Haryana Vet. (June, 2016) **55 (1)**, 80-84

Research Article

EFFECT OF REPLACEMENT OF MAIZE WITH RAW AND PROCESSED WHEAT ON PERFORMANCE OF BROILERS

V.S. PANWAR, D.S. DAHIYA, O.P. LOHAN and B.S. TEWATIA*
Department of Animal Nutrition, College of Veterinary Sciences
Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar-125 004, India

Received: 20.11.2015; Accepted: 20.02.2016

ABSTRACT

Commercial day-old broiler chicks (n=520) were randomly distributed into 13 treatments (T_1 to T_{13}) having two replicates of 20 birds each to study the effect of replacing maize with raw or dry heated wheat with or without multi-enzyme supplementation on their performance. Maize and soybean meal based mash was formulated as control group ration (T_1). In treatments T_2, T_3 and T_4 maize was replaced with raw wheat at 50, 75 and 100% level, respectively. In T_5, T_6 and T_7 maize was replaced with dry heated wheat at 50, 75 and 100 % level, respectively. Other treatments were T_8 (T_2 with multi-enzyme), T_9 (T_3 with multi-enzyme), T_{10} (T_4 with multi-enzyme), T_{11} (T_2 in the form of pellets), T_{12} (T_3 in the form of pellets) and T_{13} (T_4 in the form of pellets). Significantly ($P<0.05$) higher body weight gain was recorded during overall growth period when maize was replaced with wheat at 75% level. Dry heating of wheat showed non-significant improvement in weight gain as compared to control. However, supplementation of enzymes in 50% wheat based diet and pelleting of 75% wheat based diet resulted in significantly ($P<0.05$) higher body weight gain as compared to control. Reduced feed intake was recorded in T_2 as compared to T_3 and T_4 treatments, however, statistically this difference was non-significant. Among wheat fed groups significantly ($P<0.05$) higher feed intake was recorded in T_3 and T_4 treatments as compared to T_2 treatment. Dry heating of wheat showed non-significant effect on feed intake during overall growth period. Supplementation of enzyme did not affect feed intake. Pelleting of 50 and 75% wheat based diet resulted in lower ($P<0.05$) feed intake as compared to control; whereas 100 percent wheat based pelleted diet showed non-significant difference. Incorporation of wheat in place of maize did not affect the feed conversion ratio (FCR) significantly. Similarly, dry heating of wheat showed no significant effect on FCR. Enzyme supplementation to 50% wheat based diet improved ($P<0.05$) the FCR as compared to control diet. Significantly ($P<0.05$) better FCR were also recorded when 50 and 75% wheat based pelleted diets were fed to broilers as compared to control diet. The total feed cost was lower in all the treatment groups as compared to control. Higher weight gains in dry heated, enzyme supplemented and pelleted groups resulted in better gross returns in these groups. The present study suggested that maize can be safely replaced with wheat up to 100% level without affecting the performance of broilers.

Key words: Broilers, enzyme, growth performance, pelleting, wheat

Poultry production in India during the last decades has taken a shape of industry. However, in recent years poultry production has crippled many times due to rising feed cost and diseases. Feed accounts for more than two-third of production cost. Traditionally maize is used as an energy source in poultry feeds. Total requirement of maize would be around 112 million tonnes in 2025 with allocation of 28 million tonnes for poultry (45% of poultry diet; Mandal, 2009). Thus, major challenge is the shortage of feedstuffs. It is, therefore, essential to identify alternate energy feedstuffs for economic poultry production. Wheat can be an alternate to maize, however, the utilization efficiency of wheat is lower than that of corn because it contains more anti-nutritive factors, especially non-starch polysaccharides (NSP).

