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Response of Skip-a-Day Limit Fed Growing Pullets as Affected by Increased Micro-Nutrient Content in Diets under Semi Arid Swaziland

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Abstract: The study investigated growth and feed-cost benefit of limit-fed growing pullets as affected by increased micro-nutrients content in diets. Grower diet (1) was used as a control. Treatments 2, 3 and 4 pullets were deprived of 10, 20 and 30% plain feed to appetite respectively, while treatments 5, 6 and 7 were on the same limit-feeding, but with 25% increased micro-nutrients content each. Four hundred and twenty, 9- week old Hi- line W-77 were randomly divided into 7 groups of 60 birds with 3 replicates per group. Birds were allowed one day *ad libitum* feeding for all the groups, followed by 2-day limit feeding. Results showed 30% plain feed limit-fed pullets to be significantly ($p<0.05$) least in the final body mass, but birds on 10 and 30% diets with increased micro-nutrient were statistically comparable to those in the control. Daily mass gain was higher ($p<0.05$) in the 10 and 20% limit-fed pullets with increased premix than other groups. Birds on the control diet significantly ($p<0.05$) consumed more feed and the feed conversion was superior ($p<0.05$) in the limit-fed pullets with increased micro-nutrient content. It was more expensive to produce kg/mass in the control and 10% plain feed limit-fed pullets. The study concluded that limit-feeding of 9-week old pullets containing 25% increased micro-nutrient in the diets has comparable response in growth performance with superior economic advantage even at 30% feed restriction. Further investigation to determine the optimal premix usage at what level of restriction, will provide added information.

Key words: Limit-feeding, pullets, micro-nutrients, performance, feed-cost, Swaziland

INTRODUCTION

The scarcity of feed ingredients and exorbitant cost of finished feeds have been some of the factors that militate against cheaper delivery of poultry products to consumers. Despite the phenomenal increased production performance of the modern poultry birds as a result of advanced genetics, nutrition and husbandry methods, the industry has continued to experience feed problems asserted to account for 60-80% of the total cost of intensive poultry production (Barnejee, 1998; Oluyemi and Roberts, 2000). In recent decades, nutritionists have extensively researched on the feed situation through alternative feed formulation (Babatunde, 1989), probiotics (Ahmad and Taghi, 2006) and modified plant feedstuffs (Ishibashi and Yonimochi, 2003). The competition of poultry with man for common feed items due to the similarity as simply stomach animals, also aggravated the precarious feed problems of the industry.

One of the major areas of controversy in the feed problem has been the concept of feed withdrawal or restriction of the quantity or quality of feed that birds could voluntarily consume for production. As a practice, feed withdrawal, restriction or limit-feeding has often been imposed essentially for husbandry reasons including force-moulting (Swanson and Bell, 1970; Bar *et al*., 2001) eggs glut (Isika *et al*., 1998) and improved health (Zubai and Leeson, 1996) or for maximum profit (Richard and Jacqueline, 2000). However, 'Animal Right and Welfare Groups' have criticised any form of animal restriction which they considered to be an infringement on the right of existence (Millman, 2002) irrespective of any advocated benefit of the program.

Several researchers including Zubai and Leeson (1996) and Benyi and Habbi (1998) have contended that, meat-type poultry breeds on *ad libitum* feeding experienced high fat deposition, mortality, incident of metabolic diseases and skeletal disorder and so favour

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the need for feed restriction. On the other hand, when broilers were subjected to 60% feed restriction early in life for some days, birds were able to withstand high ambient temperature as juveniles, showed better survival, growth rate and anti-body production than those not fasted. In any case, it has been observed that a specific body mass of pullets at the on set of lay was necessary to optimise ovarian function at sexual maturity (Hocking, 1993) thus making *ad libitum* feeding a *sine qua non*. Supportive evidence showed that feed-restricted pullets suffer delayed growth rate and increased mortality (McDonald *et al*., 1996). It seems therefore, that the argument on limit-feeding will require a humane approach which should enhance poultry welfare, so as to harness the advantages of the concept. Hitherto, information in respect to limit-feeding of rearing pullets as mitigated by increased micro-nutrients is still scanty.

