Egyptian J. Anim. Prod. (1996) 33 (2): 125-144

EFFECT OF ENZYME SUPPLEMENTATIONS ON PERFORMANCE, CARCASS CHARACTERISTICS AND DIGESTA PASSAGE TIME OF BROILER CHICKS FED DIFFERENT CEREAL GRAINS

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SUMMARY

Two hundred and eighty eight unsexed, four- day old Hurbbard broiler chicks were distributed to 48 battery brooder of six chicks each and allocated to 12 dietary treatments, each replicated four times. Four cereal grains were used, in one of them corn was the major energy source, while in the other diets corn was completely replaced by local cereal grains, sorghum (Sorg), triticale (Trit) or barley (Barl) on weight : weight basis. Each diet had three sub-treatments. In two of them, Kemzyme (Kem) or Energex (Eng) was supplemented at 0.5 kg enzyme/ton diet. The third was the control without such enzyme preparations. Diets were fed from 4-45 days of age. Digesta passage time of the experimental diets were determined for two successive days during 2*nd* and 3*rd* wks of age.

Final body weight and overall body weight gain of chicks fed corn and sorghum based diets were significantly heavier than those fed barley containing diets. Overall feed conversion of corn fed groups were better than those fed sorghum, triticale and barley containing diets, with barley having the worst conversion.

A significant interaction between enzyme supplementation or type and cereal were noticed in final body weight and overall body weight gain, while only a significant interaction between enzyme type and cereal grain (energy source) was found in overall feed conversion ratio.

Abdominal fat, liver, gizzard, giblets, pancreas, spleen and gallbladder percentages were significantly affected by cereal grains. Significant interactions between cereal type and enzyme supplementa-tion were noticed in liver, giblets, pancreas and gallbladder percentages.

Barley had the greatest digesta passage time as compared with other cereals, whereas enzyme supplementation decreased digesta passage time, with significant cereal by enzyme supplementation interaction. Economic efficiency was ameliorated by using Kem in broiler diets specially when barley was fed.

Keywords: Broiler, feed enzyme, energy sources, performance, digesta passage, carcass characteristics

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INTRODUCTION

Partial or complete substitution of corn may be done by other cereal grains. Such substitution is needed to lower the feeding cost for poultry in Egypt. Triticale is a grain crop resulting from the intergeneric cross of durum wheat and rye. The crude protein content of triticale varies widely from 18.6 to 11.5 % (Fernandez *et al.*, 1973 and Ruiz *et al.*, 1987). Feeding studies indicate that triticale is competitive to wheat, maize, sorghum and barley as a cereal source in live stock diets (Sell *et al.*, 1962; Wilson and McNab, 1975; and Rao *et al.*, 1976).

Anti-nutritional factors, tannins, β-glucan and trypsin inhibitor and pentosan were found in sorghum, barley and triticale, respectively. These factors are known to impair growth and feed conversion of birds when the intake of any reach a certain level. Some enzyme preparations are known to have specific activities that could overcome such anti-nutritional factors and reduce gut viscosity (Bedford and Sheppy, 1995), act on cell wall content making available nutrients which remain protected by intact walls (Hesselman and Äman, 1986); or to increase nutrient digestibility and ME value of feedstuffs (Friesen *et al.*, 1992; Benabdeljelil, 1995). Due to limited supply of energy sources for poultry diets in Egypt, and to the increase in the availability of commercial enzyme preparations, using new enzyme biotechnology may help to eliminate the disadvantages found in unconventional feedstuffs (Makled, 1993).

This paper describes the utilization of different cereal grains, other than corn, as energy sources in broiler diets and the influence of two different commercial enzyme preparations on improving nutritive value of these cereals. Growth performance, carcass characteristics, economic efficiency, and digesta passage time were the studied parameters.

MATERIALS AND METHODS

Trial 1

This trial was carried out during January through March, 1995 at the Faculty of Agriculture in Damanhour. Twelve dietary treatments were randomly distributed in nested manner to 48 battery brooders (40x45x60cm) of six unsexed chicks each. One treatment included corn while in the three others it was completely substituted on weight : weight basis, by sorghum (Giza 15); triticale or barley in iso-caloric, iso-nitrogenous diets. Each cereal was fed without or with enzyme supplementation, using two different enzyme preparations [Kem or Eng] at the level recommended by their producing companies of 0.5 kg/ ton. Diet formulations and calculations are presented in Table (1). All diets were formulated to meet the nutrient requirements of broiler chicks based on tabulated values for feedstuffs (NRC, 1984). The experimental period was from 4 to 45 days of age, birds were fed grower diets from 4 to 30 days of age then switched to finisher diets from 31 to 45 days of age.

The chicks were weighed at 4, 31 and 45 days of age. Feed residuals were weighed at 16, 31 and 45 days of age. Feed conversion was calculated at 31 and 45 days of age. At 45 days of age, six broiler chicks from each treatment as 3 from each six

Table 1. Composition of the experimental diets.

Ingredients	Cereal energy source							
	Grower diets				Finisher diets			
	Corn	Sorg	Trit	Barl	Corn	Sorg	Trit	Barl
Yellow corn	62.00	.....	.....	.....	67.50	.....	.....	.....
Sorghum	.....	62.00	.....	.....	.....	67.50		.....
Triticale	.....	.....	62.00	.....	.....	.....	67.50	
Barley	.....	.....	.....	62.00	.....	.....	.....	67.50
Soya bean meal(44%)	24.30	21.10	19.17	20.17	17.05	13.40	11.56	14.85
Broiler Concent.[1,2]	10.00	10.00	10.00	10.00	7.000	7.000	7.000	7.000
Wheat bran	.....	.....	.....	.....	5.940	5.940	5.940	.....
Lime stone	0.600	0.160	0.600	0.500	0.350	.....	0.250	0.470
Bone meal	0.500	1.060	0.560	0.290	1.000	1.600	1.150	0.900
Poultry fat	.....	1.790	2.620	6.050	0.970	2.950	3.790	7.840
DL-methionine	0.090	0.152	0.118	0.129	0.060	0.133	0.090	0.098
L-lysine	......	0.110	.....	....	0.085	0.212	0.057	0.036
Sand[3]	2.510	3.628	4.932	0.861	0.045	1.265	2.663	1.306
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Calculated values								
ME kcal/ kg	2900	2900	2900	2900	3000	3000	3000	3000
Crude protein,%	21.35	21.40	21.30	21.27	18.01	18.00	18.00	18.00
Crude Fiber, %	3.51	3.34	4.25	5.00	3.17	3.44	4.46	4.79
Methionine, %	0.502	0.518	0.502	0.502	0.407	0.429	0.408	0.407
TSAA, %	0.813	0.813	0.865	0.821	0.676	0.680	0.733	0.686
Lysine, %	1.173	1.170	1.196	1.188	1.000	1.000	1.000	1.000
Ca, %	1.20	1.21	1.23	1.11	1.02	1.07	1.03	1.03
Available P, %	0.49	0.49	0.49	0.49	0.47	0.47	0.48	0.47
Cost/ton, L. E.[4]	737.3	738.5	703.0	707.6	684.9	687.0	643.8	646.5

