidal activity; butyrate appears to play a role in development of the intestinal epithelium (Leeson 2005). Prebiotics (e.g. mannanoligosaccharides, MOS) are nondigestible feed ingredients that can selectively stimulate growth or metabolic activity of a limited number of intestinal microorganisms (Gibson and Roberfroid, 1995). This study was, therefore, conducted to investigate effectiveness of mannanoligosaccharides and butyric acid as potential alternatives to AGP in broilers.

Materials and methods Two hundred and eighty eight one-day-old male broiler chicks (Arbor Acres Plus) were raised over a 42 d experimental period. Dietary treatments were: 1) Negative control, antibiotic free diet; 2) Positive control diet (containing 15mg/kg of avilamycin); 3) Negative control with MOS (Bio-Mos, Alltech Inc., Nicholasville, KY, USA, 2g/kg of the diet) and 4) Negative control with butyric acid (BabyC4, SILO, Industria Zootecnica, Florence, Italy, 3 g/kg of the diet to 21 days). Chicks were randomly assigned to 4 replicates per treatment and 18 birds per replicate. Dietary treatments were fed during starter (0-14 d), grower (14-28 d) and finisher (29- 42 d) periods. All diets within each period were prepared with the same batch of ingredients and had the same nutrient composition. For intestinal morphometric examination, two birds per replicate (8 birds per treatment) were euthanized at day 28 and 2-cm segments of the midpoint of the jejunum were removed and fixed in 10% buffered formalin. Serial sections were cut at 5 µm and placed on glass slides. Sections were deparaffinized in xylene, rehydrated in a graded alcohol series, stained with hematoxylin and eosin, and examined by light microscopy. Data were analyzed using the GLM procedure of SAS (2001). Differences among treatments were compared using a Duncan's multiple range tests.

Results The effects of addition of avilamycin, butyric acid and MOS on broiler performance, feed intake, body weight, villi height and crypt depth in the jejunum are shown in table 1. Birds fed MOS and butyric acid were significantly heavier than negative controls ($P<0.05$). There were no significant differences among dietary additive groups with respect to body weight gain. Dietary supplementation with avilamycine, butyric acid and MOS significantly improved FCR ($P< 0.01$) although this improvement was greater in butyric acid and MOS compared to avilamycin groups. Carcass yield in butyric acid groups was greater than negative controls ($P=0.08$). Birds fed avilamycin had lowest small intestine weight ($P< 0.01$). There were no significant effects of feed additives on villi height and crypt depth.

Table 1 Effects of avilamycin, butyric acid and MOS on growth performance, villi height, crypth depth, small intestine weight and carcass yield of broiler chickens

Treatment	BW gain 1-42days (g)	FCR 1-42days	Villi Height (µm)	Crypt depth (µm)	Small Intestine (% of BW)	Carcass yield (% of BW)	Breast weight (% of BW)
Negative control	2212^{b}	1.99^{a}	862	201	4.56^{a}	71.9	27.1^{b}
Avilamycin	2344^{ab}	1.83^{b}	871	189	3.45^{c}	74.5	29.8^{a}
Butyric acid	2370^{a}	1.72^{c}	925	194	3.85^{cb}	75.3	30.3^{a}
MOS	2376^{a}	1.75^{c}	869	209	4.14^{ab}	72.8	29.0^{a}
SEM	48.8	0.03	46.3	9.6	0.152	0.95	0.51
Significance	*	**	NS	NS	**	NS	**

$^{a-c}$ Means in a column without a common superscript are significantly different. ^{NS}non-significant $^{*}P<0.05$ $^{**}P<0.01$

Conclusions It was concluded that addition of butyric acid and MOS can improve broiler performance, without significant effects on intestinal morphology, including villus height and crypt depth. No difference in performance was observed between the two additives. The inclusion of avilamycin as a growth promoter was also associated with positive effects on performance of broilers. The results of this study indicated that addition of butyric acid and MOS to the diet could be an alternative to the use of antibiotics as growth promoters in broiler production.