The current study therefore, was conducted to determine the response of skip-a-day limit-fed growing pullets as influenced by increased micro-nutrients content in diets. The growth performance and feed cost-benefit analysis were investigated.

MATERIALS AND METHODS

Location of the study: The research was carried out at the poultry unit of the Teaching and Research Farm, Faculty of Agriculture, Luyengo Campus, University of Swaziland (26^0 $60^/$ S; 31^0 $28^/$ E) located at an altitude of 720 m in the lowveld semi-arid Swaziland. The annual rainfall range was 800-1400 mm, with the temperature and relative humidity of 7.3-29.6°C and 8.5-53.3%, respectively (UNISWA Meteorological Station, 2006).

Diets, design and pullets management: Seven experimental treatment groups were used. Treatment (1) was the group of birds placed on *ad libitum* feeding as the control. Treatments 2, 3 and 4 were deprived of 10, 20 and 30% plain feed to appetite, respectively. Groups 5, 6 and 7 were on 10, 20 and 30% limit-feeding with 25% increased micro-nutrient content in each diet. Four hundred and twenty, 9-week old Hi-line W-77 white Leghorn pullets were randomly divided into 21 groups of 20 birds each in a completely randomised design experiment. Three replicate groups were randomly allocated to a treatment, making a total of 60 birds. The limit-feeding protocol consisted of; the allowance of *ad libitum* feed supply to all the treatment groups for one day, followed by 10, 20 and 30% withdrawal of plain or micro-nutrients fortified feeds for the next two days. The approximate daily feed consumption for pullets to point of lay in the tropics (Oluyemi and Roberts, 2000) was adopted as a benchmark and adjusted accordingly from 9-22 weeks of the experiment. The pullets grower ration used (Table 1) had 200.04 g kg^{-1} crude protein and 2903 Kcal kg^{-1} of metabolisable energy.

The birds were reared in a conventional open-sided deep litter house which was initially washed, disinfected and rested for a minimum of two weeks to break the cycle of pathogens proliferation. The stocking density was 7 birds m^{-2} and the litter materials occasionally stirred for bristle consistency. The pullets were provided identical ventilation, medication and vaccination measures, while feeders and water troughs were regularly cleaned and refilled as specified. The lighting program was maintained at the natural day length of 12 h from the 12 th week of age and increased by 30 min per week until a constant 17 h (Oluyemi and Roberts, 2000). Throughout the experimental period, birds were humanely treated or handled in adherence to the International standard for animal welfare.

Measurements, chemical and data analysis: The experimental birds were initially weighed and thereafter weighing was on weekly basis to obtain initial body mass, final live mass and mass gain. Feed intake was obtained by difference between the total quantity of feed supplied and the remnant at a specific time interval. The feed conversion ratio was calculated as the feed consumed divided by mass gain and the cumulated mortality record

Table 1: Ingredients and chemical composition of experimental grower diets

Ingredients	g kg^{-1}
Maize	455.5
Soyabean meal	143.5
Cotton seed meal	109.9
Wheat bran	103.0
Palm kernel meal	99.0
Limestone	65.4
Dicalcium phosphate	17.9
Minerals[1]-vitamins premix[2]	2.5
Salt	2.5
DL- methionine	0.8
Total	1000.0
Composition (determined)	
Dry matter	912.0
Crude protein	200.4
Crude fibre	62.0
Ether extract	53.0
Met. Energy($Kcalkg^{-1}$)	2903.0
Total Calcium	34.8
Total Phosphorus	7.6
Lysine(% in diet)	6.9
Meth. + Cysteine (% in diet)	5.3