1- Containing 52% cp, 2810 kcal/kg diet, 1.30 Meth., 1.8% TSAA, 3.12 lysine, 7.5% calcium, 3% available phosphorus and 3% NaCl and 1% Vit and mineral Mix.,

2- Vitamin and mineral mixture provides per kilogram of diet: vitamin A (as all-trans-retinyl acetate); 5,500 IU; vitamin E (all rac-α-tocopheryl acetate); 11 IU; menadione (as menadione sodium bisulfite); 1.1 mg; Vit. D_3, 1,100 ICU; riboflavin, 4.4 mg; Ca pantothenate,12 mg; nicotinic acid, 44 mg; choline chloride, 191 mg; vitamin B_{12}, 12.1 µg; vitamin B_6, 2.2 mg; thiamine (as thiamine mononitrate); 2.2 mg; folic acid, 0.55 mg; d-biotin, .11 mg. Trace mineral (milligrams per kilogram of diet): Mn, 60; Zn, 50; Fe, 30; Cu, 5; Se, 3.

3- Each of two enzyme supplements (Kemzyme or Energex) was added at 0.50 kg\ ton diet at the expense of sand or sand plus corn when sand was not adequate, in the finisher diecontained corn, which raised the cost of the enzyme treated diets by 15.5 L. E\ton.

4-Calculated according to the price of feed ingredients when the experiment was started. One Egyptian pound (L. E.)=0.294 U. S. Dollar.

were slaughtered for carcass evaluation according to the methods cited by Saleh *et al.* (1994).

The chemical analyses of the four experimental cereal grains were carried out according to A.O.A.C. (1980). The chemical analyses of corn, sorghum, triticale and barley are shown in Table (2). Triticale was the highest in crude protein, while corn was the lowest, with little difference between sorghum and barley. The crude protein content of triticale varied widely and ranged from 18.6 to 11.5 % (Fernandez *et al.*, 1973; Ruiz *et al.*, 1987). Whereas CP of sorghum ranged from 10 to 13%, with some varieties having 15 to 16% crude protein (Gualtieri and Rapaccini, 1990). The chemical composition of maize and sorghum are in general agreement with those reported by Sharma *et al.*(1979); Fayek and Mady (1989) and Sonbol and Abd-El-Baki (1992) and within the values reported by Gadallah (1994) for corn and barley.

Table 2. Chemical composition of the cereal grains used in diet formulations.

Ingredient	D M	C P	E E	C F	Ash	N F E	M E[1]
Yellow corn	90.40	8.76	3.20	2.00	1.60	74.84	3350
White sorghum	89.36	11.15	3.27	2.20	1.90	70.84	3212
Triticale	88.40	12.36	2.48	4.20	2.70	66.66	3163
Barley	91.00	11.60	1.85	6.50	4.60	66.45	2640

[1] Tabulated value from NRC, 1984.

Corn and sorghum had similar ether extractives, but higher than those of triticale and barley which were the least. Crude fiber and ash were higher in barley and triticale than those found in corn and sorghum, while NFE were higher in corn and sorghum than those of triticale and barley that had the least.

Trial 2

Rate of digesta passage of each diet was determined in two successive days during the *2nd* and *3rd* wks of age. Feed was removed for 2 h in the testing days and then was offered for 30 min. Experimental diets were supplemented with 1% chromium oxide as a nondigestible marker (Almirall and Esteve- Garcia, 1994). Droppings were checked every 15 minutes to determine first appearance of the marker. Time of offering the feed and the corresponding time of chromium oxide emergence within the fecal material were recorded for each replicate and digesta passage time was calculated by difference.

Statistical Analysis

A nested design was conducted using the GLM procedure of SAS (1985), where the main effects were the cereals, enzyme supplementation and type and the effect of enzyme supplementation (regardless of enzyme type) within cereal and the type of enzyme within cereal. Duncan's New Multiple Range Test, Duncan (1955) was used to test mean differences at P=0.05, when a significant P value was observed. All percentages were transformed to arc sine values. In the next sections, cereals, enzyme supplementation and type will be noticed irrespective of each other due to using nested design in analysis of variance.

RESULTS

1- Performance of broiler chicks

Performance of broiler chicks as affected by cereal grains, enzyme supplementation and enzyme type are shown in Tables (3 and 4). Initial body weight did not differ among the experimental groups. Body weight of 31- day old broilers showed significant effect of cereal grains and enzyme supplementation. Moreover, the interaction between enzyme supplementation and cereal were significant. Final body weight and overall body weight gain were significantly affected by cereals and the interactions between cereal and enzyme type.

Feed consumption during 4- 31 and 32-45 days of age were significantly affected only by cereals. Feed consumption for the whole experimental period showed insignificant differences due to the experimental treatments.

Significant effects of cereals, enzyme supplementation and enzyme type by cereal interactions were shown in feed conversion ratio during 4-31 days of age. During 32-45 days of age, significant effects of cereals, enzyme type and enzyme type by cereal interaction were observed. Feed conversion ratio for the entire experimental period, exhibited significant effects of cereals and cereal by enzyme type interaction.

2- Carcass characteristics

Data for carcass characteristics are presented in Tables (5 and 6). Abdominal fat, liver, gizzard, giblets, pancreas, spleen and gallbladder percentages were significantly affected by cereals. Significant interactions between cereal and enzyme supplementation were noticed in liver, giblets, pancreas, and gallbladder percentages.

3- Digesta passage time

Table (7) shows the effect of different cereal grains, enzyme supplementation and enzyme type on digesta passage time. The data indicated that chicks fed barley based diet had significantly greater digesta passage time than those fed diets based on other cereal grains. Whereas enzyme supplementation significantly decreased digesta passage time by 12.2%, with a significant cereal by enzyme supplementation interaction.

DISCUSSION

The results indicated that body weight and gain of chicks fed corn and sorghum grains were superior to those fed barley, with triticale being intermediate. Tannins in sorghum, β-glucan in barley (White *et al.*, 1983 and Hesselman and Äman, 1986) and trypsin inhibitor and pentosan in triticale (Madl and Tsen, 1974; Abdel-Gawad and Youssef, 1992) have been reported to possess anti-nutritional activity, but their effects depends on the intakes. Similar results were reported by Thakur *et al.* (1985) Lucbert and Castaing (1986); and Fayek *et al.* (1989) who found no difference in body weight and feed efficiency between maize and low tannin sorghum. Moreover, Thakur and Sharda (1974) found that chicks fed sorghum grew better than those receiving maize.

