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Apple pomace-based rations for White Leghorn pullets

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ABSTRACT

A study was conducted on 315 layer type birds to evaluate the effect of feeding apple pomace-based diets with or without enzyme supplementation (each gram of multi-enzyme mixture contained amylase 2400, hemi-cellulase 5400, cellulose 12000, protease 2400 and α-glucanase 160 units respectively) on their performance from 21–34 weeks of age. Egg type birds (315) at 8 weeks of age were distributed into 7 treatment groups each group having 3 replicates with 15 birds in each and reared in deep litter system of housing. While T_1 acted as a control and was offered basal diet, remaining groups were offered diets where in maize was replaced by apple pomace to the extent of 10% in T_2 and T_3, 15% in T_4 and T_5, and 20% in T_6 and T_7. Diets offered to the groups T_2, T_4 and T_6 were supplemented with multi-enzyme mixture @ 1g/kg feed. The results indicated no significant difference in the age at sexual maturity through numerically it was lowest for the control and increased with corresponding increase in the level of apple pomace. Age at 25 and 50% production was higher in groups offered apple-pomace based diets. However, the increase was statistically significant for 25% egg production in T_3 group and for 50% egg production in T_5 group as compared to control.

Overall egg production was lower in the groups fed diets in which AP replaced 20% of maize either with or without enzyme supplementation while the groups offered diets with 10% replacement of maize with AP with or without enzyme supplementation and 15% replacement with enzyme supplementation had egg production which was statistically non-significant from control. Accordingly FCR both in terms of feed consumed/kg egg mass and feed consumed per dozen eggs was significantly higher (adverse) in groups with 20% replacement as well as 15% replacement without enzyme supplementation while as in groups with 10% replacement with or without enzyme supplementation and 15% replacement with enzyme supplementation, the FCR did not differ significantly from control. No significant difference between the groups was realized with respect to egg weight and mortality. Replacement of maize by apple pomace to the extent of 10% without enzyme supplementation and 15% with enzyme supplementation did not have any adverse effect on age of sexual majority and egg production from 21–34 weeks of age.

Key words: Apple pomace, Enzymes, Layer type chicken, Performance, Pullets

The apple (*Malus sylvestris*), occupies a prominent position in India (Chadha 2001) and world (FAO 2003). During processing of apple for juice and other products, a press cake (comprised of peel, pulp and seeds) known as apple pomace is produced. It represents 25–35% of the weight of fresh apple processed (Wang and Thomas 1989). Disposal of these waste posses a great environmental challenge but at the same time being a rich source of energy; 2600–2750 K.cal/kg (Bhat *et al*. 2002); it offers equally good opportunity to nutritionists for its utilization in animal feeds. Apple pomace has been used in feeding rats (Devarajan *et al*. 2004), cattle (Rust and Buskiok 2008) and broilers (Joshi *et al.* 2000, Mattoo *et al*. 2001, and Bhat *et al.* 2000, 2002, 2003). The later authors have standardized the incorporation of apple pomace in broiler diets to the extent of 10% without enzyme supplementation and 15% with enzyme supplementation and found no adverse effect on body weight gain, FCR and overall profitability of broiler production. Since all the feeding trails in broiler chicken are of short duration (4–5 weeks), it was thought desirable to study the effects of long-term feeding of apple-pomace based rations to layer type poultry. Accordingly this experiment was designed to study the effect of incorporation of different levels of apple pomace on production performance of layer type chicken.

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MATERIALS AND METHODS

White Leghorn chicks (315) were distributed into 7 treatment groups, each having 3 replicates and each replicate of 15 chicks and reared in well prepared deep litter pens under standard managemental conditions. In T_1 group basal

Table 1. Composition of the experimental ration

Ingredients	T_1 Control	$T_2$10% AP+ Enz mix	$T_3$10% AP	$T_4$15% AP+ Enz mix	$T_5$15% AP	$T_6$20% AP+ Enz mix	$T_7$20% AP
Maize	50	45	45	42.5	42.5	40	40
Apple pomace	-	5	5	7.5	7.5	10	10
Soybean meal	20	20	20	20	20	20	20
Fish meal	5	5	5	5	5	5	5
Rice polish	20.5	20.5	20.5	20.5	20.5	20.5	20.5
Lime stone	2.5	2.5	2.5	2.5	2.5	2.5	2.5
D.C.P.	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Mineral mixture	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Enzyme mixture	-	+	-	+	-	+	-
Chemical composition							
M.E (K. cal/kg)	2743.00	2712.73	2712.73	2697.5	2697.5	2682.28	2682.28
C.P%	17.98	17.95	17.95	1793	17.93	17.92	17.92
C.F%	4.93	5.81	5.81	6.25	6.25	6.69	6.69