[1]Mineral-Vitamin premix per kilogram diet: Manganese, 80 g; Zinc, 60 mg; Copper, 5 mg; Cobalt, 0.2 mg; Iodine, 1 mg; Selenium, 0.15 mg. [2]Vitamin A, 12000 IU; Vitamin D_3, 2000 IU; Vitamin E,35 IU; Vitamin K_3, 5 mg; Vitamin B, 3 mg; Choline chloride, 35 mg; Vitamin B_2, 6 mg; Niacin, 20 mg; Calcium D-Pantothenate, 6 mg; Vitamin B6, 5mg; Vitamin B12, 0.015 mg; Folic acid, 0.75 mg; D- biotin, 0.045 mg; Vitamin C, 50 mg

kept. The feed cost analysis was computed using variables including feed cost kg^{-1} and daily feed cost/ bird. The cost kg^{-1} mass gain was calculated as feed conversion by cost kg^{-1} feed. A sample of the pullet growers' diet was analysed for the proximate nutrient composition using standard methods of analysis (AOAC, 1990). Metabolisable energy content was computed based on the chemical composition of the feed (NRC, 1994). Data were subjected to one-way analysis of variance using the statistical Package for Social Sciences (SPSS, version 10). The significantly different treatments mean were separated using Duncan multiple range test at 5% probability level.

RESULTS AND DISCUSSION

Growth performance : The performance response of the skip-a-day limit-fed pullets as influenced by increased micro-nutrients in diet is presented in Table 2. The increased micro-nutrient content in the diets resulted in significant ($p<0.05$) differences among the treatment groups in final body mass, daily mass gain, feed intake, feed conversion and percent mortality. The 30% plain fed pullets were significantly ($p<0.05$) least in the final body mass compared to the other groups. The 10 and 30% micro-nutrient groups were statistically ($p>0.05$) comparable to the control, but superior to all other groups. Although, there was a progressive increased in the body mass of birds all through to 22 weeks of age, the consistent slow growth rate in the 30% normal feed pullets was noticeable during the study as shown in Fig. 1.

The least body mass in the 30% plain fed pullets was indicative of the obvious inadequate quantity of feed due to the feed restriction. There is evident that, specific body mass of pullets at the on set of lay was an indispensable factor to optimise ovarian function at sexual maturity (Hocking, 1993). The body mass of 1370g obtained for the 30% plain feed pullets in the current study did not optimise such condition and the implication is that, pullets could lay small-size eggs throughout the laying cycle (Hocking *et al.*, 1996) although large eggs may be uneconomical in some situations (Hussain *et al.*, 2005).

The recorded improved body mass of all pullets fed added premix could be attributed to the mitigation effect of the micro-nutrients on stress as a result of feed restriction. Although, it has been observed (Asuquo, 1994) that the actual body mass to achieve during pullets rearing varied with breed and strain of birds, the range of 1480-1620 g obtained in the study favourably compared the 1300 g for Leghorn strain and 1500 g in brown-egg birds at point of lay (Leeson, 2001; Ahmed, 2005). This implied that, limit-feeding beyond 30% was adverse to body mass at sexual maturity, though the severity of restriction could be tailor-made to derive benefit.

The increased premix in the 10 and 20% diets for pullets resulted in a significantly ($p<0.05$) higher daily mass gain than the other treatments, except the control. But the parameter was the same ($p>0.05$) for pullets on the 10 and 20% plain feed or 20 and 30% premix fortified groups.

Figure 2 shows the average weekly mass gain and indicated losses at the weeks 12, 15, 16, 17, 19 with the worst in week 21. The losses were more felt in pullets fed on 0, 10, 20 and 30% normal feed than the increased micro-nutrient groups. However, there was observed sharp increases in mass gain at the weeks 18 and 20.

The average mass gain varied across all the treatment groups which could be partly due to the feed restriction and perhaps the natural pattern of pullet growth phases.