Table 3. Effect of enzyme type (Kemzyme or Energex) on performance of broiler chicks fed different cereal grains as energy sources

Parameters	Cereal energy source														
	Corn			Sorghum			Triticale			Barley			Aver. enz. type		SEM
	Treatments														
	Cont[1]	Kem[2]	Eng[3]	Cont[1]	Kem[2]	Eng[3]	Cont[1]	Kem[2]	Eng[3]	Cont[1]	Kem[2]	Eng[3]	Kem[2]	Eng[3]	
4-day of age	82.9	83.8	84.8	83.7	83.8	85.3	82.6	83.0	84.0	82.6	83.7	83.5	83.6	84.4	0.83
Average		83.8			84.3			83.2			83.3				
31-days age	1157.9	1189.4	1199.9	1117.8	1140.0	1210.0	1126.5	1074.3	1104.3	992.0	1151.0	1065.0	1138.7	1144.8	31.9
Average		1182.4^{a}			1155.9^{a}			1101.7^{b}			1069.3^{c}				
45-day of age	1886.1	1884.6	1892.1	1856.8	1856.7	1907.1	1839.0	1826.5	1801.5	1656.3	1889.0	1709.0	1864.2	1827.9	44.1
Average		1887.6^{a}			1873.5^{a}			1822.3^{ab}			1751.4^{b}				
Body weight gain, g from															
4-45 day of age	1803.2	1800.8	1807.3	1773.1	1772.9	1821.8	1756.4	1743.5	1717.5	1573.7	1805.3	1625.5	1780.6	1743.5	43.9
Average		1803.8^{a}			1789.2^{a}			1739.1^{ab}			1668.2^{b}				
Feed consumption, g from															
4-31 day of age	1907.5	1835.3	1850.3	1945.0	1955.0	1977.5	2013.8	1927.3	1949.8	1775.0	1852.3	1882.3	1892.5	1915.0	65.6
Average		1864.4^{ab}			1959.2^{a}			1963.6^{a}			1836.5^{b}				
32-45 day of age	1447.3	1434.5	1359.5	1436.8	1501.5	1514.0	1476.3	1465.8	1475.8	1550.0	1563.0	1585.5	1491.2	1483.7	51.2
Average		1413.8^{b}			1484.1^{ab}			1472.6^{b}			1566.2^{a}				
4-45 day of age	3354.8	3269.8	3209.8	3381.8	3456.5	3491.5	3490.1	3393.1	3425.6	3325.0	3415.3	3467.8	3383.7	3398.7	106.2
Average		3278.2			3443.3			3436.2			3402.7				
Feed conversion, g feed/g gain from															
4-31 days of age	1.773	1.656	1.655	1.884	1.852	1.757	1.930	1.957	1.921	1.951	1.736	1.918	1.800	1.813	0.054
Average		1.695^{c}			1.831^{b}			1.936^{a}			1.868^{ab}				
32-45 days of age	1.984	2.065	1.967	1.951	2.106	2.167	2.077	1.955	2.117	2.335	2.120	2.475	2.062	2.182	0.079
Average		2.005^{b}			2.075^{b}			2.050^{b}			2.310^{a}				
4-45 days of age	1.860	1.816	1.776	1.907	1.950	1.917	1.987	1.946	1.995	2.113	1.892	2.133	1.901	1.955	0.041
Average		1.817^{c}			1.925^{b}			1.976^{b}			2.040^{a}				

[1] Presented the unsupplemented group for each treatment.
[2] Presented group supplemented by Kemzyme at 0.5kg/ ton diet for each treatment.
[3] Presented group supplemented by Energex at 0.5kg/ ton diet for each treatment.
[abc] Means within a row with no common superscripts are differ significantly P=.05, based on Duncan's separation of means.

Table 4. Effect of enzyme supplementation on performance of broiler chicks fed different cereal grains as energy sources.

Parameters	Cereal energy source										
	Corn		Sorghum		Triticale		Barley				
	Enzyme level/kg diet								Enzyme average		
	0.00	0.50[1]	0.00	0.50[1]	0.00	0.50[1]	0.00	0.50[1]	0.00	0.50	SEM
Body weight, g at											
4-day of age	82.9	84.3	83.7	84.5	82.6	83.5	82.6	83.6	82.9	84.0	0.83
31-days age	1157.9	1194.7	1117.8	1175.0	1126.5	1089.3	992.0	1108.0	1098[b]	1141.8[a]	31.9
45-day of age	1886.1	1888.4	1856.8	1881.9	1839.0	1814.0	1656.3	1799.0	1809.6	1845.8	44.1
Body weight gain, g from											
4-45 day of age	1803.2	1804.1	1773.1	1797.3	1756.4	1730.5	1573.7	1715.4	1726.7	1761.8	43.9
Feed consumption, g from											
4-31 day of age	1907.5	1842.8	1945.0	.3	2013.8	1938.6	1775.0	1867.3	1910.3	1903.8	65.6
32-45 day of age	1447.3	1397.0	1436.8	1507.8	1470.8	1550.0	1574.3	1477.6	1477.6	1487.5	51.2
4-45 day of age	3239.8	3381.8	3474.1	3474.1	3490.1	3409.4	3325.0	3441.6	3387.9	3391.2	106.2
Feed conversion, g feed/g gain from											
4-31 day of age	1.773	1.656	1.884	1.805	1.930	1.939	1.951	1.827	1.885[a]	1.807[b]	0.054
32-45 day of age	1.984	2.016	1.951	2.137	2.077	2.036	2.335	2.298	2.087	2.122	0.079
4-45 day of age	1.860	1.796	1.907	1.934	1.987	1.971	2.113	2.013	1.967	1.928	0.041
Mortality rate, %											
Mortality, %	4.2	0.00	0.00	4.20	0.00	0.00	4.20	0.00	2.10	1.05	3.72
Average	2.10		2.10		0.00		2.10				

[1] Means are pooled of 4 groups of each enzyme type.

[ab] Means within a row with no common superscripts are differ significantly P=.05, based on Duncan's separation of means.

Table 5 Effect of enzyme type (Kemzyme or Energex) on carcass characteristics of broiler chicks fed different cereal grains.

Parameters	Cereal energy source														
	Corn			Sorghum			Triticale			Barley					
	Treatments												Aver. enz. type		
	Cont[1]	Kem[2]	Eng[3]	Cont[1]	Kem[2]	Eng[3]	Cont[1]	Kem[2]	Eng[3]	Cont[1]	Kem[2]	Eng[3]	Kem[2]	Eng[3]	SEM
Dressing. %	61.78	60.79	61.71	61.99	61.07	60.67	62.02	62.56	61.49	62.72	60.71	60.58	61.28	61.16	0.66
Average	61.43			61.24			62.02			61.34					
Breast, %	23.79	23.49	24.77	24.44	24.20	24.07	24.14	24.60	24.21	24.93	24.43	24.38	24.18	24.36	0.65
Average	24.02			24.24			24.32			24.58					
Thigh, %	21.82	20.56	20.94	21.71	21.63	21.51	21.82	20.68	20.35	21.32	22.03	21.98	21.23	21.20	0.65
Average	21.11			21.62			20.95			21.78					
Abdominal fat %	1.47	1.80	1.59	2.34	2.29	2.28	2.07	1.77	1.74	1.26	1.42	1.42	1.82	1.76	0.22
Average	1.62^{bc}			2.30^{a}			1.86^{b}			1.37^{c}					
Liver, %	2.441	2.304	2.282	2.239	2.144	2.133	2.176	2.516	2.476	2.567	2.473	2.466	2.359	2.339	0.11
Average	2.342^{a}			2.172^{b}			2.389^{a}			2.502^{a}					
Gizzard, %	2.174	2.399	2.166	2.095	1.940	1.929	2.111	2.259	2.223	2.105	1.960	1.956	2.140	2.069	0.09
Average	2.246^{a}			1.988^{b}			2.198^{a}			2.007^{b}					
Giblets, %	5.195	5.237	5.055	4.875	4.678	4.653	4.866	5.368	5.284	5.161	4.946	4.936	5.057	4.982	0.15
Average	5.162^{a}			4.735^{b}			5.173^{a}			5.014^{a}					
Pancreas, %	0.261	0.214	0.241	0.243	0.193	0.193	0.179	0.246	0.242	0.284	0.256	0.255	0.227	0.233	0.02
Average	0.239^{ab}			0.210^{c}			0.222^{bc}			0.265^{a}					
Spleen, %	0.155	0.113	0.146	0.132	0.121	0.120	0.143	0.156	0.153	0.193	0.183	0.182	0.143	0.150	0.02
Average	0.138^{b}			0.124^{b}			0.151^{b}			0.186^{a}					
Gallbladder, %	0.115	0.108	0.112	0.105	0.092	0.092	0.131	0.099	0.098	0.108	0.092	0.092	0.098	0.099	0.006
Average	0.112^{a}			0.096^{b}			0.109^{a}			0.097^{b}					

