The Use of High-oil Corn in Young Broiler Chicken Diets

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ABSTRACT : The objective of this study was to measure performance of young broiler chickens fed three varieties of high-oil corn (HOC 1, 2, and 3) compared with eight varieties of normal corn (NC). HOC varieties contained about 80% more oil than NC (average crude fat; 6.71% vs 3.72%) and about 29% more protein (average CP; 9.54% vs 7.38%). Each experimental diet was formulated with the same amount (55.205%) of each corn hybrid. Experiment 1 had by six dietary treatments (HOC1 and five NC varieties, 360 chickens) and Experiment 2 had five treatments (HOC2, HOC3, and three NC varieties, 250 chickens). In Exp. 1, for feed efficiency (F/G), the treatment contained HOC1 had better performance ($p<0.05$) than other NC varieties except NC5. As expected, there was no significant difference in average daily feed intake ($p>0.05$) among dietary treatments. The dietary treatment of HOC1 gave an improvement of 4.3% in F/G that came from 6% higher gross energy (GE) value of HOC1. Compared with Exp. 2, the dietary treatments contained HOC hybrids gave 4.4% higher F/G than NC dietary treatments, which came from a 5% increase in GE value. HOC varieties had superior nutrients content to NC for poultry, due to the fact that HOC contained higher concentrations of energy, protein, lysine, and methionine, thus improving growth and F/G. ***(Asian-Aust. J. Anim. Sci. 2003. Vol 16, No. 6 : 880-883)***

Key Words : Broiler Chicken, High-Oil Corn, Growth Performance

INTRODUCTION

In most areas of North America corn is the predominant source of energy in poultry feeds mainly because of its abundance, low cost and highly digestible. The variations in corn grain composition caused by genetic, agronomic and managerial factors are of concern to nutritionists in the poultry industry. Improving the nutritional value of corn through genetic alternation has become of great interest to poultry producers (Saleh et al., 1997). The published research regarding the utilization of high-oil corn (HOC) varieties (Han et al., 1987; Dale and Whittle, 1991; Adams et al., 1994; Bartov and Bar-Zur, 1995; Saleh et al., 1997; Parsons et al., 1998; Benitez et al., 1999; Lee et al., 2001) typically has been limited in scope, due in part to limitation of test material available. Also due to the development of new varieties of HOC yearly, recent studies are limited and somewhat conflicting in their results. The objective of this study was to measure performance of young broiler chickens fed three varieties of HOC compared with normal corn (NC) varieties.

MATERIALS AND METHODS

Animals and Management

Three day-old broiler chickens of a commercial line (Tyson Co. bred®) were housed in thermostatically controlled (25 to 33°C) batteries equipped with raised wire floors and exposed to 24 h constant lighting. Each battery was equipped with separate water and feeder to prevent contamination. Feed and water were supplied for *ad libitum* consumption. The University of Missouri-Columbia Animal Care and Use Committee approved all animal protocols used in this study.

Experimental procedures

On day 3 of posthatching, chicks were weighed, wing-banded and randomly allotted to each dietary treatment. The experimental diets exceeded the broiler chicken (0 to 3 wks) recommended requirements of NRC (1994). Each experimental diet was formulated with the same amount of each corn hybrid (55.205%; table 1). After 14 days, chicks and feed were weighed for determinations of weight gain, feed intake, and feed efficiency. A total of 11 varieties of corn samples were used which included 8 varieties of NC and three varieties of HOC. These corn varieties were from multiple genetic lines, grown in different locations of USA in past five years. Therefore, this study did not allow for separation of environmental effects (location and cultivated year) on nutritional value. All corn samples were determined for the proximate analysis (AOAC, 1990) and the amino acids content. The gross energy (GE) value for each corn sample was determined by bomb calorimeter (Model 1341 Oxygen Bomb Calorimeter, Parr® Instrument Co.). The nutritional compositions of these corn varieties are shown in table 2.

Experimental design

Data from this experiment were analyzed using the GLM procedures of SAS (1992) within each experiment in a completely randomized design (CRD). The experimental unit was the each pen, Experiment 1 had six dietary

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Table 1. The composition of basal experimetal diet of young broiler chicks for experiment 1 and 2 (%)

Ingredients	Composition
Corn grain (11 hybrids)	55.205
SBM (CP 48%)	35.922
Corn oil	5.180
Dicalcium-phosphate	1.888
Limestone	0.850
Salt	0.408
DL-Methionine	0.206
L-Lysine·HCl	0.054
Trace mineral premix [1]	0.100
Vitamin premix [2]	0.075
Choline chloride	0.072
Selenium premix [1]	0.030
$CuSO_4$	0.010

[1] Provided the followings per kilogram of diet (milligrams): Mn, 110; Zn, 110; Fe, 60; I, 2; Mg, 27; and Se, 0.18.
[2] Provided the followings per kilogram of diet: vitamin A, 7,700 IU; vitamin D_3, 2,750 IU; vitamin E, 11 IU; niacin, 44 mg; d-pantothenic acid, 13.2 mg; riboflavin, 5.5 mg; vitamin B_6, 2.2 mg; menadione, 1.65 mg; folic acid, 1.1 mg; thiamine, 1.1 mg; biotin 0.11 mg; and vitamin B_{12}, 16.5 μg.

treatments (six chickens per pen, 10 replications; total 60 pens and 360 chickens) and Experiment 2 had five treatments (five chickens per pen, 10 replications; total 50 pens and 250 chickens). A total of 610 broiler chickens were used in these experiments. Treatments in each experiment were randomly allotted to pens.

