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Full Length Research Paper

Performance of chicken broilers fed with diets substituted with mulberry leaf powder

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The effect of substituting commercial broiler diet with mulberry leaf powder on feed intake, growth rate and feed conversion efficiency was studied. Treatment diets were prepared by substituting 20, 30, 40 and 50% with mulberry leaf powder to commercial broiler feed. The crude fibre and crude protein contents of the treatment diets were higher than those of the control (100% commercial feed) but the crude fat content was lower. No significant difference (*p*>0.05) in feed intake was observed for broilers fed with diet containing up to 30% mulberry leaf powder but significant decrease (*p*>0.05) was observed for broilers fed with diet of more mulberry leaf powder. Broilers fed diet containing more than 40% mulberry leaf powder also had significantly lower (*p*>0.05) body weight at the end of the trial. Feed conversion ratio (FCR) was significantly higher (*p*>0.05) in broilers fed diet containing 40% or more mulberry leaf powder compared to other diets during week 1 and 2. No mortality was recorded in broilers fed diet containing up to 30% mulberry leaf powder. In conclusion, this study showed that mulberry leaf powder can substitute up to 30% of commercial feed without any adverse effect on the feed intake, growth, FCR and mortality of the broiler chicken. An estimated cost reduction of 24.82% for starter feed and 26.09% for grower feed was recorded.

Key words: Broiler chicken, feed intake, growth performance, mulberry leaf.

INTRODUCTION

Poultry production cost has gone up substantially in recent years due to the increase in price of feed ingredient particularly soya bean and corn (Raghavan, 2009). Since feed cost is a major expense in poultry production, accounting for 60 to 70% of total production cost (Chang, 2005), the search for cheap, locally available and equally nutritive feed source to partially substitute commercial poultry diet has never been more pressing (Preston, 1995; Wong and Tan, 2009).

Mulberry (*Morus alba*) has a huge potential as alternative feed source because of the large amounts of high quality forage it produces (Sanchez, 2000). Yields of about 40 tonnes /ha/year of fresh leaves have been reported in India (Mehla et al., 1987). Summarizing the data from different countries, Sanchez (2000) reported yields of edible materials (leaves and young stems) and total biomass of 15.5 and 45.2 tonnes of dry matter per hectare per year. Shivakumar et al. (1995) reported that mulberry is nutritious and nontoxic. Mulberry fodder does not contain tannin and phenol or are only present in very small quantities (Singh and Makkar, 2002). Mulberry leaves are rich in protein, calcium and ascorbic acid and also contain carotene, vitamin B1, folic acid, folinic acid

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and vitamin D (Schmidek et al., 2002; Sarita et al., 2006). Comparing to soya bean, the main source of protein in commercial poultry feed, mulberry leaves have higher amino acids content (Al-Kirshi et al., 2010). Based on their high nutritional value and favorable condition for cultivation in the tropics, mulberry has a very high potential as alternative feed source to be further assessed. Due to the high fibre content in mulberry, most researches have tested it as food source for animals whose digestive system can handle fibrous diet. Fresh mulberry leaves have been fed to herbivores such as dairy cattle (Sanchez, 2000; Ramesh et al., 2003), goats (Kouch et al., 2003; Nguyen et al., 2005), sheep (Ramesh et al., 2003; Kandylis et al., 2009) and rabbits (Prasad et al., 2003; Bamikole et al., 2005). Sadi et al. (2007) suggested that mulberry could be fed in larger quantities, even in excess of 50% of ruminant ration. Ground mulberry leaves have also been fed to non-ruminants such as layers (Lokaewmanee et al., 2009; Al-Kirshi et al., 2010). However, there is dirt of information on the feeding of ground mulberry leaf to broilers. Nonetheless, the higher amino acid content of mulberry leaf meal compared to soya bean meal suggest that it might just compensate for the negative effect that high fibre content might have on broiler performance. Therefore, this experiment was conducted to assess the effect of substituting commercial broiler diet with up to 50% mulberry leaf powder (MLP) on feed intake, growth rate, feed conversion ratio and mortality of broiler chickens.

MATERIALS AND METHODS

The trial was conducted at the poultry unit in Universiti Putra Malaysia Bintulu Sarawak Campus, Malaysia. A total of 200 heads of one day-old broiler chicks (Ross Breed) of both sexes with weights ranging from 35 to 45 g were used in this study. Chicks were reared in a raised floor system in cages of 2.5' × 5' with a capacity of 10 chicks/cage for a period of 42 days. A 100-watt electric bulb was used as heat source for the brooding and early growth period of 6 weeks. The brooding temperature was 33°C at the first week and this decreased gradually at the rate of 3 to 4°C per week until it reached to normal room temperature. Chicks were allocated at random to the five dietary treatments (Table 1).