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Growth curve models for commercial pullets under severe heat stress condition

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Introduction The objectives of our study were to propose a growth curve and to develop a mathematical model to describe the body weight of pullet experiencing severe heat stress (42^{o}C). Poultry producers who raise their own replacement pullets can control their pullet's growth, condition and development. Many of the problems which occur during the early part of lay can be traced back to insufficient or improper type of body weight attained during the various stages of the growing period. In order to avoid these problems, the body weight of pullets must be controlled. Rearing conditions for pullets vary depending on environmental pressures and can affect growth rate. Without the basic knowledge of the flock grow-out, it is virtually impossible to understand and possibly solve problems which may later occur during the laying period. It must be kept in mind that once egg production begins, it is too late to solve problems resulting from growing period. The two most important criteria of pullet quality are uniformity within the flock and proper body weight at a specific age. Almost anything that adversely affects a pullet will usually be reflected in lower body weights and poorer flock uniformity. High ambient temperatures can be devastating to commercial pullet growth rate; coupled with high humidity they can have an even more harmful effect on proper and recommended body weight. Heat stress interferes with the poultry comfort and suppresses performance efficiency. In order to verify the effect of heat stress on pullet growth rate, many curve modelled, fitted and verified to proposed best one.

Materials and methods 2250 leghorns (HyLine-W36) pullets were used for the study which was conducted during the hot months of year in Mollasani educational and research centre (Ramin agricultural university, north west of Iran). All the bird fed isoenergetic and isonitrogenous diets. Body weight, age, mortality and DMI were recorded every week. Temperature and humidity were recorded and the Thermal-Humidity Index (THI) was calculated every day. The collected data were analysed by the Statistical Analysis Systems (SAS) NLIN procedure (SAS, 2005), and CurveExpert 1.3 software to fit and compare the Gompertz, Richards, Weibull, MMF, Logistic, Von bertalanffy and some other curves.

Results The most fitted one was Gompertz model with r=0.998 and MSE= 24.11 and with parameters a= 1441.431; b=1.205; and c=0.023**.** Consequently, under heat stress condition the growth model proposed by company is changed, and this must be considered by producers to achieve the best profit in production period.

Table 1 comparing some models fitted for pullet reared in hot environment conditions.

Model Name	Coefficient of determination	Standard Error	Parameter of model A	b	c	d
Gompertz	0.998423	24.107	1441.4318	1.2053797	0.022682751	
4th Degree Polynomial	0.998499	25.041	50.305531	1.9294874	0.23985574	-0.002306
Richards	0.998352	25.397	1405.1059	-0.7664503	0.024911281	0.11889103
Weibull	0.998344	25.462	1451.4692	1400.4615	0.000732897	1.6011592
MMF	0.998323	25.620	58.263176	3332.0639	1869.7764	1.7846243
Logistic	0.996937	33.583	1265.264	13.149497	0.041046892	

The form of equations mentioned above was as y=a*exp(-exp(b-cx)) for Gompertz model , y=a+bx+cx^2+dx^3...for 4th Degree Polynomial model, y=a/(1+exp(b-cx)^(1/d)) for Richards model, y=a-b*exp(-c*x^d) for Weibull model, y=(a*b+c*x^d)/(b+x^d) for MMF model and y=a/(1+b*exp(-cx)) for Logistic model. The Coefficient of determination or R^2 was high for all models but the lowest standard error was seen in Gompertz model. So the Gompertz model proposed for its lower standard error and for using 3 parameters.

Conclusion Under heat stress condition the growth model proposed by the company is changed, and this must be considered by producers to achieve the best profit in production period.

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The effect of increasing levels of fish oil on immune responses of broiler chickens

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Introduction There has been interest in the enrichment of poultry meat with long chain n-3 polyunsaturated fatty acids (PUFA) as a means of increasing the low consumption of these acids by humans consuming western diets. There is some concern, however, that at high levels of consumption, n-3 PUFA may have detrimental effects on immune function. However, research to date shows that strong controversy surrounds this immunomodulation. The aim of this experiment was to determine the effects of dietary long chain PUFA on aspects of immune function in broiler chickens.