1 Presented the unsupplemented group for each treatment.
2 Presented group supplemented by Kemzyme at 0.5kg/ ton diet for each treatment.
3 Presented group supplemented by Energex at 0.5kg/ ton diet for each treatment.
abc Means within a row with no common superscripts are differ significantly P=.05, based on Duncan's separation of means.

Table 6. Effect of enzyme supplementation on carcass characteristics of broiler chicks fed different cereal grains.

Parameters	Cereal energy source										
	Corn		Sorghum		Triticale		Barley		Enzyme average		
	Enzyme level/kg diet										
	0.00	0.50[1]	0.00	0.50[1]	0.00	0.50[1]	0.00	0.50[1]	0.00	0.50	SEM
Dressing, %	61 78	61.25	61.99	60.87	62.02	62.03	62.72	60.65	62.13	62.20	0.66
Breast, %	23 79	24 13	24.44	23.14	24.14	24.41	24.93	24.41	24.33	24.27	0.65
Thigh, %	21.82	20.75	21.71	21.57	21.82	20.52	21.32	22.01	21.67	21.22	0.65
Abdominal fat %	1 47	1 70	2.34	2.29	2.07	1.76	1.26	1.42	1.79	1.79	0.22
Liver, %	2.441	2.293	2.239	2.139	2.176	2.496	2.567	2.470	2.356	2.349	0.11
Gizzard, %	2 174	2.283	2.095	1.935	2.111	2.241	2.105	1.958	2.121	2.105	0.09
Giblets, %	5.195	5.146	4.875	4.666	4.866	5.326	5.161	4.941	5.024	5.020	0.15
Pancreas, %	0.261	0.228	0.243	0.193	0.179	0.244	0.284	0.256	0.242	0.230	0.02
Spleen, %	0.155	0.130	0.132	0.121	0.143	0.155	0.193	0.183	0.156	0.147	0.02
Gallbladder, %	0.115	0.110	0.105	0.092	0.131	0.099	0.108	0.092	0.115^a	0.099^b	0.006

[1] Means are pooled of 4 groups of each enzyme type.

[ab] Means within a row with no common superscripts are differ significantly P=.05, based on Duncan's separation of means

Table 7. Digesta passage time of broiler chicks fed different cereal grains supplemented with different enzyme preparations.

Parameters	Cereal energy source: Corn, Enzyme level/kg diet 0.00	Corn 0.50*	Sorghum 0.00	Sorghum 0.50*	Triticale 0.00	Triticale 0.50*	Barley 0.00	Barley 0.50*	Enzyme average 0.00	Enzyme average 0.50	SEM
Digesta passage time, min											
Time, Min	134.4	124.9	138.1	132.8	144.2	122.3	165.9	131.3	145.6[a]	127.8[b]	0.099

	Enzyme type: Corn Cont[1]	Corn Kem[2]	Corn Eng[3]	Sorghum Cont[1]	Sorghum Kem[2]	Sorghum Eng[3]	Triticale Cont[1]	Triticale Kem[2]	Triticale Eng[3]	Barley Cont[1]	Barley Kem[2]	Barley Eng[3]	Aver. enz. type Kem[2]	Aver. enz. type Eng[3]	SEM
Body weight gain, g from															
Time, Min	134.4	125.0	124.8	138.1	132.8	132.8	144.2	122.3	123.3	165.9	122.6	139.9	125.7	130.2	0.099
Average	128.1[b]			134.6[ab]			129.9[b]			142.8[a]					

* Means are pooled of 4 groups of each enzyme type.

[1] Presented the unsupplemented group for each treatment.

[2] Presented group supplemented by Kemzyme at 0.5kg/ ton diet for each treatment.

[3] Presented group supplemented by Energex at 0.5kg/ ton diet for each treatment.

[ab] Means within a row with no common superscripts are differ significantly P=.05, based on Duncan's separation of means.

Table 8. Economic efficiency of broiler chicks fed different cereal grains supplemented with different enzyme preparations.

Parameters	Cereal energy source														
	Corn			Sorghum			Triticale			Barley			Average Treatment		
	Treatments														
	Cont[1]	Kem[2]	Eng[3]	Cont[1]	Kem[2]	Eng[3]	Cont[1]	Kem[2]	Eng[3]	Cont[1]	Kem[2]	Eng[3]	Cont[1]	Kem[2]	Eng[3]
Cost of feeding[4*]	239.1	238.6	234.5	242.3	252.9	255.5	236.6	235.1	237.4	225.8	237.4	241.1	235.9	241.0	242.1
Average	237.4			250.2			236.4			234.8					
Total cost[5*]	479.1	478.6	474.5	482.3	492.9	495.5	476.6	475.1	477.4	465.8	477.4	481.1	475.9	481.0	482.1
Average	477.4			490.2			476.4			474.8					
Selling income[6*]	721.3	720.3	722.9	709.2	709.1	729.5	702.5	697.4	687.0	629.5	722.1	650.2	690.6	712.2	697.4
Average	721.5			715.9			695.6			667.3					
Net income[7*]	242.2	241.7	248.4	226.9	216.2	234.0	225.9	222.3	209.6	163.7	244.7	169.1	214.7	231.2	215.3
Average	244.1			225.7			219.3			192.5					
Economic effi.[8*]	50.6	50.6	52.3	47.1	43.9	47.2	47.4	46.8	43.9	35.1	51.3	35.1	45.1	48.1	44.6
Average	51.1			46.1			46.0			40.5					

1 Presented the unsupplemented group for each treatment.
2 Presented group supplemented by Kemzyme at 0.5kg/ ton diet for each treatment.
3 Presented group supplemented by Energex at 0.5kg/ ton diet for each treatment.
* calculated by P. T.
4 Total feed consumption x price of kg feed.
5 Cost of feeding+ fixed cost (240 P. T./ chick) including price of chicks, medication, care, labor, vaccination, water, electricity,
6 Body weight gain x price of kg live body weight of broiler.
7 Differences between selling income and total cost.
8 As relative to total cost.