Four to six month-old fresh mulberry leaves with stems were collected from Sematan Silk Farm in Kuching, Sarawak, Malaysia. The leaves were carefully separated from the stems and their fresh weights were determined. The leaves were then dried under direct sunlight for about 4 h before being transported back to Bintulu, Sarawak, Malaysia. The leaves were then dried in an oven at a temperature of 60°C for 24 h or until constant weight was achieved. Samples were ground using a Grinder (Cutting Mill, SM 100; Brand Rettsch from Rheinische, Germany) to a particle size of 0.5 mm. The MLP was then mixed with the commercial feed to prepare the treatment diets. Commercial starter and grower feed used in this study were obtained from Gold Coin Feed Mill in Kuching, Sarawak. In this experiment a straight forward substitution of commercial feed with MLP was used as this would be easier to implement by small holder farmers.

The chicks were fed with either 100% starter feed or treatment diet from day 1 to 21. The starter feed were then replaced with the grower feed until slaughter at day 42. Feed were prepared weekly and stored in airtight containers at room temperature. Clean water was provided *ad-libitum* at all times during the study.

Treatments were laid out in a split-plot design with two feeding regimes as main-plots and five dietary treatments as sub-plot treatments. Ten chicks were allocated per treatment combination and all treatments were replicated twice.

All chickens were weighed individually before the morning feeding on a weekly basis until the seventh week (day 7, 14, 21, 28, 35, and 42) to determine their growth rate. Feed intake was determined on daily basis as the difference between the quantity of feed given the previous day and the quantity left the next morning. Feed Conversion Ratio (FCR) was calculated as the ratio of feed intake over body weight gain. Mortality was recorded on a daily basis throughout the 42 days rearing period.

All data, except mortality, were subjected to analysis of variance (ANOVA) at $p<0.05$ while differences between means were compared using the Duncan's New Multiple Range Test (DMRT). Analysis was carried out using the SAS Package (Ver. 9.1).

RESULTS AND DISCUSSION

Chemical composition of diet

The MLP used in this study contained 24.81% crude protein, 16.87% crude fibre and 2.97 % crude fat (Table 2). Similar values were reported by previous authors. For example, Nguyen and Le (2003) reported crude protein values ranging from 22.2 to 24.3% of dry matter while Sanchez (2000) reported crude protein values ranging from 15 to 28%. Bamikole et al. (2005) reported that crude protein, crude fibre and crude fat contents of mulberry leaf were 23.2, 38.4 and 3.2%, respectively. The crude protein and crude fibre contents of MLP were 48 and 368% higher respectively, than the grower feed used in this study. Consequently, when the commercial feed was incrementally replaced by MLP, the crude protein and crude fibre contents of the mixture increased (Table 2). This can lead to contrasting effect on feed intake where one would expect the higher crude protein content to have a positive effect while the high crude fibre content would have a negative effect.

In contrast, the substitution with MLP significantly decreased ($p<0.05$) the level of crude fat content compared to the commercial feed. Gross energy reduced significantly ($p<0.05$) in diet containing 30% or more MLP. This was predictable as MLP had very low crude fat content (2.97%). Thus, when MLP was added to commercial feeds, the levels of crude fat and gross energy in the mixture will be reduced.

Feed intake

The effect of substituting 20, 30, 40 and 50% of commercial feed with MLP on feed intake is shown in Table 3.

Table 1. Dietary treatments.

Treatment	Day 1 to 21		Day 22 to 42	
	Starter feed (%)	Mulberry leaves (%)	Grower feed (%)	Mulberry leaves (%)
T1	100	-	100	-
T2	80	20	80	20
T3	70	30	70	30
T4	60	40	60	40
T5	50	50	50	50

Table 2. Chemical composition of mulberry leaf and treatment diets containing 0 (T1), 20 (T2), 30 (T3), 40 (T4) and 50% (T5) MLP.