Arabinoxylans, major NSP fractions in wheat, increase digesta viscosity, reduce the digestibility of nutrients and decrease the feed efficiency and growth performance especially in broiler chickens (Choct and Annison, 1992). Moreover, dietary NSP can also accelerate small intestinal fermentation by modulating the intestinal microflora (Nian *et al*., 2011), which might be detrimental to nutrient digestion and absorption for chickens (Choct *et al.*, 1999). Broilers lack endogenous enzymes to degrade arbino-xylans of wheat. Supplementation of exogenous feed grade enzymes to the cereal based diets have been reported (Devegowda and Nagalakshmi, 1992; Koning and Perdek, 1996) to improve the performance of broilers. Various processing techniques like cooking, reconstitution (Raman *et al*., 1999), micronization (Niu *et al*., 2003) and pelleting (Scott *et al*., 2003) have been used to increase utilization of wheat in broiler diets with inconsistent results. Feed processing techniques like dry heating and pelleting may facilitate the nutrient utilization of energy feed stuffs like wheat. Keeping these facts in mind, present work was planned to study the effect of maize replacement with wheat on the growth performance of broilers.

*Corresponding author: bstewatia44@gmail.com

MATERIALS AND METHODS

To study the effect of replacement of maize with raw or dry heated wheat with or without enzyme supplementation and pelleting, 520, day-old commercial broiler chicks were weighed and randomly distributed into 13 treatments with two replicates of 20 birds each. The birds were raised in deep litter system using wheat bhoosa as litter material. The feed ingredients used in ration formulation were analyzed for proximate nutrients as per AOAC (1995) and chemical composition of feed ingredients is presented in Table 1. The crude protein and metabolizable energy levels of diets were formulated as per BIS (1992) specifications. The feed grade multi-enzyme mixture (Allazyme™ SSF) containing protease, pectinase, phytase, pentosanase, cellulase, amylase, and β-glucanase enzymes was mixed @ 20g/quintal. The processing of wheat was done by heating the ground wheat in an iron pan for 10 min. Pellets were prepared by raising the moisture to 18% by adding hot water instead of steam and then feed was forced through 5 mm diameter die.

The treatments were T_1 (control mash), T_2 (50% maize replaced with raw wheat), T_3 (75% maize replaced with raw wheat), T_4 (100% maize replaced with raw wheat), T_5 (50% of maize replaced with dry heated wheat), T_6 (75% of maize replaced with dry heated wheat), T_7 (100% of maize replaced with dry heated wheat), T_8 (T_2 with multi-enzyme), T_9 (T_3 with multi-enzyme), T_{10} (T_4 with multi-enzyme), T_{11} (T_2 in the form of pellets), T_{12} (T_3 in the form of pellets) and T_{13} (T_4 in the form of pellets).

Feed ingredients composition and feed additives added in dietary treatments in starter and finisher rations are presented in Table 2. Body weight and feed intake were recorded fortnightly to calculate weight gain, feed intake and feed conversion ratio (FCR). Relative economics of feeding under different treatments was also calculated. The cost of production included chick cost and feed cost. The feed cost included the cost of feed ingredients, binders, feed additives, labour charges and charges for dry heating and pelleting. The total cost of feed consumed was added to the cost per chick survived to get the cost of production per bird. Data thus collected were statistically analyzed as per Snedecor and Cochran (1994) and comparison among treatment means was done by using Duncan's Multiple Range Test as modified by Kramer (1956).

RESULTS AND DISCUSSION

Body weight gain (g/bird) ranged from 2151.90 to 2319.14 in different treatments (Table 3) and was significantly ($P<0.05$) higher when maize was replaced with 75% raw wheat (T_3). Dry heating of wheat (T_5, T_6 and T_7) showed non-significant improvements in weight gain as compared to control (T_1). Contrary to this Raman (1997) reported that addition of cooked wheat in the diet of broilers significantly enhanced growth rate as compared to control diet. Supplementation of enzymes in 50% wheat based diet (T_8) and 75% wheat based pelleted diet (T_{12}) resulted in significantly ($P<0.05$) higher body weight gain as compared to control mash diet. The improved growth performance due to enzyme supplementation in wheat based diets in this study was supported by various studies conducted earlier by Singh and Khatta (2003) and Gupta (2004). Improved weight gain due to pelleting of feed was reported by Gao-Feng *et al.* (2000) and Jamroz *et al.* (2001). Higher body weight gain in enzyme supplemented diets may be due to reduced viscosity of digesta and increased metabolizability of nutrients (Bedford and Classen, 1992; Selle *et al.*, 2003).