AP, Apple pomace.

ration was fed to birds. In T_2 and T_3 replacement of maize by apple pomace was at 10% level, T_4 and T_5 replacement at 15% level, and in T_6 and T_7 the replacement was at 20% level. Diets offered to the groups T_2, T_4 and T_6 were supplemented with multi enzyme mixture @ 1g/kg feed. The composition of ration offered to chicks is given in Table 1.

Age at sexual maturity (age at first egg), daily egg production, and mortality was recorded. Egg production, FCR (feed consumed/dozen eggs and feed consumed/kg egg mass) and mortality at bi- weekly intervals was calculated from 21 –34 weeks of age. At the end overall egg production during the period (21–34 weeks of age) for different groups was also calculated (Table 2). The data was analyzed through one way analysis of variance (Snedecor and Cochran 1990), and difference between the means was calculated through Duncans; multiple range test (Duncan 1950)

RESULTS AND DISCUSSION

Age at sexual maturity (Table 3) did not differ significantly among different groups though numerically it was lowest in T_1 followed by T_2, T_5, T_6, T_7, and T_4 and T_3. Age at 50% production was significantly less in T_1 as compared to T_3. None of the values differed significantly from each other or from T_1 or T_3 groups. Likewise statistically significant differences in age at 50% production were recorded between T_1 and T_3 and T_7 groups. Age of 5% production in T_2 and T_4 groups did not differ significantly, neither from T_1 nor from T_5 groups but was significantly lower than that of T_7 group. Similarly in T_3 and T_6 groups the age at 50% production did not differ significantly from T_5 and T_7 groups but was significantly higher than that of T_1 group. The overall results suggested that barring few exceptions the age at achieving various production related milestones increased with increasing levels of incorporation of apple pomace and enzyme supplementation did not make any significant difference in age of achieving such milestones.

Table 2. Feed consumption (g)/bird/day in different treatment groups during different periods

Period (Week)	Feed Consumption (g)/bird/day
21–22	95
23–24	100
25–26	115
27–28	120
29–31	120
31–32	120
33–34	120

Bi-weekly and overall egg production in different groups offered different levels of apple pomace with or without enzyme supplementation is represented in Table 4. For all the groups there was a steady increase in hen day egg production over consecutive 5 bi-weekly intervals right from 21 to 30 weeks of age. Over the remaining two bi-weekly intervals the production marginally declined.

With increase in the level of apple pomace the egg production showed decline but difference was not significant between hen day egg production of control group and that of groups T_2, T_3, and T_4 groups while decline was significant with respect to the egg production of groups T_5, T_6 and T_7. The results therefore revealed no adverse effect of replacing maize with apple pomace to the extent of 10% without enzyme supplementation and 15% with enzyme supplementation. An almost identical trend was evident with respect to FCR (both on the basis of kg feed/down eggs as well as kg feed/kg egg mass), with the groups T_2, T_3 and T_4 having nonsignificant differences in FCR from that of control. With increase in the level of apple pomace, there was corresponding increase in FCR in T_5, T_6 and T_7 groups.

The egg weight had an increasing trend in all the groups (Table 5) with each consecutive bi-weekly interval but between various treatments groups no significant difference

Table 3. Effect of replacing maize by apple pomace on age (in days); at sexual maturity, 25 and 50% egg production

Trait	T_1 Control	T_2 10% AP+Enz mix	T_3 10% AP	T_4 15% AP+Enz mix	T_5 15% AP	T_6 20% AP+Enz mix	T_7 20% AP
Age at sexual maturity	136.67±5.21	139.67±0.88	146.00±5.58	143.00±3.61	139.67±2.73	141.33±2.60	141.67±2.33
Age at 25% production	143.67^{a}±5.36	151.00^{ab}±1.00	156.33^{b}±0.88	150.33^{ab}±0.88	152.33^{ab}±0.66	151.00^{ab}±0.58	151.67^{ab}±5.17
Age at 50% production	152.00^{a}±1.00	158.67^{ab}1.2	162.00^{bc}±1.53	158.00^{ab}±0.00	161.33^{b}±1.86	164.33^{bc}±4.67	169.00^{c}±2.65

Means bearing different superscripts within a row differ significantly at $P < 0.05$.