There were numerical insignificant decreases in body weight of broiler chicks fed triticale than those fed corn at 31 and 45 days of age. This result agreed with those reported by Reddy *et al.* (1979) who found that triticale was inferior to maize as a source of energy. Similar results were also reported by Ruiz *et al.* (1987) using Beagle triticale. The results reported by Sell *et al.* (1962) on chicks and Hale (1984) on pigs showed no adverse effect of triticale in growth performance. Rao *et al* (1976) found that replacement of up to 75% of maize by triticale had no adverse effect on body weight gain and feed efficiency. Furthermore, Bragg and Sharby (1970) found that triticale could replace wheat in broiler diets without adverse effect on growth and feed efficiency. In concern with the current results, Rose and Arscott (1962); Gadallah (1994) and Saleh *et al.* (1994) found that barley containing diets decreased body weight and efficiency of feed utilization of broiler chicks.

Broz and Frigg (1986) and Hesselman and Äman (1986) reported that feeding barley based diet to broiler chicks reduced feed intake, but β- glucanase supplementation overcame this decrease. This may be due to faster gut clearance when enzymes were supplemented. The current results showed similar effect during 4-31 days of age and this was diminished thereafter. For the entire experimental period, insignificant differences were found in feed consumption among cereal grains, although chicks fed sorghum, triticale and barley seemed to consume more feed, this might be due to the fact that actual ME values of cereal grains were lower than those calculated based on NRC (1984) and/ or ME value of corn was higher than that calculated. It is very well known that chickens eat to satisfy their energy requirements. Better feed conversion values were recorded by chicks fed corn followed by a decreasing order of those fed sorghum and triticale, while those fed barley exhibited the poorest. Similar results were reported by Fayek *et al.* (1989) on sorghum, Gadallah (1994) and Saleh *et al.* (1994) on barley and Proudfoot and Hulan (1988) on triticale.

Although plant diets are expected to be affected more by enzyme supplementation, practical diets were chosen in this experiment due to their common use in feeding broilers in Egypt. Only significant effect of enzyme supplementation was shown on body weight of 31day old chicks, in which enzyme supplementation improved weight gain and feed conversion significantly by 4.0 and 4.1%, respectively. Significant interactions between enzyme supplementation or type and cereal grains were shown in overall body weight gain and feed conversion. The results indicated that enzyme supplementation ameliorated both parameters of chicks fed diets containing corn, sorghum or barley during 4-31 days of age (Table 4).

Overall feed conversion of chicks fed corn and barley-containing diets was enhanced as a result of enzyme supplementation by 3.4 and 4.7%, respectively. These enhancements were due to supplementation of Eng to corn (4.5%) and Kem to triticale (2.1%) and barley (10.5%) containing diets as compared to their unsupplemented counterpart groups. Kem mixture contained, α-amylase, β-glucanase, cellulase, lipase and protease enzymes. These enzymes could be the cause of this enhancement. These enzymes have been reported to have a positive influence on bio-availability and liberation of nutrients from cell walls, reduced gut viscosity and increased nutrient absorption; subsequently, improved performance was shown. Similarly Jensen *et al.* (1957); Willingham *et al.* (1959); Hesselman and Äman (1986); Rotter *et al.* (1989) and Friesen *et al.* (1992) indicated that the improvement in nutritive value by enzyme supplementation to barley containing diets coincided with greater digestion and absorption of starch, protein and fat and this enrichment depended on inclusion rate of grain in the diet. Additionally, Gadallah (1994) reached a similar conclusion.

Eng is a multi-enzyme which hydrolyses abroad range of carbohydrate polymers and containing cellulase and improves the overall utilization of energy sources especially when pentosan and hemicellulose containing cereals are incorporated in poultry diets. Ghazalah *et al.* (1994) found that Eng plus Bio-feed(pro) improved growth and feed conversion of broiler chicks fed sorghum and corn containing diets only during the first four weeks of age, and this improvement based on type of diets and age of birds. Salih *et al.* (1991) showed that the effectiveness of β-glucans on birds was affected by their age and the magnitude of the response decreased with age. This finding indicates that adult birds have a sufficiently developed gastrointestinal tract to neutralize the negative effects of the β-glucans reported in barley. Almirall and Esteve-Garcia, (1994) reached similar conclusion. Enzyme supplementation are expected to increase ME value of sorghum-, triticale- and barley- based diets. Similarly, Friesen *et al.* (1992) and Benabdeljelil (1995) found that enzyme supplementation improved ME value of wheat, barley, oats and rye by different percentages.

The improvement in feed conversion as a result of enzyme supplementation during 4-31 days of age, and that of corn and barley containing diets for the entire experimental period indicates that the response to enzyme supplementation depends on the presence of target substance, i.e high fiber containing diets or anti-nutritional factors and age of birds. Similarly, Willingham *et al* (1959); Rotter *et al.* (1989); Brake (1992); El- Faham *et al.* (1994) and Ghazalah *et al.* (1994) showed a significant improvement in feed conversion ratio due to enzyme supplementation. The absence of enzyme supplementation effect on growth and feed conversion of broiler chicks fed triticale containing diet, may be due to lack of target substance, although water insoluble pentosan and trypsin inhibitor have been reported (Madl and Tsen, 1974 and Abdel-Gawad and Youssef, 1992). However, pancreas enlargement was not shown (Table 5 and 6). This result was in agreement with those reported by Ried (1984) who did not find any improvement in feed conversion as a result of enzyme supplementation to milo-soya diet. Additionally, Mohamed and Hamza (1991) found insignificant effect of Eng plus Bio-feed(pro) on growth and feed conversion of broiler chicks fed corn-soy diet. From the data shown in Table (3); the proper enzyme for each cereal grain should be chosen for improving performance of broiler chicks based on anti-nutritional factor(s) found and the target substance in each feedstuff.

The greater improvement in feed conversion showed with Kem treatment could be due to its contents of lipase and protease enzymes as compared with Eng. Gadallah (1994) and Attia *et al.* (1995) found an improvement in protein and lipid digestion due to Kem treatment. Makled (1993) reported that multi-enzyme rather than single or couple once may have a greater influence due to the synergetic effects among different enzymes. Additionally, Bedford and Sheppy (1995) reported that addition of lipase and protease to wheat- based diets improved performance of broiler chicks and indicated that increasing the concentration of pancreatic enzyme activities such as amylase, lipase and protease can help to overcome constraints.

