EVALUATING HIGH AND LOW NUTRIENT DENSITY FEED FOR THE FINISHING STAGES OF MUSCOVY BROILER DUCKS

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ABSTRACT

Since growing ducks are less efficient converters of feed than chickens, there could be economic advantage if duck feeds can be of lower nutrient density and cheaper than chicken feeds. Low nutrient density feeds are mainly formulated from cheaper feed resources. This study aimed to evaluate the performance of broiler Muscovy ducks during the finishing stage on a high nutrient density broiler chicken feed and a low density commercial feed formulated from locally available agro-industrial by-products such as copra meal and wheat mill-run for feeding rabbits. The results show that ducks on the high nutrient density feed have a higher weight gain than those on rabbit feed. However, costs per kilogram of liveweight gain show no significant difference between feeds. Break-even or threshold ratios at which low intensity feeds can be competitive with the high intensity feed were determined. The commercial rabbit feed proved as economic as broiler finisher but it will take a longer time for ducks to reach marketable weight. If a low nutrient density feed equivalent to the rabbit pellet can be developed to feed ducks during the finishing stage, the ratio of prices (commercial broiler finisher: low density feed) must be higher than the threshold of 1.72 for males and 1.67 for females to make it economical.

Key Words: *Muscovy ducks; cost of growth; low intensity feeding*

INTRODUCTION

Domestic ducks are not native to Papua New Guinea (PNG) but were introduced by early missionaries at the turn of the century. The popular breed in PNG is the Muscovy duck (*Cairina moschata)*, although other breeds such as the Khaki Campbell (*Anas platyrhynchos*) exist in limited quantities. The spread of ducks around the country was more recent than for chickens with the first recorded organized distribution of Muscovy ducks by the Department of Agriculture, Stock and Fisheries (DASF) in 1974 (Quartermain 2000a). Only the Muscovy ducks have been adopted into the subsistence farming system. Muscovy ducks are being promoted by the National Agricultural Research Institute (NARI), Salvation Army in Eastern Highlands and other NGOs, the Food Security Branch of the Department of Agriculture and Livestock (DAL) and several provincial governments. These ducks are widely promoted as dual purpose birds for rural farming communities to keep under semi-intensive systems. In these systems, ducks for meat can be eaten at around four months of age, while breeders can be kept for about two years.

Reports from consultations with farmers and extension officers have shown that duck keeping and interest in keeping ducks is increasing among smallholder farmers in rural and peri-urban areas (Quartermain 2000b and NARI Nius 2002). With the need to improve production of Muscovy ducks, many duck farmers are utilizing commercial feeds. For growing Muscovy ducks for meat, some farmers are using broiler chicken feeds to raise them to around 12 weeks, when they are sold (NARI Nius 2002). These commercial poultry feeds are expensive. Most of the raw materials like grains and soybean meal for poultry feeds are imported, with only small amounts of maize and sorghum and low quality fishmeal and wheat milling by-products (millrun) available locally. Hence the cost of producing these feeds is high.

The commercial poultry feeds used to feed ducks are of high nutrient density. Since ducks eat more feed than chickens for the same growth, it can be uneconomical to feed high nutrient density feeds to ducks. It would be appropriate if suitable feeding systems based on increased content of available and cheaper feed resources such as agro-industrial by-products be developed. Although some farmers have raised their ducks under free-ranging systems with supplementary feeding, it takes a long time for these ducks to reach marketable size. It takes nearly 20 weeks to raise a duck to marketable size under a free-ranging system with supplementary feeds of kitchen wastes, surplus food crops and waste fruits. This makes it necessary to develop low nutrient density commercial feeds for duck farmers in peri-urban areas or homemade ration mixes for duck farmers in rural areas. With this development, more

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farmers will be encouraged to venture into duck keeping activities in rural and peri-urban areas leading to food security, adequate supply of household protein and cash income. This research, as part of the NARI livestock programme to develop low cost poultry feeding systems, aimed to test a low nutrient density feed against the standard commercial broiler feed during the finishing stage of Muscovy broiler duck production. It was expected that the recommendations from this research would lead to subsequent development and field-testing of a low intensity commercial feed or home made rations based on agro-industrial by-products (copra meal, wheat millrun, palm kernel meal and pyrethrum marc) for ducks.