Table 4. Effect of replacing maize by apple pomace on egg production (21–34 weeks)

Period (weeks)	T_1Control	$T_2$10% AP + Enz mix	$T_3$10% AP	$T_4$15%A.P +Enz mix	$T_5$15% AP	$T_6$20%A.P + Enz mix	$T_7$20% AP
21–22	4.06^{c}±0.68	1.5^{ab}±0.15	0.7^{a}±0.32	1.84^{ab}±0.30	1.42^{ab}±0.19	2.00^{b}±0.34	1.34^{ab}±0.37
23–24	8.29^{c}±0.32	6.95^{c}±0.36	5.8^{ab}±0.81	6.82^{bc}±0.41	5.32^{ab}±0.16	5.15±0.71	4.22^{a}±0.59
25–26	9.49^{b}±0.19	9.37^{b}±0.08	9.19^{b}±0.21	8.98^{b}±0.68	7.02^{a}±0.56	7.11±0.31	7.14^{a}±0.36
27–28	10.29^{c}±0.21	10.38^{c}±0.15	10.36^{c}±0.16	9.51^{bc}±0.26	8.03^{ab}±0.63	8.44±0.16	7.56^{ab}±0.48
29–30	9.64^{b}±0.26	10.08^{b}±0.18	9.99^{b}±0.17	9.56^{b}±0.32	9.63^{b}±0.71	9.33±0.10	9.21^{a}±0.09
31–32	9.58^{b}±0.23	9.63^{b}±0.14	9.45^{ab}±0.19	9.42^{ab}±0.19	8.92^{a}±0.34	8.36±0.42	8.41^{a}±0.49
33–34	7.37^{ab}±0.39	7.66^{ab}±0.14	6.91^{a}±0.45	7.15^{ab}±0.07	8.02^{b}±0.21	7.89±0.12	7.20^{ab}±0.54
Overall	8.38^{b}±0.08(21)	7.87^{b}±0.07(21)	7.43^{ab}±0.26(21)	7.61^{ab}±0.19(21)	7.05^{a}±0.31(21)	7.04±0.16(21)	6.84^{a}±0.55(21)
Total egg production (hen day)	58.88^{c}±0.62 (21)	55.09^{bc}±0.53 (21)	52.07^{ab}±1.85 (21)	53.37^{abc}±1.29 (21)	48.99^{a}±2.07 (21)	49.29±1.09 (21)	47.98^{a}±3.72 (21)
Per cent egg production (hen day)	60.08^{b}±0.63 (21)	56.21^{b}±0.54 (21)	53.13^{a}±1.89 (21)	54.46^{ab}±1.31 (21)	49.98^{a}±2.11 (21)	50.29±1.12 (21)	48.96^{a}±3.79 (21)

Overall mans bearing different superscripts within a row differ significantly at $P<0.05$. Treatment means in a particular period bearing different superscript differ significantly at $P<0.05$.Figures within parenthesis are number of observations.

Table 5. Effect of replacing maize by apple pomace on egg weight (g) in pullets during different periods