Feed intake (Table 3) was significantly ($P<0.05$) higher in T_3 than T_1. Significantly ($P<0.05$) higher feed intake was recorded in T_3 and T_4 treatments as compared to T_2. Gupta (2004) also observed significantly ($P<0.05$) higher feed intake in broilers fed diets having wheat replacing 100% maize. Dry heating of wheat did not affect feed intake. Similarly, supplementation of enzyme also did not affect feed intake as compared to control. Contrary to this, Gupta (2004) reported higher feed intake in broilers fed enzyme supplemented wheat based diets. Pelleting of 50 and 75% wheat based diet resulted in significantly ($P<0.05$) lower feed intake as compared to control; whereas 100% wheat based pelleted diet showed non-significant difference. Among pelleted groups, significantly

Table 1
Nutrients composition of feed ingredients (% DM basis)

Ingredient	DM (%)	Crude protein (%)	Crude fibre (%)	Ether extract (%)	Lysine* (%)	Methionine* (%)	Metabolizable energy* (Kcal/kg)
Maize	86.49	8.55	1.26	3.84	0.18	0.15	3300
Wheat	88.66	11.00	1.60	2.18	0.47	0.21	2850
Soybean meal	89.17	44.00	4.43	2.82	2.57	0.76	2230
Fish meal	90.03	45.00	2.41	13.70	2.48	0.86	2600
Rice polish	90.87	14.12	4.10	15.70	0.57	0.28	2937

*Reported values by Singh and Panda (1988)

Table 2
Ingredients composition (%) and quantities of feed additives in the Starter (0-4 weeks) and finisher ration (4-6 weeks)

Feed ingredients	Ingredients (%) in defferent treatments												
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}	T_{13}
							Starter ration						
Maize	52	26	13	-	26	13	-	26	13	-	26	13	-
Wheat	-	26	39	52	26	39	52	26	39	52	26	39	52
Soyabean meal	30	30	30	30	30	30	30	30	30	30	30	30	24
Fish meal	10	10	10	10	10	10	10	10	10	10	10	10	10
Rice polish	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
Mineral mixture	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Total	100	100	100	100	100	100	100	100	100	100	100	100	100
Feed additives* (g/100kg feed)	340	340	340	340	340	340	340	340	340	340	340	340	340
Enzyme-premix (g/100kg)	-	-	-	-	-	-	-	20	20	20	-	-	-
							Finisher ration						
Maize	60	30	15	-	30	15	-	30	15	-	30	15	-
Wheat	-	30	45	60	30	45	60	30	45	60	30	45	60
Soyabean meal	21	21	21	21	21	21	21	21	21	21	21	21	21
Fish meal	10	10	10	10	10	10	10	10	10	10	10	10	10
Rice polish	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
Mineral mixture	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Total	100	100	100	100	100	100	100	100	100	100	100	100	100
Feed additives* (g/100kg feed)	340	340	340	340	340	340	340	340	340	340	340	340	340
Enzyme-premix (g/100kg)	-	-	-	-	-	-	-	20	20	20	-	-	

Feed additives* included Spectromix (10g), Spectro BE (20g), coccidiostat (50g), choline chloride (50g), cygro (10g), lysine (50g) and methionine (150g).

($P<0.05$) higher feed intake was recorded in T_{13} than T_{11} and T_{12}.