Muscovy duck feeding

Although much poultry feed and nutrition information is available locally for chickens, very limited information is available for Muscovy ducks. Local duck feeding studies include Abdelsamie (*unpublished*) on protein and energy requirements of Muscovy ducks in the PNG environment, Bilong (1981) on the performance of Muscovy ducks on sweet potato, and Bakau and Tom (1996) on *yawa* banana in feeding Muscovy ducks. Effective feeding and management systems for duck keeping under subsistence and semi-subsistence systems are described by Abdelsamie (1979) and Bauer (1980). Overseas studies include Leclercq and Carville (1986a) and Leclercq and Carville (1986b) describing the growth and body composition of Muscovy ducks in France and dietary energy, protein and phosphorus requirements of Muscovy ducks. The review of nutrient requirements for meat type ducks by Dean (1986), with his recommended nutrient levels in diets, provides useful information for developing duck feeds.

Studies by Abdelsamie (*unpublished*) on Muscovy ducks during the first six weeks of life showed that growth rate and feed conversion of males and females were similar during the first and second week, but then males started to grow much faster and converted their feed more efficiently than females. The same study on the effects of varying energy and protein levels in diets showed that the fastest growth rate by males and females was achieved with a diet of 20 percent crude protein and metabolizable energy of 10.46 MJ/kg. It was reported that ducks have higher weight gains on the low energy diet compared to other diets of 11.72 MJ/kg and 12.56 MJ/kg, while low protein diets of 15 percent did not give good growth rates and feed conversion. It was also reported that increased protein level in the diet for male Muscovy ducks seemed to be producing faster growth rates, while female Muscovy ducks seemed to tolerate low protein levels better than males.

Bilong (1981) studied the performance of Muscovy ducks from 45 days old on cooked and mashed sweet potato (*Ipomoea batatas* L. Lam) supplemented with meat and bone meal. Sweet potato was chosen because it is an important food crop in PNG, the leaves can be fed for supplementary vitamins and it is available in large quantities. Male and female ducklings were kept separate, fed broiler starter for 45 days *ad lib* and then fed four different diets of broiler finisher and sweet potato. The diets were broiler finisher (18% crude protein) and different levels of sweet potato and meat and bone meal with protein levels of 16, 18 and 20 percent. Results showed that males had faster growth rates than females (50g/day vs 35g/day), with a higher body weight at 45 days (2361g vs 1652g) on broiler starter. After 45 days, the performance of ducks on broiler finisher was better than that on sweet potato based diets with a growth rate of 28g/day compared to ducks on sweet potato with 17g/day, 16g/day and 23g/day for 16, 18 and 20 percent protein diets respectively. Corresponding body weights at slaughter were 3500g, 2920g, 2950g and 3360g respectively for the diets.

Growth of Muscovy ducks is characterized by very pronounced sexual dimorphism and slower development than in Pekin ducks (Leclercq and Carville 1986a). Sexual dimorphism appears after two or three weeks of age as shown by Abdelsamie (unpublished), Bilong (1981) and Leclercq and Carville (1986a). In France, the maximum live weight of male and female Muscovy ducks is reached at 12 and 10 weeks respectively (Leclercq and Carville 1986a). The maximum daily gain of 80g/day in males occurs at seven weeks of age and falls rapidly afterwards. In females, the maximum daily weight gain is considerably less (a little more than 50g/day) and occurs at six weeks of age. Muscovy ducks are slaughtered at 10 weeks of age for females and 11 – 12 weeks of age for males when their growth rate has fallen almost to zero. Leclercq and Carville (1986a) highlighted that this was very different from other poultry species such as chickens or turkeys.

MATERIALS AND METHODS

The research trial was conducted at the NARI Labu Livestock Research Center situated at latitude 06° 40′ South and longitude 146° 54′ East and receiving an average annual rainfall of about 2900 mm.

The trial design was a factorial experiment using a completely randomized design with two factors, feed and sex, each at two levels. The two feed types were commercial rabbit pellets (RP) (Grant *et al.* 1996) and broiler finisher pellets (BF) from the Lae Feed Mills (Goodman Fielder Limited). A total of 48 ducklings with equal numbers of males and females were sexed immediately after hatching and randomly allocated to small brooder pens (1 x 1 m) with males and females reared separately for five weeks on commercial broiler starter. After five weeks, the ducklings were weighed again and allocated into 16 experimental pens (3 x 4 m) with three birds of the same sex randomly selected for each pen. There were eight pens on each side of the growing shed.