RESULTS AND DISCUSSION

The HOC varieties contained about 80% more oil than NC varieties (average crude fat; 6.71% vs 3.72%), and about 29% more protein (average CP; 9.54% vs 7.38%). Lysine content of HOC varieties was 17% higher than NC (0.28% vs 0.24%) and methionine content showed the same the trend (31% higher; 0.21% vs 0.16%). The average GE value of HOC (4,714 kcal/kg) was about 5 % greater than NC varieties (4,503 kcal/kg) due to the higher oil and protein contents (table 2).

Most of the oil in corn is contained in the germ portion, and then increased germ size (in HOC) increases oil and essential amino acids contents (Watson, 1987). The endosperm protein is mainly composed the insoluble zein proteins which are known to be lysine deficient (Moeser et al., 2002; Wilson, 1987). On the other hand, the protein in the germ portion is composed mainly of albumins (35% of germ protein) and globulins (18% of germ protein), which are particularly rich in lysine compared with endosperm fraction.

In Experiment 1 (table 3), in the aspect of feed efficiency (F/G), the dietary treatment including HOC1 had better performance than other treatments of NC varieties ($p<0.05$) except NC5. The treatment of HOC1 improved F/G by 4.3% compared with NC treatment diets might due to the 6% higher GE value.

As expected, there was no significant difference in average daily feed intake (ADFI; $p>0.05$) among dietary treatments. Young broilers have the limited gastric volume and HOC cannot increase this, but there could be grater absorption of amino acdids and energy from the small

Table 2. The nutrient composition of HOC and NC varieties (%) [1]

	HOC1	HOC2	HOC3	NC1	NC2	NC3	NC4	NC5	NC6	NC7	NC8
Moisture	11.08	9.82	8.96	11.13	11.29	11.04	10.89	10.78	10.32	9.81	9.39
Crude fat	6.84	6.58	6.71	3.61	3.17	4.12	3.87	4.03	3.81	3.84	3.31
Crude protein	9.08	9.63	9.92	6.89	6.96	7.24	7.94	7.55	7.58	7.42	7.46
Crude fiber	2.23	2.10	1.70	1.51	1.63	1.75	1.98	1.71	1.72	2.16	1.89
Ash	1.34	1.50	1.39	1.29	1.13	1.24	1.32	1.15	1.09	1.29	1.33
Gross energy (kcal/kg)	4,819	4,631	4,693	4,519	4,547	4,571	4,535	4,575	4,457	4,434	4,388
Amino acid profile											
Lysine	0.29	0.26	0.28	0.22	0.25	0.22	0.26	0.23	0.24	0.26	0.23
Methionine	0.25	0.20	0.18	0.16	0.15	0.18	0.17	0.16	0.16	0.13	0.16
Cystine	0.22	0.24	0.21	0.18	0.18	0.19	0.19	0.19	0.19	0.17	0.20
Arginine	0.43	0.42	0.43	0.34	0.35	0.34	0.38	0.35	0.36	0.35	0.36
Threonine	0.33	0.32	0.34	0.24	0.25	0.25	0.30	0.27	0.26	0.28	0.26
Tryptophane	0.06	0.04	0.04	0.06	0.06	0.06	0.06	0.05	0.04	0.04	0.06
Histidine	0.25	0.27	0.28	0.19	0.20	0.18	0.22	0.21	0.21	0.21	0.23
Valine	0.43	0.44	0.49	0.27	0.33	0.25	0.38	0.35	0.35	0.37	0.37
Isoleucine	0.31	0.33	0.37	0.18	0.23	0.17	0.26	0.24	0.27	0.27	0.28
Leucine	1.17	1.17	1.30	0.75	0.78	0.80	0.98	0.94	0.91	0.90	0.94
Phenyalanine	0.46	0.46	0.52	0.31	0.33	0.33	0.39	0.37	0.37	0.38	0.38
Glycine	0.36	0.33	0.35	0.28	0.28	0.28	0.32	0.29	0.29	0.29	0.29
Tyrosine	0.31	0.28	0.31	0.21	0.22	0.23	0.26	0.25	0.23	0.23	0.23
Serine	0.43	0.40	0.42	0.33	0.30	0.37	0.37	0.36	0.34	0.34	0.32

[1] All data were calculated on a dry matter (DM) basis.