The FCR differed non-significantly in wheat replaced groups when compared to control (Table 3). Contrary to the present findings, higher FCR in groups fed wheat replacing maize at 25, 50 and 100% level was observed by Sharma and Sharma (1993). Dry heating of wheat showed no influence on FCR, however, enzyme supplementation in 50% wheat based diet showed significantly ($P<0.05$) better FCR as compared to control diet. These results are in agreement with those reported earlier (Jamroz *et al.*, 2001; Saxena, 2003). The improvement in FCR of birds fed enzyme supplemented wheat based diets could be due to better absorption and retention of nutrients (Ravindran *et al.*, 1999). Significantly ($P<0.05$) better FCR was recorded when 50 and 75% wheat based pelleted diet was fed to broilers as compared to control diet. Among pelleted groups better FCR was recorded in groups fed with 75% wheat based pelleted diet followed by 50 and 100% wheat based pelleted diets.

The Performance index (PI) did not vary significantly amongst treatments. Contrary to the present findings, Gupta (2004) recorded decreased PI in groups fed wheat than fed maize. Dry heating of wheat did not improve the PI. The perusal of data further indicated significantly ($P<0.05$) higher PI in T_8 treatment than that in T_1. These results are in agreement with those reported by Annison (1992). The PI was significantly ($P<0.05$) higher in T_{11} and T_{12} treatment than that of T_1. This showed that pelleting of wheat based diet had a significant ($P<0.05$) influence on the performance of birds at 50 and 75% level as compared to maize based mash diet.

Relative economics of feeding under different dietary treatments is given in Table 4. Total feed cost was lower in all treatments as compared to control; this might be due to lower cost of wheat than that of maize. Dry heating and pelleting of diets increased feed cost by Rs. 10/-quintal, while supplementation of enzyme increased the feed cost by Rs. 20/quintal. Even after this increase, the total feed cost in these treatment groups was lower than control. Higher weight gains in groups fed dry heated, enzyme supplemented and pelleted feed resulted in better gross returns. The results on economic efficiency are in agreement with those reported by Selle *et al.* (2003). Relative profits (Rs/bird) in T_2, T_3, T_4, T_5, T_6, T_7, T_8, T_9, T_{10}, T_{11}, T_{12} and T_{13} treatments as compared to control

Table 3

Growth performance in broiler chicks fed different types of wheat based diets with or without enzyme supplementation

Treatments	Body weight gain (g)	Feed intake (g)	FCR	Performance index (PI)
T_1	$2151.90^{b}\pm78.44$	$4853.90^{ab}\pm80.94$	$2.26^{a}\pm0.12$	$956.70^{c}\pm85.50$
T_2	$2187.45^{ab}\pm1.22$	$4604.46^{bcd}\pm227.11$	$2.10^{abc}\pm0.10$	$1041.78^{bc}\pm52.54$
T_3	$2316.77^{a}\pm61.88$	$4952.95^{a}\pm52.91$	$2.14^{abc}\pm0.08$	$1085.20^{abc}\pm69.48$
T_4	$2244.39^{ab}\pm6.90$	$4960.51^{a}\pm149.92$	$2.21^{ab}\pm0.06$	$1016.22^{bc}\pm24.46$
T_5	$2272.61^{ab}\pm13.41$	$4738.61^{abc}\pm62.06$	$2.08^{abcd}\pm0.01$	$1089.99^{abc}\pm1.40$
T_6	$2254.91^{ab}\pm38.96$	$4654.25^{abc}\pm43.57$	$2.06^{abcd}\pm0.05$	$1093.24^{abc}\pm47.98$
T_7	$2233.14^{ab}\pm31.14$	$4565.36^{bcd}\pm36.79$	$2.04^{abcd}\pm0.04$	$1092.86^{abc}\pm39.27$
T_8	$2294.34^{a}\pm15.10$	$4657.22^{abc}\pm15.23$	$2.03^{bcd}\pm0.03$	$1130.40^{ab}\pm18.57$
T_9	$2239.32^{ab}\pm64.68$	$4769.65^{abc}\pm108.55$	$2.13^{abc}\pm0.11$	$1055.71^{bc}\pm84.88$
T_{10}	$2200.65^{ab}\pm20.11$	$4765.69^{abc}\pm143.50$	$2.16^{abc}\pm0.08$	$1018.39^{bc}\pm49.27$
T_{11}	$2260.91^{ab}\pm53.17$	$4450.27^{cd}\pm53.51$	$1.97^{cd}\pm0.07$	$1150.08^{ab}\pm67.85$
T_{12}	$2319.14^{a}\pm62.61$	$4334.30^{d}\pm24.31$	$1.87^{d}\pm0.04$	$1241.46^{a}\pm60.04$
T_{13}	$2272.98^{ab}\pm18.13$	$4726.52^{abc}\pm121.38$	$2.08^{abcd}\pm0.07$	$1094.30^{abc}\pm45.54$
CD	132.88	318.53	0.22	168.64