Materials and methods A total of 18 one-day-old male Ross 308 broiler chicks were reared as a single group for 21 d, and fed a common starter diet. At 21 d, birds were randomly allocated to one of six pens (106x106x108cm), three chicks per pen. Water and feed were provided ad libitum. The broilers were fed for 33 d one of three wheat-soyabean meal based diets. All diets contained 60g/kg added oil, which was either 0,60; 30,30; or 60,0 g fish oil (FO) and soya oil respectively. Chickens were sacrified between 54 and 60 d of age and samples of blood, bursa of Fabricus, spleen and thymus were collected. The bursa of Fabricus, spleen and thymus were weighed. Heparinised blood was layered on equal volumes of histopaque for preparation of peripheral blood leukocytes. Lymphocyte subsets from the freshly harvested spleen and thymus were prepared and stained with four monoclonal antibodies (mAb): anti-CD3, anti-CD4, anti-CD8 and BU-1A (B cell marker). Immune cells were then enumerated using the FACSCalibur^{TM} flow cytometer. Quantitative analysis of the phagocytic activity of peripheral mononuclear phagocytes in whole blood was performed using phagotest commercial kits, (ORPEGEN-Pharma). Results were expressed as percentage of fluorescent cells and data were analysed by CellQuest^{TM} software. The overall differences of the effects between the three dietary treatments were analysed using one-way analysis of variance (ANOVA) and the general linear model procedure of Minitab was applied in all the tests. Differences between the treatment groups were considered statistically different at $P \leq 0.05$.

Results Increasing levels of fish oil did not affect the weights of the spleen. However, chickens fed diet with 60 g/kg FO had significantly lower bursa weights ($p<0.01$) than those fed diets with 0 g/kg and 30 g/kg FO (Table 1). Chickens fed diets containing 30 g/kg FO had significantly higher thymus weights compared to chickens fed 0 and 60 g/kg ($p<0.05$). There was no significant effect of increasing fish oil level on the percentage positive and mean fluorescence intensity (MFI) of the leukocyte subsets in peripheral blood, spleen and thymus. However, the proportion of B-cells in peripheral blood and the MFI of CD8 subsets in the spleen approached significance, P=0.058 and 0.054, respectively (data not shown). Results of phagocytic activity show that the different levels of FO in the experimental groups neither affected the positive percentage of cells nor MFI. However, there was a trend towards a lower proportion of monocytes being engaged in phagocytosis when broilers were fed diets containing 60 g/kg FO (p=0.055) (Table2).

Table 1 % Body weight of different tissues

Diet (g/kg FO)	Tissue[1] Spleen	Thymus	Bursa
0	0.12	0.15 [a]	0.30[a]
30	0.15	0.17 [b]	0.28[a]
60	0.12	0.12 [a]	0.14[b]
SE Mean	0.01	0.01	0.02
P value	0.164	0.022	0.001

[1]For each tissue weight %, values with different superscripts are significantly different

Table 2 Effect of diet on % of phagocytic leukocytes and their MFI

Diet	Monocytes		Granulocytes	
(g/kg FO)	% of +ve cells	MFI	% of +ve cells	MFI
0	46.78	2148	69.77	1737
30	48.76	2306	82.34	3448
60	35.16	2044	72.84	2204
SE Mean	3.788	630	3.76	992
P value	0.055	0.962	0.102	0.267

Conclusions These results show no evidence of detrimental effect of enrichment with fish oil under the circumstances of this study. However, further studies should be conducted on different immune functions under different situations (e.g. challenge with pathogen), especially as there is an evidence of a potential threshold effect in some cases. Such studies would help the poultry industry to improve or maintain the health status of poultry at an optimum level in circumstances when poultry meat is being enriched with long chain n-3 polyunsaturated fatty acids.

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Effect of dietary Phytase and NSP-degrading enzymes in diets containing rape seed meal on broiler performance

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Introduction In comparison to 44% crude protein of soybean meal (SBM), the protein content of rapeseed meal (RSM) is about 35- 40% and has a physiologically suitable amino acid combination in animal nutrition, but RSM contains nutritionally unfavourable substances such as glucosinolates, sinapin, tannin, phytate and non starch polysaccharides (NSP) (Kocher *et al*., 2000). Enzymes have the potential to be used in diets contain antinutritional factors that hinder nutrient availability. NSPs include cellulose, B-glucans, arabinoxylans, and pectins that may increase viscosity of digesta and cause a decrease in nutrient digestibility and performance of broiler chickens. Phytase activity from digestive secretions, some feed ingredients, resident bacteria, exogenous microorganisms, or both resident bacteria and exogenous microorganisms is present in the digestive tract of broiler chickens (Kornegay, 2001), but its efficiency at a practical level is very low. It is accepted that broilers lack sufficient levels of phytase activity to effectively hydrolyse the phytate molecule. Phytate-bound P is not well digested, so inorganic P is added to broiler diets that increased feed costs (Lescoat *et al*., 2005). The purpose of this study was to investigate the replacement value of SBM with locally grown RSM and two types of enzymes (NSP-degrading and phytase) on performance of broiler chickens.