Table 3. Growth performance affected by corn varieties for young broiler chickens (3 to 17 d) in experiment 1[1]

Items \ Corn hybrids	HOC1	NC1	NC2	NC3	NC4	NC5	SE	Note
Start wt. (g)	72.79[b]	75.13[a]	74.08[a]	74.20[a]	74.63[a]	74.48[a]	0.435	-
Total gain (g)	496.84[ab]	485.33[bc]	476.02[c]	478.50[bc]	486.72[abc]	499.30[a]	4.465	-
Total intake (g)	538.84	545.72	545.32	538.06	550.30	554.01	7.216	NS[2]
17 d wt. (g)	569.63[ab]	560.47[bc]	550.10[c]	552.70[c]	561.35[bc]	573.78[a]	4.597	-
ADG (g)	35.49[ab]	34.67[bc]	34.00[c]	34.18[c]	34.77[abc]	35.66[a]	0.319	-
ADFI (g)	38.49	38.98	38.95	38.43	39.31	39.57	0.515	NS
F/G ratio	1.078[b]	1.123[a]	1.146[a]	1.123[a]	1.131[a]	1.110[ab]	0.014	-

[a, b, c] Means with the same letter are not significantly different ($p<0.05$).

[1] Feed data were calculated on a dry matter (DM) basis.

[2] NS; Means are not significantly different ($p>0.05$).

Table 4. Growth performance affected by corn varieties for young broiler chickens (3 to 17 d) in experiment 2[1]

Items \ Corn hybrids	HOC2	HOC3	NC6	NC7	NC8	SE
Start wt. (g)	63.26[a]	60.68[ab]	59.52[b]	61.06[ab]	61.04[ab]	1.179
Total gain (g)	468.14[ab]	477.20[a]	437.20[c]	444.96[bc]	471.78[ab]	10.151
Total intake (g)	520.64[b]	548.10[a]	522.17[b]	531.33[ab]	536.56[ab]	6.529
17 d wt. (g)	531.40[ab]	546.46[a]	496.72[c]	514.08[b]	532.82[ab]	8.897
ADG (g)	33.44[ab]	34.70[a]	31.23[c]	32.36[bc]	33.70[ab]	0.649
ADFI (g)	37.19[b]	39.15[a]	37.30[b]	37.95[ab]	38.33[ab]	0.466
F/G ratio	1.110[c]	1.129[bc]	1.200[a]	1.175[ab]	1.138[bc]	0.016

[a, b, c] Means with the same letter are not significantly different ($p< 0.05$).

[1] Feed data were calculated on a dry matter (DM) basis.

intestine because of a greater supply of nutrients to that part of the digestive tract.

In the Experiment 2 (table 4) the HOC2 and HOC3 diets tended to give better F/G than the NC diets; HOC2 gave the best F/G. The mean F/G for the HOC diets was 4.4% better than the NC mean; this improvement came from the 5% greater gross energy (GE) of the hybrid corns.

If HOC hybrids improved the feed efficiency, the energy increasing from HOC hybrids did not reflect the F/G improvement as shown in figure 1. The reason is not clear. The fiber content could affect the energy and protein utilization (Moeser et al., 2002). The germ fraction contributes approximately 16% of the total kernel fiber, which could be related the size of germ.

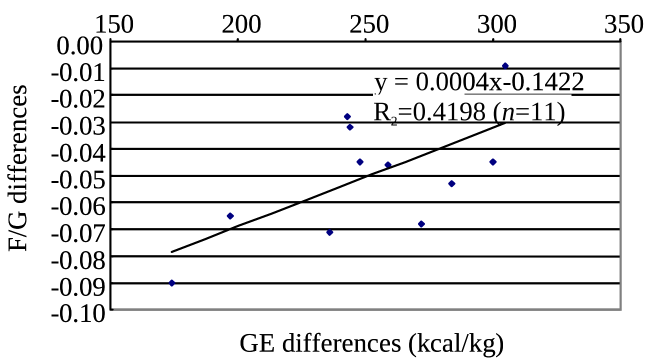

Figure 1. The linear relationship between the Ge differences from corn hybrids and F/G differences

The regression equation illustrated in figure 1 indicates that corn with 200 kcal/kg more GE improves F/G by 0.06 units. With HOC2 vs NC2 and HOC3 vs NC6, 100kcal/kg greater GE improved F/G by 0.05 units.

Han et al. (1987), Bartov and Bar-Zur (1995), Saleh et al. (1997), and Benitez et al. (1999) reported no significant difference in growth performance between broiler diets containing normal corn and HOC. This would be expected since their diets were formulated to be isonitrogenous and isocaloric, but same ratio of corn replacement could improve performance. Han et al. (1987) showed that HOC varieties were superior to NC in nutrients content for poultry, due to the fact that HOC contained higher concentrations of ME (oil), protein, lysine, and carotenoids than NC, thus improving growth and feed efficiency of broiler. Also HOC have an advantage of increasing supplemental oil that may increase intestinal retention time of feed, resulting in more complete digestion of non-lipid dietary constituents (Mateos et al., 1982; Sell et al., 1983; Parsons et al., 1998).

In this study, all diets contained the same percentage of each corn variety, therefore, the HOC hybrids diets contained more oil and protein. Hence, it might be expected that birds fed these diets should have improved performance, but the feed efficiency improvement was not reflected linearly by the increasing energy (GE) content from HOC hybrids.

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