Variables	MLP	Day 1 to 21					Day 22 to 42				
		T1	T2	T3	T4	T5	T1	T2	T3	T4	T5
Moisture (%)	8.33^{a}	8.74^{a}	8.16^{a}	9.20^{a}	8.91^{a}	9.19^{a}	9.46^{a}	8.51^{a}	9.24^{a}	9.10^{a}	8.46^{a}
Gross energy, (MJ/kg)	17.73^{b}	19.48^{a}	20.72^{a}	17.63^{bc}	17.08^{bc}	16.22^{c}	18.67^{ab}	19.15^{a}	17.13^{cd}	16.93^{cd}	16.32^{d}
Crude protein (%)	24.81^{d}	23.15^{e}	23.45^{e}	25.07^{c}	26.02^{b}	27.06^{a}	16.75^{d}	17.19^{cd}	17.59^{c}	17.87^{c}	18.60^{b}
Crude fibre (%)	16.87^{a}	3.90^{e}	6.23^{d}	7.44^{c}	8.41^{c}	9.57^{b}	3.60^{e}	6.09^{d}	7.16^{cd}	7.66^{c}	9.56^{b}
Crude fat %	2.97^{e}	7.58^{a}	6.73^{b}	6.85^{b}	6.13^{c}	5.11^{d}	7.77^{a}	6.73^{b}	6.68^{b}	5.84^{c}	4.83^{d}

Means within rows with the same superscripts are not significantly different (p>0.05) according to DMRT.

Table 3. Effect of substituting MLP on mean feed intake (g/day).

Diet	T1	T2	T3	T4	T5
Starter (1 to 21 days)	35.17^{a}	34.26^{a}	33.56^{a}	25.06^{b}	21.63^{b}
Grower (22 to 42 days)	95.70^{a}	95.35^{a}	94.41^{a}	84.45^{b}	75.14^{c}

Means within rows with the same superscripts are not significantly different (p>0.05) according to DMRT.

Throughout the 42 days feeding period, no significant difference in feed intake was observed for broilers fed with starter, grower or diet substituted with up to 30% MLP. However, when mulberry substitution exceeded 40%, a significant reduction (p<0.05) in feed intake was observed for both starter and grower phase. A similar finding was reported by Bamikole et al. (2005) with rabbit whereby, daily meal intake (DMI) was not significantly different until substitution rate exceed 50%. In contrast Al-Kirshi et al. (2010) reported that feed intake of laying hens was significantly reduced when the diet contained 10% mulberry leaf meal.

Feed intake decrease at substitution rate above 30% indicates that the positive attributes of higher amino acid content in MLP (Machii, 1989) can no longer compensate for the negative effect of high fibre content of feed. The percentage of insoluble fibre has probably exceeded the consumable threshold for the chicken. Unlike that of ruminants, the digestive tract of chicken lacked the necessary micro-organism which can digest fibre, so diet containing high fibre can lead to indigestion and reduction in feed intake. In addition to that lower feed intake of diets containing high levels of MLP could also be a result of the bitter and astringent taste of the mulberry leaves (Machii, 1989; Ly et al., 2001) affecting palatability and hence appetite (Behnke, 2001). Similar findings have been reported by Kyriazakis and Emmans (1995) and Tsaras et al. (1998) in pigs where feed refusal was observed in rations that contain more than 30% of mulberry leaf meal.

Growth performance

The significant negative effect of high level substitution on feed intake is translated into lower body weight at day 42. As shown in Table 4, no significant difference in the final live body weight was observed for chicken fed with diet containing up to 30% MLP. However, at higher substitution levels, live body weight at 7week of age was significantly lower (p<0.05) compared to the control. Final body weights of chickens fed diet containing 40 and 50% MLP were significantly lighter (p<0.05) by 14.1 and

Table 4. Effect of substituting MLP on live body weight.

Weight (g/bird)	T1	T2	T3	T4	T5
Initial body weight	41.15^{a}	42.28^{a}	42.38^{a}	41.30^{a}	40.45^{a}
Final live weight	2047.17^{a}	1991.67^{a}	1994.25^{a}	1758.58^{b}	1265.67^{c}

Means within rows with the same superscripts are not significantly different (P>0.05) according to DMRT.

Table 5. Effect of substituting MLP on FCR.

Week	T1	T2	T3	T4	T5
1	1.25^{d}	1.98^{b}	1.71^{c}	2.94^{a}	3.04^{a}
2	1.39^{b}	1.33^{b}	1.63^{b}	1.17^{b}	2.98^{a}
3	1.52^{ab}	1.67^{a}	1.59^{ab}	1.23^{c}	1.34^{bc}
4	1.55^{a}	1.55^{a}	1.51^{a}	1.32^{a}	1.46^{a}
5	1.41^{a}	1.26^{a}	1.51^{a}	1.30^{a}	1.77^{a}
6	1.28^{a}	1.33^{a}	1.25^{a}	1.35^{a}	1.58^{a}

Means within rows with the same superscripts are not significantly different (P>0.05) according to DMRT.