Due to different experimental treatments, differences in dressing, breast and thigh percentage were not significant (Table 5). The results were in general agreement with those reported by Reddy *et al.* (1979); Fayek *et al.* (1989); Sonbol and Abd- El-Baki (1992) and Gadallah (1994). Emmanuel and Jeong (1989) and Wyatt and Goodman (1992) found that enzyme supplementation had no beneficial effect on carcass characteristics. Ghazalah *et al.* (1994) showed similar results. Abdominal fat was found to be affected by cereal grains in which those fed barley containing diet had the least and group fed sorghum based diets exhibited the highest. Benabdeljelil (1995) reported a similar result. Liver, gizzard and giblets percentages were affected by different cereal grains, the results showed that the lightest relative weights of liver, gizzard and giblets were from those fed sorghum containing diets, with no differences among the rest of the treatments. Also, Nir *et al.* (1994) found that corn fed chicks had heavier empty gizzard than those of wheat and sorghum.

No constant trend was seen in pancreas tissues, since groups fed corn containing diet had similar pancreas percentage to those fed barley and triticale, the latter group did not differ from those fed sorghum containing diets. Spleen enlargement was observed only on barley fed groups. Gadallah (1994) found similar results. This may be due to the change in the gastrointestinal microorganisms associated with feeding barley. Hofshagen and Kaldhusdal (1992) found an increased number of *Clostridium perfringens* in the intestinal of young chicks fed barley based diets. Stutz and Lawton (1984) observed a growth depression in connection with increased numbers of *Clostridium perfringens* and an antibiotic could overcome it (Schurz and Jeroch, 1994). Gallbladder percentage of sorghum and barley containing diets were the lightest, while those of groups fed corn or triticale were the heaviest.

Significant interactions between enzyme supplementation and cereal were found in pancreas, gallbladder, liver and giblet percentages. The data indicated that pancreas percentage was decreased by enzyme supplementation to all cereal grains except that from triticale which showed enlargement. The same was also true in liver and giblets percentages. Similarly, Dworkin *et al.* (1976) showed that the structure and function of the small intestine can be significantly modified by dietary manipulation. Along the same line, Ritz *et al.* (1995a) found that villus length within the jejunum, and the ileum was significantly increased at 2 and 3 wks of age by amylase supplementation when compared with the control and xylanase diets. This was coincided with better absorption of nutrients, feed utilization, and body weight gain (Ritz *et al.*, 1995b). Isaksson *et al.* (1982); Fingler and Marquardt (1988) showed that soluble fibers were found to inhibit the activities of lipase, amylase and trypsin *in vitro* studies.

The adaptative response found in , gallbladder, liver and giblets to enzyme supplementation agreed with the results found by Brenes *et al.* (1993) and Gadallah (1994) in gastrointestinal tract, pancreas and spleen. Moran (1985) reported that birds could adjust for changing in diet, particularly dietary starch, by altering the amount of amylase secreted from the pancreas and by altering intestinal surface area. Mohamed and Hamza (1991) showed similar results.

When barley was fed, the increase in digesta passage time and its decrease with enzyme supplementation, confirmed the results reported by Gohl (1977); Fengler and Marquardt (1988); Pettersson and Äman (1989) and Hamdy *et al.* (1995) who showed that barley and wheat containing diet had higher viscosity of digesta and enzyme supplementation decreased it. β-glucan of barley and pentosan of wheat, rye and triticale were linked with higher digesta viscosity. Enzyme supplementation has been shown to have direct effect on the viscosity of digesta by decreasing the amount of non-starch polysaccharides within barley, wheat, triticale and rye (Graham *et al.* 1993); and these coincided with increasing crude fat and crude protein digestibility when β-glucanase was added (Almirall *et al.*, 1993). Kem treatment decreased digesta passage time of barley and triticale and improved feed conversion of both ingredients by different magnitudes. In the literature, there was an apparent correlated negative response between viscosity of digesta and performance of broiler chicks (White *et al.*, 1983 and Bedford and Sheppy, 1995).

Data for economic evaluation are summarized in Table (8). These data are based on the recent prices of local market for feed ingredients and selling price of live broiler chickens. There were considerable saving cost\ ton diet and in actual feeding cost when triticale or barley cereals were used. Enzyme supplementation raised the cost/ ton feed by 15.5 L. E. as compared to un-supplemented diets. Net income of the two enzyme preparations (return- feeding cost) were better than that of untreated diets, with that of Kem groups were better than Eng groups. The greatest improvement was shown when barley was treated by Kem. This emphasized the role of selecting the appropriate enzyme for each cereal grain to improve performance and economic efficiency.

Economic efficiency percentage of barley treated by Kem was similar to chicks fed corn based diet. The results indicated that sorghum and triticale provided similar economic efficiency, but lower than that of corn. However, untreated sorghum or triticale could be fed when corn is in short supply in Egyptian markets. There are several times during the year when corn gets scarce and its price goes up by about 25%. When barley is available it could be used as energy source in broiler diet considering proper enzyme supplementation. Gadallah (1994) and Ghazalah *et al.* (1994) reported that enzyme supplementation improved economic efficiency when used in the broiler diets containing barley or sorghum.

This study along with others, Gadallah (1994), and Ghazalah *et al.* (1994) demonstrated the role of enzyme supplementation in improving nutritive value and performance of broilers when the target feed ingredient was found. The results also indicated that sorghum and triticale may be useful feedstuffs in broiler diets.

REFERENCES

Abdel-Gawad, A. S., and M. K. E. Youssef, 1992. Comparative studies on the pentosan levels in intact and fractionated wheat and triticale. Pages 66-76 in 2nd Alex. Conf. Fd. Sci. Tech. Alexandria, Egypt.

Almirall, M., and E. Esteve-Garcia, 1994. Rate of passage of barley diets with chromium oxide: Influence of age and poultry strain and effect of β-gluncanase supplementation. Poultry Sci. 73: 1433-1440.

Almirall, M., J. Brufau, and E. Esteve-Garcia, 1993. Effects of intestinal viscosity on digestive enzyme activities at different ages supplemented with β-glucanases. Pages 69-72 in: Enzymes in animal nutrition. C. Wenk and M. Boessinger, ed. Institut für Nutztierwissenschaften, Zurich, Switzerland.

Association of Official Analytical Chemists, (A.O.A.C), 1980. Methods of analysis. 13th edition, Assoc. Offici. Anal. Chem., Arlington, USA.

Attia, Y. A., M. Osman, M. Saleh-EL-Din, 1995. Effect of enzyme mixture treatment on performance and nutrient digestibilities of Alexandria layers fed diets containing different levels of whole rice milling by product. In Proc. First Egyptian Hungarian Poultry Conference, Alex. Egypt. Spet. 1995, Pages 322-338 .

Bedford, M., and C. Sheppy, 1995. How enzymes improve the nutritional value of wheat in poultry diets. Poultry international -Sept. 1995: 92-93.

Benabdeljelil, K., 1995. Influence of an enzyme mixture added to barley based diets on broiler performance. Poultry Sci 74: (supplementary 1), 126. (Abstr.).

Bragg, D. B., and T. F. Sharby, 1970. Nutritive value of triticale for broiler chick diets. Poultry Sci. 49: 1022-1027.

Brake, J. T. 1992. Egg production of broiler breeders increases when fed diets containing commercial enzyme preparations-possible method to improve performance in hot climates. Proceeding 19th World's Poultry Congress Amsterdam, 3: 416-418.