Period (weeks)	T_1Control	$T_2$10% AP + Enz mix	$T_3$10% AP	$T_4$15% AP +Enz mix	$T_5$15% AP	$T_6$20% AP + Enz mix	$T_7$20% AP
21–22	41.20±1.85	41.56±1.56	42.45±1.36	43.14±0.98	41.83±1.34	40.50±2.31	40.10±1.14
23–24	45.97±1.21	44.23±0.31	44.11±1.14	44.64±0.23	45.46±1.71	44.11±0.8	43.4±0.89
25–26	49.95±0.47	50.32±0.23	51.07±0.48	50.77±0.25	50.78±0.51	50.84±0.47	50.73±0.24
27–28	49.95±0.47	50.31±0.23	51.20±0.42	50.77±0.25	58.78±0.51	50.84±0.47	50.73±0.24
29–30	53.16±1.12	52.37±0.39	53.19±0.46	53.06±0.49	53.41±0.39	54.18±1.67	54.31±0.63
31–32	52.39±1.38	53.59±0.42	55.25±0.68	53.68±0.85	53.91±0.22	54.46±1.8	54.73±0.15
33–34	55.20±0.56	55.06±0.46	55.44±1.04	56.39±1.05	56.00±0.31	56.36±0.42	57.00±0.30
Overall	47.48±1.52(21)	49.29±0.16(21)	50.12±0.57(21)	49.49±0.51(21)	49.89±0.09(21)	47.74±2.02(21)	49.71±0.33(21)

Overall means bearing different superscripts within a row differ significantly at $P< 0.05$. Treatment means in a particular period bearing different superscript differ significantly at $P< 0.05$. Figures within parenthesis are number of observations.

was observed thus indicating no significant effect of incorporating apple pomace on egg size. Same was the case with mortality, as there was only one mortality in T_4 group during the entire period of study and that too was not related in any way with apple pomace feeding. Literature is replete with numerous reports on use of number of non-conventional feed ingredients in livestock and poultry rations. Apple pomace in particular has been successfully incorporated in the rations of dairy cows (Tiwari *et al.* 2008), calves (Tiwari *et al.* 1994) and sheep (Alibes *et al.* 1984). Though majority of non-conventional feed ingredients have higher fibre content on account of which these can be incorporated into poultry diets to a limited extent but chicken are capable of high degree of anatomical and physiological adaptation to

Table 6. Effect of replacing maize by apple pomace on feed conversion ratio (kg feed/dozen eggs)

Period (weeks)	T_1Control	$T_2$10%A.P + Enz mix	$T_3$10% A.P	$T_4$15%A.P +Enz mix	$T_5$15% A.P	$T_6$20%A.P + Enz mix	$T_7$20% A.P
21–22	$4.10^{a}\pm0.77$	$10.36^{a}\pm1.13$	$38.76^{b}\pm20.24$	$9.05^{a}\pm1.55$	$11.43^{a}\pm1.49$	$8.42^{a}\pm1.69$	$13.96^{a}\pm4.23$
23–24	$2.03^{a}\pm0.08$	$2.44^{ab}\pm0.12$	$3.0^{bc}\pm0.39$	$2.42^{a}\pm0.09$	$3.18^{bc}\pm0.09$	$3.41^{bc}\pm0.54$	$3.84^{c}\pm0.53$
25–26	$2.04^{a}\pm0.41$	$2.06^{a}\pm0.02$	$2.11^{a}\pm0.05$	$2.18^{a}\pm0.18$	$2.79^{b}\pm0.23$	$2.72^{b}\pm0.12$	$2.72^{b}\pm0.15$
27–28	$1.96^{a}\pm0.41$	$1.94^{a}\pm0.03$	$1.95^{a}\pm0.03$	$2.12^{a}\pm0.06$	$2.26^{b}\pm0.16$	$2.39^{b}\pm0.05$	$2.30^{b}\pm0.12$
29–30	$2.09^{a}\pm0.05$	$2.00^{a}\pm0.04$	$2.02^{a}\pm0.04$	$2.11^{ab}\pm0.06$	$2.12^{ab}\pm0.07$	$2.16^{b}\pm0.02$	$2.17^{b}\pm0.06$
31–32	$2.10^{a}\pm0.05$	$2.21^{ab}\pm0.03$	$2.21^{ab}\pm0.07$	$2.24^{ab}\pm0.04$	$2.27^{bc}\pm0.09$	$2.26^{bc}\pm0.09$	$2.28^{bc}\pm0.11$
33–34	$2.45^{a}\pm0.04$	$2.53^{ab}\pm0.05$	$2.64^{ab}\pm0.08$	$2.61^{ab}\pm0.04$	$2.77^{bc}\pm0.09$	$2.86^{bc}\pm0.04$	$2.83^{bc}\pm0.23$
Overall	$2.24^{a}\pm0.02(21)$	$2.40^{ab}\pm0.02(21)$	$2.54^{abc}\pm0.08(21)$	$2.47^{abc}\pm0.05(21)$	$2.67^{bc}\pm0.08(21)$	$2.68^{bc}\pm0.06(21)$	$2.79^{c}\pm0.23(21)$

Overall means bearing different superscripts within a row differ significantly at P< 0.05. Treatment means in a particular period bearing different superscript differ significantly at P<0.05. Figures within parenthesis are number of observations.