Ducklings were fed *ad libitum* broiler starter feed for the five weeks before starting the experimental phase. In the experimental phase (6 -12 weeks), rabbit pellets and broiler finisher feed were fed *ad libitum* with daily weighing of feed given and uneaten residuals and weekly weighing of birds. The three birds in each pen were tagged with different coloured rubber bands to monitor individual growth. Statistical analyses were done on the final weight, weight gain and weekly weights on an individual basis while other variables were analysed on a pen mean basis.

It was assumed that standard broiler commercial feed would give better growth rates than the low density feed in terms of intake and hence the latter ducks would eat more to compensate their requirements. It was decided to determine the price (or cost of feed) ratio between the high intensity (high nutrient density) feed and the lower intensity feed such that the feed cost of producing a kilogram of liveweight during the finishing period of a bird would be equal. This can be considered as the break-even or threshold ratio. Any value of the ratio of actual feed prices above the threshold would indicate an economic advantage in favour of the lower intensity system. An increase in the actual ratio could occur if the high intensity feed price rose or the cost of lower intensity feed can be reduced relatively.

The threshold ratio is calculated as follows and is independent of the actual feed prices.

Cost of 1 kg of liveweight gain on the high intensity feed = $\frac{\text{(Intake H) (Price H)}}{\text{(Gain H)}}$

Cost of 1kg of liveweight gain on the low intensity feed = $\frac{\text{(Intake L) (Price L)}}{\text{(Gain L)}}$

At the threshold,

$$\frac{\text{(Intake H) (Price H)}}{\text{(Gain H)}} = \frac{\text{(Intake L) (Price L)}}{\text{(Gain L)}}$$

And the Threshold Ratio of Feed Costs (TRFC),

$$\frac{\text{(Price H)}}{\text{(Price L)}} = \frac{\text{(Intake L) (Gain H)}}{\text{(Intake H) (Gain L)}}$$

Table 1. **Average weekly weights (grams) from five weeks to 11 weeks for the four treatment groups**

Feed (F)	Sex (S)	Wk 5	Wk 6	Wk 7	Wk 8	Wk 9	Wk 10	Wk 11
Boiler Finisher Pellet	Male	1165	1600	2016	2365	2630	2872	3091
Boiler Finisher Pellet	Female	996	1274	1539	1720	1849	1922	1999
Rabbit Pellet	Male	1197	1462	1816	2029	2311	2579	2759
Rabbit Pellet	Female	963	1148	1343	1475	1523	1655	1731
Significant effects ($p<0.05$)		S	F, S	F, S	F*S	F, S	F, S	F, S
Lsd (p=0.05)		51	43	58	59	138	82	77

Table 2. **Average final weight (FW), weight gain (WG), feed conversion ration (FCR), feed intake (FI), and cost per kilogram gain (CKG) for the four treatments.**

Feed (F)	Sex (S)	Final weight (g)	Weight gain (g)	Feed conversion ration (pen basis)	Feed Intake (pen basis) (kg)	Cost per Kilogram (K)
Boiler Finisher Pellet	Male	3165	1999	3.72	22.34	3.53
Boiler Finisher Pellet	Female	2014	1018	4.88	14.88	4.63
Rabbit Pellet	Male	2816	1618	6.38	30.93	3.50
Rabbit Pellet	Female	1796	834	8.22	19.90	4.46
Significant effects ($p<0.05$)		F*S	F*S	F, S	F*S	S
Lsd (p=0.05)		89	111	0.81	0.94	0.47

RESULTS

Results of the analyses are presented in Tables 1 and 2, while growth curves across the 12 weeks are depicted in Figure 1.
The week five weights are prior to the feeding of the two treatment diets. These initial weights show a significant sex difference ($p<0.05$) in weights, while the consecutive weeks also show significant differences ($p<0.05$). From week six to week 11, there are also significant differences between feeds ($p<0.05$). At week 8, there was significant ($p<0.05$) interaction between sex and feed.

For final weight, weight gain and feed intake, there are significant differences ($p<0.05$) in main effects of sex and feed and also significant ($p<0.05$) interactions. For the feed conversion ratio, there are significant differences ($p<0.05$) for sex and feed. For cost per kilogram of liveweight gain there are no significant differences ($p>0.05$) for feed but there are significant differences ($p<0.05$) for sex.