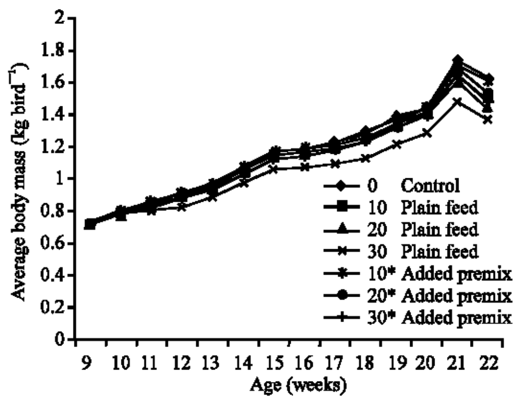

Fig. 1: Average weekly body mass (kg $bird^{-1}$) of skip-a-day limit-fed growing pullets as affected by increased micro-nutrient content in diets

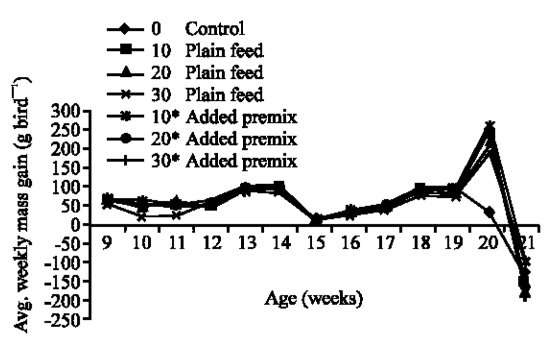

Fig. 2 : Average weekly mass gain (g $bird^{-1}$) of skip-a-day limit-fed growing pullets as influenced by increased micro-nutrient content in diets

The mass losses observed in some weeks of the study coincided with or is attributed to the shift in body growth emphasis from physical to physiological development leading eventually to sexual maturity (Oluyemi and Roberts, 2000; Amaefule and Obioha, 2005).

However, cases of observed increased mass gain in the last weeks, prior to the on-set of lay in the limit-fed pullets irrespective of treatment may not have been unconnected with the rapid increased in growth of the ovary, oviduct, comb (Parker, 1968) calcium phosphate in medullary bone and the yolk storage precursors in the liver (Morris, 2004).

The daily feed intake was highest ($p<0.05$) in the control pullets, while the 30% plain feed group, consumed the least. The average daily feed intake as presented in Fig. 3 had a consistent trend of depressed consumption for all the treatment groups as observed in week 15, except the control.

But the decreases were consistent across all groups in weeks 16, 17 and 20 to some extent which roughly compares the general growth pattern in pullets. The feed conversion ratio was significantly ($p<0.05$) superior in the 0, 10, 20 and 30% pullets fed increased micro-nutrient content, compared to those on the 10, 20, 30% plain feed restriction (Table 2). A similar pattern was observed for the feed efficiency ratio, while mortality rate was highest ($p<0.05$) in the 30% plain feed limit-fed pullets. In the 10% micro-nutrient and the control groups, mortality did not differ ($p<0.05$) significantly.

The depressed feed intake particularly in the 30% plain feed pullets group was perhaps, the obvious impact of the feed restriction. It was expected that compensatory eating could manifest during the alternating *ad libitum* one day feeding of the program, which was not clearly depicted in the study. The result failed to agree (Oluyemi and Roberts, 2000; Nesheim and Card, 1975) that the limiting of feeding period, merely train the birds to consume sufficient feed in a short time, developing larger crop and to digest the feed more slowly. The study indicated an advantage of increased micro-nutrient content in diets as evident in the body mass and mass gain, to which feed intake could have increased in the same magnitude, but data showed that only the 10% added premix group of pullets consumed feeds at par with the control birds. Perhaps, other than the stress factor of the feed restriction, dietary nutrient imbalance and environment (Ishibashi and Yonimochi, 2003) as well as the nature of feeds (NRC, 1994) and anti-nutrient substances (Amaefule *et al*., 2006) may have also affected the feed intake.