Table 7. Effect of replacing maize by apple pomace on feed conversion ratio (kg feed/kg egg mass)

Period (weeks)	T_1Control	$T_2$10% AP + Enz mix	$T_3$10% AP	$T_4$15% AP +Enz mix	$T_5$15% AP	$T_6$20% AP + Enz mix	$T_7$20% AP
21–22	$8.24^{a}\pm1.47$	$20.89^{a}\pm1.87$	$75.58^{b}\pm39.46$	$17.49^{a}\pm2.95$	$22.67^{a}\pm3.13$	$17.23^{a}\pm3.29$	$28.68^{ab}\pm7.98$
23–24	$3.7^{a}\pm0.09$	$4.59^{a}\pm0.23$	$5.66^{bc}\pm0.65$	$4.52^{ab}\pm0.19$	$5.87^{bc}\pm0.29$	$6.41^{c}\pm0.92$	$7.37^{c}\pm0.87$
25–26	$3.64^{a}\pm0.13$	$3.61^{a}\pm0.01$	$3.58^{a}\pm0.05$	$3.79^{a}\pm0.32$	$4.83^{b}\pm0.41$	$4.84^{b}\pm0.15$	$4.76^{b}\pm0.25$
27–28	$3.27^{a}\pm0.07$	$3.22^{a}\pm0.06$	$3.17^{a}\pm0.05$	$3.54^{ab}\pm0.06$	$3.70^{b}\pm0.29$	$3.91^{b}\pm0.06$	$3.87^{b}\pm0.19$
29–30	$3.28^{a}\pm0.13$	$3.18^{a}\pm0.06$	$3.16^{a}\pm0.08$	$3.32^{ab}\pm0.4$	$3.29^{ab}\pm0.27$	$3.32^{b}\pm0.07$	$3.34^{b}\pm0.38$
31–32	$3.35^{a}\pm0.13$	$3.43^{a}\pm0.05$	$3.33^{a}\pm0.07$	$3.33^{a}\pm0.07$	$3.5^{b}\pm0.14$	$3.31^{b}\pm0.08$	$3.29^{b}\pm0.18$
33–34	$4.15^{ab}\pm0.20$	$3.98^{ab}\pm0.04$	$4.42^{b}\pm0.28$	$4.32^{ab}\pm0.13$	$3.83^{a}\pm0.14$	$3.79^{a}\pm0.06$	$4.14^{ab}\pm0.32$

compensate for variation is nutrient concentration of their diet (Kandre *et al.* 1974). It is possibly this compensatory effect that did not allow 10% of maize replacement (Table 6,7) with apple pomace to cause any adverse effect on egg production, FCR even without any enzyme supplementation. At higher level of apple pomace (15%) the enzyme supplementation was required while at ever higher level (20%) the fibre content of ration was perhaps too high for the biological system of birds to handle, thereby lead to decline in production and adverse effect on FCR. Similarly levels of incorporation of applepomace (10% without enzyme supplementation and 15% with enzyme supplementation) have been advocated in broiler chicken (Bhat *et al.* 2000, 2003). Kong *et al*. (2010) found that incorporation of fermented apple pomace as growth promoter in egg type chicken @ 1% level lead to higher egg production.

Other non-conventional feed ingredients in layer diets like tomato pomace (Persia *et al.* 2003, Mansoori *et al.* 2008), olive pulp (Zarei *et al*. 2011), wheat middling (Kaveh and Tahir 2010) were incorporated with varying levels with or without enzyme supplementation to spare conventional feed ingredients and thereby economizes production.

Maize could be replaced to the extent of 10% without enzyme supplementation and 15% with enzyme supplementation in layer diets without adversely affecting the production performance and feed conversion ratio.

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