38.2% compared to those of chickens fed the control diet. The low body weight of chicken fed diet containing 40% or more MLP can be attributed to reduced supply of energy and nutrients caused by low feed intake. It was reported that most of the energy and nutrients consumed by birds younger than four weeks of age would contribute to growth while after four weeks most of the available nutrients would contribute towards the maintenance of the body (Saki, 2005; Panda and Reddy, 2007). Thus, when energy and other nutrients are deficient during the early stage of a bird's life, growth will be retarded (Deaton, 1995; Dibner et al., 1998; Hossain et al., 2008). It is also possible that the high fibre content of mulberry leaf interfered with protein utilization (Deloreme and Wojeik, 1982).

Poor growth performance in broilers fed with more than 40% MLP could also be due to nutrient imbalance. Commercial feeds are formulated and balanced to meet the nutrient requirement of chicken at different stage of growth. However, in this experiment, the simple substitution of commercial feed with MLP, which is rich in terms of protein and fibre, might have altered such balance in nutrient content of the feed. The effects could be magnified with the reduction in feed intake leading to significant drop in growth performance. Observation during the first week of this study showed that when more than 40% of the feed was substituted with MLP, broilers began to show some refusal in eating the feed during the first seven days and only began to show some adaptation thereafter. Such refusal could have led to a reduced feed intake at an early age resulting in reduced body weight, which failed to recover by the time the broilers were sold at 42 day of age.

Feed conversion ratio

Feed conversion ratio (FCR) is an important indicator on how efficient a feed can be converted to meat. This study showed that FCR was significantly higher ($p<0.05$) in chickens fed with diet containing more than 40% MLP compared to those fed with diet containing 0, 20 and 30% MLP (Table 5). The effect on FCR was only evident up to week 3 and by week 4 to 6, no significant difference was observed for all treatments.

Differences in FCR depend on two factors, namely growth rate and feed intake and both are affected by the quality of the diet. High FCR is obtained when feed intake is low and growth rate is high as would happen with an unbalanced diet. It is known that high fibre content reduces feed intake in broilers (Janssen and Carré, 1985) but the better amino acid composition in mulberry leaves (Al-Kirshi et al., 2010) could have compensated for this effect. This may explain why low FCR were recorded for chicken fed diet containing 40% MLP, for example at 3 weeks of age. The effect on FCR may also be a reflection of the different amino acid requirement at different stage of growth of broilers.

Mortality

No adverse effect was observed on the survival rate of broilers when substitution with MLP less than 30% (Table 6). Nonetheless, some mortality was observed during week 1 to 4 for substitution level of 40% and more. Mortality was eventually reduced during the later grower phase of the broilers. The high mortality rate during the

Table 6. Number of dead birds according to supplementary MLP.

Feed phase	Week	T1	T2	T3	T4	T5
Starter	1	0	0	0	3	7
	2	0	0	0	3	5
	3	0	0	0	3	3
Grower	4	0	0	0	2	1
	5	0	0	0	0	0
	6	0	0	0	0	0

Table 7. Cost of feed for 30% substitution level in Malaysian Ringgit (RM)

Variable		Cost of Feed (RM)*
Commercial starter feed (100%)	X_S	93.74
Commercial starter feed (70%)	Y_S	65.36
Mulberry leaves (30%)	Z_S	5.11
Cost reduction (starter feed)	$[(X_S-Y_S-Z_S)/X_S)] \times 100\%$	24.82%
Commercial grower feed (100%)	X_G	209.16
Commercial grower feed (70%)	Y_G	146.66
Mulberry leaves (30%)	Z_G	7.92
Cost reduction (grower feed)	$[(X_G-Y_G-Z_G)/X_G)] \times 100\%$	26.09%

* for 40 heads for 42 days

early broiler stage could be attributed to the reduction in feed intake observed during the starter period (Table 2) which generally affected the live weight of broilers.

Broiler chicks initially refused to feed on diets, which contained 40% or more MLP. Slow adaptability to mulberry substitution may have caused broilers to reduce their feed intake during the early stage of growth leading to starvation, depressed immune response and eventually death (Panda et al., 2006). Conversely chick's immune response can be improved through good nutrition (Panda and Reddy, 2007).

Reduction in feed cost

The positive effects of incorporating up to 30% MLP in broiler diet include a substantial reduction in feed cost and hence cost of production. Based on costing shown in Table 7, an estimated cost reduction is 24.82% for starter feed and 26.09% for grower feed.

Conclusion

It can be concluded that up to 30% of commercial feed can be substituted with MLP without adversely affecting feed intake, growth performance and mortality. At 30% level of substitution a cost reduction of 24.82 and 26.09% is possible at the starter and grower phase.

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