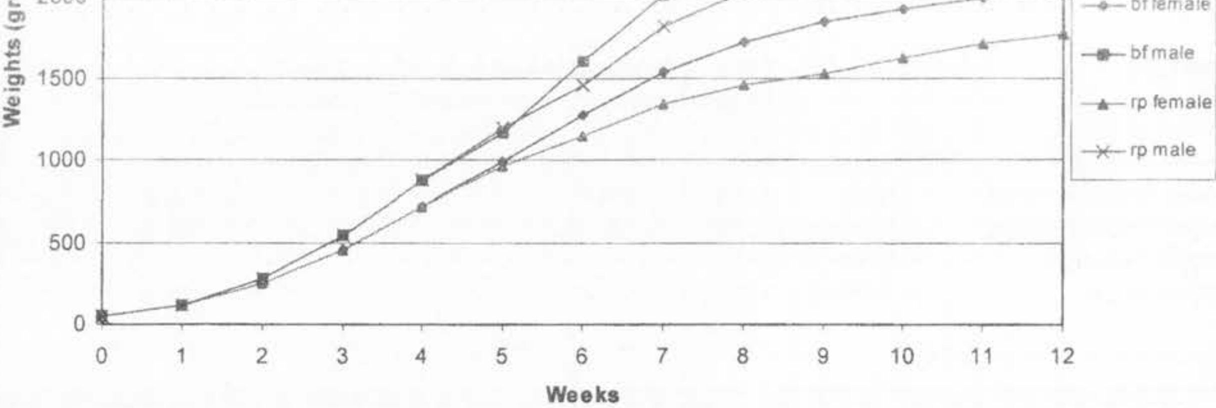
The TRFC (Threshold Ratio of Feed Costs) values are 1.72 for male and 1.67 for female Muscovy broiler ducks. With the cost of BF and RP at PNG Kina 0.95 and Kina 0.55 respectively, the actual cost ratio of the feeds at the time of the study was 1.73, meaning that for males the cost of producing one kilogram of gain was about equal for the two feeds. There could be a slight advantage in feeding females on the lower priced feed.

DISCUSSION AND CONCLUSION

Male ducks are heavier than females with higher weight gains, better feed conversion and higher intakes over 12 weeks. Sexual dimorphism is as reported by Abdelsamie (*unpublished*), Bilong (1981) and Leclercq and Carville (1986a). As shown in Table 1 and Figure 1, males are heavier than females at least as early as three weeks of age and were heavier than females when the treatment diets were introduced at five weeks.

From the evaluation of the two feeds, ducks on high nutrient density broiler finisher have higher weight gains, better feed conversion and lower feed intakes than those on the lower intensity rabbit feed. The broiler finisher has more nutrients to meet their requirements compared to the same amount of the low intensity rabbit feed. Therefore, on rabbit pellets the ducks consume more of the feed to meet their requirements. Comparison of the two feeds in terms of the cost of a kilogram of weight gain shows that the low intensity and cheaper rabbit pellet is competitive with but not better than the high intensity broiler finisher. At the prices current at the time of the study, the cost of producing a kilogram of weight gain for broiler Muscovy ducks is similar for either feed. Males are cheaper to produce since they have a higher growth rate than females. TRFC value for males and females (1.72 vs 1.67) shows that the cost of producing a kilogram of gain was equal for males on the two feeds while females may have a slight advantage on the lower priced feed.

Figure 1. Weekly weights of male and female broiler ducks on broiler starter (0-5 wks) and broiler finisher or rabbit pellets (6-12 wks)



Studies by Abdelsamie (*unpublished*) have shown that under lowland conditions, a low energy diet of 10.46 MJ/kg gives adequate growth rates. Since there is less demand by ducks for energy compared to broiler chickens, commercial broiler starter and finisher feed may not be the most economical for feeding ducks. Even with commercial rabbit pellets having high fibre and lower energy density compared to broiler finisher, we could not assume that ducks would not grow properly on this feed. In this study, broiler ducks grew well on broiler finisher and were heavier at 12 weeks of age. However, in terms of the cost of a kilogram of liveweight, there was no difference between the two feeds. If the price of the broiler finisher increases at a faster rate than that of rabbit pellets giving a ratio greater than the TRFC, low nutrient density feed can be profitably fed to ducks despite the longer time to reach marketable size.

This study shows that the low nutrient density rabbit feed is as good as broiler finisher. The TRFC values found are 1.72 for males and 1.67 for females. If low nutrient density feeds based on copra meal, wheat millrun or other by-products and having a similar nutrient value to rabbit pellet can be formulated to feed ducks at a low enough price to give a price ratio with broiler finisher greater than the TRFC values, then the cost of production can be considerably reduced. It is very important that minimal cost rations for ducks should be developed using locally available agro-industrial by-products such as copra meal and wheat millrun.

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