Brenes, A., M. Smith, W. Guenter, and R. R. Marquardt, 1993. Effect of enzyme supplementation on the performance and digestive tract size of broiler chickens fed wheat-and barley-based diets. Poultry Sci. 72: 1731-1739.

Broz, J., and M. Frigg, 1986. Effects of beta-glucanase on the feeding value of broiler diets based on barley or oats. Arch. Geflügelkd. 5: 41-47.

Duncan, D. B., 1955. The multiple Range and F. Testes. Biometrics. 11.1-45.

Dworkin, L. D., G. M. Levine, J. J. Farber, and N. H. Spector, 1976. Small intestine mass of the rat is partially determined by indirect effects on intraluminal nutrition. Gastroenterology 71: 626-630.

El-Faham, A. I., S. A. Ibrahim and N. A. Hattaba, 1994. Effects of Kemzyme or Biosavor on the performance of growing chickens. In Proc. The Second Scientific Conf. on Poultry, Kafr El-Sheikh, Egypt, Sept, 1994, Pages 166-183.

Emmanuel, N., and J. Jeong, 1989. Barley and full - fat canola seed in broiler diets. Poultry Sci. 68: 1374-1380.

Fayek, H. M. and Y. A. Mady, 1989. Protein quality of Egyptian and imported sorghum grains as compared to yellow corn. Egypt. Poultry Sci. 9: 115-131.

Fayek, H. M., Y. A. Mady, and M. S. Shulkamy, 1989. Incorporation of Egyptian sorghum grains in broiler diets. Egypt. Poultry Sci. 9: 99-114.

Fengler, A. I., and R. R. Marquardt, 1988. Water soluble pentosans form rye 1 Isolation, partial purification and characteristics. Cereal Chem. 65: 291-297.

Fernandez, R., S. M. Kim, J. L. Buenrostro, and J. McGinnis, 1973. Triticale and rye as main ingredients in diets for laying hens. Poultry Sci. 52: 2244-2252

Friesen, O. D., W. Guenter, R. R. Marquardt, and B. A. Rotter, 1992. The effect of enzyme supplementation on the apparent metabolizable energy and nutrient digestibilities of wheat, barley, oats and rye for young broiler chick, Poultry Sci. 71: 1710-1721.

Gadallah, A. G., 1994. Improvement of the nutritional value of barley and wheat by enzyme supplementation in broiler diets. Ph. D. Fac. of Agr. Alex. Univ. Egypt.

Ghazalah, A. A., O. M. El-Husseiny, H. M. Fayek, and S. Abou El-Wafa, 1994. Influence of Enzyme preparations and Growth promoters on broiler performance. In Proc. The Second Scientific Conf. on Poultry, Kafr El-Sheikh, Egypt, Sept, 1994, Pages 140-165.

Gohl, B., 1977. Influence of water treatment of barley on digestion process in rats. Z. Tierphysiol. Tierernähr. Futtermittelkd. 39: 57-67.

Graham, H., M. Bedford, and M. Choct, 1993. High gut viscosity can reduce poultry performance. Feedstuffs, February 1, 1993: 14-15.

Gualtieri, M., and S. Rapaccini, 1990. Sorghum grain in poultry feeding. World's Poultry Sci. J. 46: 246-254.

Hale, O. M., 1984. Performance of fed grain sorghum and Beagle 82 triticale diets. Pages 135-146. In: Georgia Nutr. Conf. USA.

Hamdy, S. M., A. A. Asar, A. A. El-Deek, Y. A. Attia, and G. Gadallah, 1995. Enzymes as a tool for improving the nutritional value of barley and wheat in broiler diets. Poultry Sci 74: (supplementary 1), 19. (Abstr.).

Hesselman, K, and P. Äman. 1986. The effect of β-glucanase on the utilization of starch and nitrogen by broiler chickens fed on barley of low and high viscosity. Animal Feed Science and Technology, 15: 83-93.

Hofshagen, M., and M. Kaldhusdal, 1992. Barley inclusion and avoparcin supplementation in broiler diets. 1-Effect of small intestinal bacterial flora and Performance. Poultry Sci. 71: 959-969.

Jensen, L. S., R. E. Fry, J. B. Allred, and J. McGinnis, 1957. Improvement in the nutritional value of barley for chicks by enzyme supplementation. Poultry Sci. 36: 919-921.

Isaksson, G., I. Lundquist, and I. Ihse, 1982. Effect of dietary fiber on pancreatic enzyme activity in vitro: The importance of viscosity, pH, ionic strength, absorption and time of incubation. Gastroenterology 82: 918-924.

Lucbert, J., and J. Castaing, 1986. Utilisation de sorghos differentes teneurs en tannins pour l' alimentation des poulets de chair. Proceedings 7th European Poultry Conference 1: 472-476.

Madl, L. R., and C. C. Tsen, 1974. Trypsin and chymotrypsin inhibitor in triticale. In triticale: First Man-Made Cereal. Washington, The American Association of Cereal Chemists, Inc, USA.

Makled, M. N., 1993. Enzyme as poultry feed supplement. In 4th Symp. Anim. Poult. & Fish Nutri., El-Fayoumi, Egypt, Pages 5-9.

Mohamed, M. A., and A. S. Hamza, 1991. Using enzyme preparations in corn-soybean meal broiler rations. Egypt. J. Anim. Prod. Vol., 28: (2) 245-254.

Moran, E. T., Jr., 1985. Digestion and absorption of carbohydrates in fowl and events through perinatal development. J. Nutr. 115: 665-674

National Research Council, (NRC), 1984. Nutrient requirements of Poultry. 8 th ed. National Academy of Sci. Washington , D. C., USA

Nir, I., R. Hillel, G. Shefet, and Z. Nitsan, 1994. Effect of grain particle size on performance 2-Grain texture interactions. Poultry Sci. 73: 781-791.

Pettersson, D., and P. Äman, 1989. Enzyme supplementation of a poultry diet containing rye and wheat. Br. J. Nutr. 62: 139-149

Proudfoot, F. G., and H. W. Hulan, 1988. Nutritive value of triticale as a feed ingredient for broiler diet. Poultry Sci. 67: 1743-1749.

Rao, D. R., W. M. Johnson, and G. R. Sunki, 1976. Replacment of maize by triticale in broiler diets. Br. Poultry Sci., 17: 269-274.

Reddy, N. V., D. R. Rao, and G. R. Sunki, 1979. Comparison of maize, wheat and triticale in broiler diets. Br. Poultry Sci., 20: 357-362.

Reid, B. L., 1984. Enzyme and laying hen performance. Final report. Animal Science Department, Univ. of Arizona, USA.

Ritz, C. W., R. M. Hulet, B. B. Self, and D. M. Denbow, 1995a. Growth and intestinal morphology of male turkeys as influenced by dietary supplementation of amylase and xylanase. Poultry Sci. 74: 1329-1334.

Ritz, C. W., R. M. Hulet, B. B. Self, and D. M. Denbow, 1995b. Effects of protein level and enzyme supplementation upon growth and rate of digesta passage of male turkeys. Poultry Sci. 74: 1323-1328.