Materials and methods Three levels of (0.0, 25.0 and 50%) SBM protein was replaced with RSM protein and two levels of Phytase enzyme (0 and 500 FTU Phyzyme/kg, Phyzyme XP is a bacterial phytase from *Schizosacchromyces*), two levels of a dietary NSP-degrading enzyme (0, 0.17%, Grindazyme, minimum activity of 36000 U/g xylanase and 15000 U/g Beta-glucanase) were added to the diets during starter (7-21 days of age) and grower (21-42 days of age) periods. All diets had 0.5% available P and 0.95% Ca, and were isocaloric and isonitrogenous (2969 kcal/kg ME and 21.70% CP in starter; 3118.43 kcal/kg ME and 19.65% CP in grower period). 360 Ross strain chickens were used in a 2×2×3 factorial arrangement in a completely randomized design with twelve treatments, three replicates and ten birds per replicate. Feed consumption and body weight gain of chicks were recorded 4 h after the removal of feed and feed conversion ratio (FCR) calculated at end of every week. All Data were analysed by SAS (2000). Means compared by Duncan's test.

Results The results of this experiment indicated that FI, BWG and feed efficiency of broiler were significantly ($P<0.05$) decreased by increasing RSM in all period of experiment (table 1). These factors were highest in diet without RSM. The BWG and FI of broiler were significantly ($P<0.05$) increased by addition of Grindazyme, but were not affected by supplementation of Phytase in the diet. However Broiler fed diets contains phytase have numerically more FI and BWG than control diet.

Table 1 The main effects of diets contain Phytase and NSP-degrading enzyme and rapeseed meal on broiler performance

	Weigh gain (kg)			Feed intake (kg)			FCR		
	7-21	22-42	7-42	7-21	22-42	7-42	7-21	22-42	7-42
Phytase	0.50	1.31	1.81^{a}	0.79	2.60	3.39^{a}	1.56	1.99	1.87^{a}
No Phytase	0.52	1.33	1.84^{a}	0.78	2.63	3.41^{a}	1.51	1.99	1.85^{a}
SEM	0.01	0.01	0.02	0.007	0.02	0.01	0.03	0.01	0.01
Grindazyme	0.51	1.28^{b}	1.80^{b}	0.78	2.60^{b}	3.37^{b}	1.52	2.02^{a}	1.87^{a}
No Grindazyme	0.51	1.35^{a}	1.86^{a}	0.79	2.64^{a}	3.43^{a}	1.55	1.95^{a}	1.85^{a}
SEM	0.01	0.05	0.04	0.007	0.03	0.04	0.02	0.05	0.01
0% RSM	0.54^{a}	1.36^{a}	1.90^{a}	0.79^{a}	2.65^{a}	3.44^{a}	1.47^{b}	1.95^{a}	1.81^{b}
25% RSM	0.49^{b}	1.31^{ab}	1.80^{b}	0.78^{b}	2.62^{ab}	3.39^{ab}	1.58^{a}	2.00^{a}	1.89^{a}
50% RSM	0.51^{b}	1.28^{b}	1.78^{b}	0.79^{ab}	2.57^{b}	3.36^{b}	1.55^{a}	2.02^{a}	1.89^{a}
SEM	0.02	0.04	0.06	0.006	0.04	0.04	0.07	0.04	0.07

SEM: standard error of means; FCR: Feed conversion ratio; RSM: Rape seed meal

Conclusion Levels of RSM showed more adverse effects on performance. It seems addition of enzyme was an effective method to overcome the anti nutrition factor of RSM. Therefore, it may be concluded that NSP-degrading and Pytase enzymes incorporated in rapeseed meal based broiler diet could be beneficial..

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