Means bearing different superscripts, in a column, differ significantly ($P<0.05$)

T_1=Control mash; T_2=50% maize replaced with raw wheat; T_3=75% maize replaced with raw wheat; T_4=100% maize replaced with raw wheat; T_5=50% of maize replaced with dry heated wheat; T_6=75% of maize replaced with dry heated wheat; T_7=100% of maize replaced with dry heated wheat; T_8=T_2 with multi-enzyme; T_9=T_3 with multi-enzyme; T_{10}=T_4 with multi-enzyme; T_{11}=T_2 in the form of pellets; T_{12}=T_3 in the form of pellets; T_{13}=T_4 in the form of pellets

Table 4

Economics of feeding different dietary treatments

Treatments	Chick cost* (Rs/bird)	Total feed cost (Rs)	Total production cost** (Rs)	Live weight at 6 weeks of age (g)	Gross return*** (Rs/bird)	Profit (Rs/bird)	Relative profit or loss/ bird (Rs)
T_1	18.94	55.61	74.55	2151.90	84.76	10.21	-
T_2	18.94	50.62	69.56	2187.45	87.48	17.92	07.71
T_3	18.46	53.30	71.76	2316.77	92.67	20.91	10.70
T_4	20.00	52.27	72.24	2244.39	89.77	17.53	07.32
T_5	19.45	52.61	72.10	2272.61	90.90	18.80	08.99
T_6	18.46	50.66	69.12	2254.91	90.19	21.07	10.86
T_7	18.46	48.62	67.08	2233.14	89.32	22.24	12.03
T_8	18.46	52.37	70.83	2294.34	91.77	20.94	10.73
T_9	18.94	52.56	71.50	2239.32	89.57	18.07	07.86
T_{10}	19.45	55.36	70.81	2200.65	88.04	17.21	07.00
T_{11}	20.57	49.52	70.11	2260.91	90.43	20.32	10.11
T_{12}	19.45	47.28	66.72	2319.14	92.76	26.03	15.82
T_{13}	18.94	50.33	69.27	2272.98	90.91	21.64	11.43

T_1=Control mash; T_2=50% maize replaced with raw wheat; T_3=75% maize replaced with raw wheat; T_4=100% maize replaced with raw wheat; T_5=50% of maize replaced with dry heated wheat; T_6=75% of maize replaced with dry heated wheat; T_7=100% of maize replaced with dry heated wheat; T_8=T_2 with multi-enzyme; T_9=T_3 with multi-enzyme; T_{10}=T_4 with multi-enzyme; T_{11}=T_2 in the form of pellets; T_{12}=T_3 in the form of pellets; T_{13}=T_4 in the form of pellets

*Chick Cost=(No. of chicks at the start of experiment/ No. of chicks at the end of experiment)×Cost of day old chick

**Production cost=Feed cost+chick cost

***Bird sold @ Rs. 40/Kg live weight

(T_1) were 7.71, 10.70, 7.32, 8.99, 10.86, 12.03, 10.73, 7.86, 7.00, 10.11, 15.82 and 11.43, respectively. The results showed highest profit in T_{12} followed by other treatments.

On the basis of these results, it can be concluded that wheat can replace maize without affecting the growth adversely. Dry heating of wheat did not improve the performance of broilers. Supplementation of enzyme and pelleting of wheat based diets improved the performance of birds.

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