Rose, R. J., and G. H. Arscott, 1962. Use of barley in High-efficiency broiler rations. 5-Further studies on the use of enzymes, soaking and pelleting barley for chicks. Poultry Sci. 41: 124-130.

Rotter, B., M. Neskar, R. Marquardt, and W. Guenter, 1989. Effects of different enzyme preparations on the nutritional value of barley in chicken diets. Nutr. Rep. Int. 39: 107-120.

Ruiz, N., J. E. Marion, R. D. Miles, and R. B. Barnett, 1987. Nutritive value of new cultivars of triticale and wheat for broiler chick diet. Poultry Sci. 66: 90-97.

Saleh, K., Y. A. Attia, and H. Younis, 1994. Partial replacement of the dietary energy and protein sources by local feedstuffs and its effects on the broiler performance. In Proc. The Second Scientific Conference on Poultry. Kafr El-Sheikh, Egypt, Sept. 1994, Pages 222-241.

Salih, M. E., H. L. Classen, and G. L. Campbell, 1991. Response of chickens fed on hull-less barley to dietary β-glucanase at different ages. Anim. Feed. Sci. Tech. 33: 139-149.

SAS Institute, 1985. SAS® User's Guide: Statistics. Version 5 Edition. SAS Institute Inc., Cary, NC., USA.

Schurz, M., and H. Jeroch, 1994, In Proc. 9th European Poultry Conf., Glasgow, UK, Aug. Pages 441-442.

Sell, J. L., G. C. Hodgson, and J. H. Shebeski, 1962. Triticale as a potential component of chick ration. Can. J. Anim. Sci. 42: 158-166.

Sharma, B. D., V. R. Sadagopan, and V. R. Reddy, 1979. Utilization of different cereals in broiler diets. Br. poultry Sci., 20: 371-378.

Sonbol, S. M., and S. M. Abd-El-Baki, 1992. Cassava as a new animal feed in Egypt 4- Influence of cassave meal, white corn and sorghum grains as substitutes for yellow corn in broiler diets. Egypt. J. Appl. Sci., 7(12): 937-951

Stutz, M. W., and G. C. Lawton, 1984. Effects of diet and antimicrobials on growth, feed efficiency, intestinal Clostridium perfringens, and ileal weight of broiler chicks. Poultry Sci. 63: 2036-2042.

Thakur, R. S., and D. P. Sharda, 1974. Studies on replacing maize with sorghum in broiler chicks. Journal of Research, HAU, 4: 236-241.

Thakur, R. S., P. C. Gupta, and G. P. Lodhi, 1985. Comparative efficiency in different sorghum varieties in broiler diets. Indian Journal of Animal Nutrition 2: 87-88.

White, W. B., H. R. Bird, M. L. Sunde, J. A. Marlett, N. A. Prentice and W. C. Burger, 1983. Viscosity of β-D-glucan as a factor in the enzymatic improvement of barely for chicks. Poultry Sci., 62: 853-862.

Willingham, H. E., L. S. Jensen, and J. McGinnis, 1959. Studies in the role of enzyme supplementation and water treatment for improving the nutritional value of barley. Poultry Sci. 38: 539-544.

Wilson, B. J., and J. M. McNab, 1975. The nutritive value of triticale and rye in broiler diets containing field beans (Vicia faba L.). Br. Poult. Sci., 16: 17-22.

Wyatt, C., and T. Goodman, 1992. Performance and carcass composition of broilers fed a barley -corn diet supplemented with an enzyme preparation. Poult. Sci. 71 (Supplementary 1): 185 (Abstr.)

تأثير الإضافات الإنزيمية على صفات النمو والذبيحة ومعدل مرور الغذاء بالقناة الهضمية لكتاكيت اللحم المغذاه على أنواع مختلفة من الحبوب

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١ قسم الإنتاج الحيواني و الدواجن - كلية الزراعة بدمنهور - جامعة الإسكندرية ٢ قسم الدواجن - كلية الزراعة شبين الكوم - جامعة المنوفية

أجريت هذه الدراسة على عدد ٢٨٨ من كتاكيت اللحم - سلالة هبرد - الغير مجنسة عمر أربعة أيام ووزعت عشوائيا على ٤٨ قفص ببطاريات تسمين بكل واحد منها ٦ كتاكيت . قسمت الأقفاص إلى ١٢ معاملة غذائية في كل واحدة ٤ مكررات .

وقد استخدمت أربعة أنواع من الحبوب أولها الذرة الصفراء كمصدر رئيسي للطاقة بينما استخدم في العلائق الأخرى كل من السورجم الأبيض والتريتكال والشعير وذلك بأن يحل كل واحد منها محل الذرة كليا وزنا بوزن .ثم قسمت كل واحدة من المعاملات الأربعة إلى ثلاث مجموعات فرعية . اثنان منهم تم إضافة نوعين من الأنزيمات إليهما والثالثة بدون إضافة واعتبرت كمجموعة مقارنة .

استمرت التجربة من عمر ٤ إلى ٤٥ يوم ، كما تم تقدير معدل مرور الغذاء بالقناة الهضمية لجميع المعاملات أثناء الأسبوع الثاني والثالث من العمر .

وأوضحت الدراسة النتائج الآتية :

١- كانت الزيادة الوزنية الكلية ووزن الجسم النهائي في الطيور التي غذيت على الذرة أو السورجم الأبيض أعلى معنويا من تلك التي غذيت على الشعير ، بينما لوحظ عدم أختلاف المجموعة التي غذيت على التريتكال معنويا عن باقي المجاميع بغض النظر عن إضافة الأنزيم أو نوعه .

٢- سجلت الطيور التي غذيت على الذرة أفضل معدل لكفاءة الغذائية بينما التي غذيت على الشعير أسوأ معدل بغض النظر أيضا عن إضافة الأنزيم أو نوعه .

٣- كان التداخل بين الإضافة الأنزيمية ونوع الأنزيم ونوع الحبوب معنويا بالنسبة لوزن الجسم والزيادة الوزنية وكان التداخل بين نوع الأنزيم ونوع الحبوب معنويا بالنسبة للكفاءة الغذائية الكلية .

٤- تأثرت النسبة المئوية لدهن البطن و القونصه والحلويات والبنكرياس والطحال والحويصلة المرارية معنويا بنوع الحبوب وبغض النظر عن المعاملات الأنزيمية ، وكان التداخل بين نوع الحبوب والإضافة الأنزيمية معنويا في نسب الكبد والحلويات والبنكرياس والحويصلة المرارية .

٥- كان معدل مرور الغذاء بالقناة الهضمية في الطيور المغذاه على الشعير أكبر من باقي المجاميع بغض النظر عن الإضافة الأنزيمية والتي ادت إلى تقليل معدل المرور في جميع المعاملات .

٦- كان التداخل بين نوع الحبوب والاضافة الأنزيمية معنويا بحيث أدت إضافة الكيمزيم الى تقليل وقت مرور الغذاء المحتوى على الشعير .

٧- أدى استخدام المخلوط الأنزيمى كيمزيم إلى تحسين الكفاءة الاقتصادية خاصة عند استخدام الشعير في علائق كتاكيت اللحم