The superior feed conversion and feed efficiency ratio of all the limit-fed pullets on increased micro-nutrient content compared to those on normal feed, suggested more competence in adjustment to feed restriction as a stress. Although, the feed conversion was poor across all treatments, this observation supported the fact that, there is a continuous decrease in feed utilisation for growth with age of the fowl (Lewis and Perry, 1995; Leeson, 2001) even when feed consumption increases. The highest mortality of 14% was evidently ameliorated even up to 30% limit-fed pullets on fortified micro-nutrient content. Generally the normal rate of mortality during pullets rearing phase was never more than 5% (Oluyemi and Roberts, 2000).

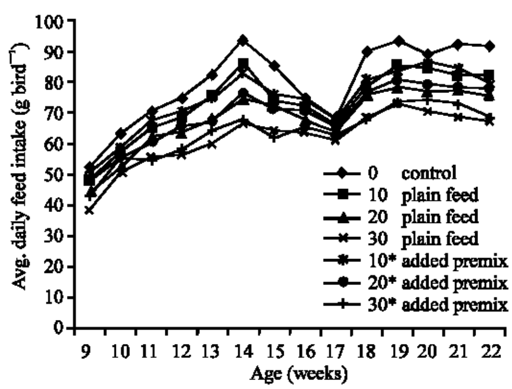

Fig. 3: Average daily feed intake (g bird^{-1}) of skip-a-day limit-fed pullets as affected by increased micro-nutrients content in diet

Table 2: Performance response of limit- fed pullets as influenced by increased micro-nutrient in diets

	Level of limit feeding (%)							
Parameter	0	10	20	30	10*	20*	30*	SEM
Initial body mass (kg b^{-1})	0.73	0.73	0.71	0.74	0.72	0.73	0.71	0.12
Final body mass (kg b^{-1})	1.62^{a}	1.49^{b}	1.44^{b}	1.37^{c}	1.61^{a}	1.53^{ab}	1.48^{b}	0.22
Daily mass gain (g b^{-1})	9.80^{a}	8.35^{b}	8.02^{b}	7.03^{c}	9.78^{a}	8.90^{b}	8.40^{b}	1.03
Daily feed intake (g b^{-1})	97.47^{a}	72.67^{c}	67.52^{d}	61.05^{d}	76.47^{b}	68.90^{c}	62.89^{d}	2.11
Feed conversion ratio	8.11^{b}	8.72^{c}	8.42^{cb}	8.68^{c}	7.51^{a}	7.74^{a}	7.43^{a}	1.02
Feed efficiency	0.12	0.12	0.12	0.12	0.13	0.13	0.14	0.02
Mortality (%)	0.00^{a}	1.67^{b}	5.00^{c}	14.00^{d}	0.00^{a}	1.67^{b}	5.00^{c}	0.14

^{a,b,c,d}Means in the same row with different superscripts are significantly ($p<0.05$) different. * Twenty five percent increased micro-nutrients in diets. SEM = Standard Error of the Mean

Table 3: feed-cost benefit of limit- fed pullets as influenced by increased micro-nutrient in diets

	Level of limit feeding (%)							
Parameter	0	10	20	30	10*	20*	30*	SEM
Feed cost/kg (E)	2.14	2.14	2.140	2.14	2.14	2.14	2.14	0.32
Daily feed intake (g b^{-1})	79.47^{a}	72.67^{b}	67.52^{c}	61.05^{d}	76.47^{b}	68.90^{c}	62.89^{d}	7.98
Daily mass gain (g b^{-1})	9.80^{a}	8.35^{b}	8.02^{b}	7.03^{c}	9.78^{a}	8.90^{a}	8.46^{b}	1.03
Daily feed cost/b (E)	1.70^{a}	1.6^{a}	1.40^{b}	1.30^{bc}	1.60^{a}	1.50^{b}	1.30^{c}	0.32
Cost/ kg mass gain (E)	13.79^{a}	13.92^{a}	11.79^{b}	11.28^{bc}	12.02^{b}	11.61^{b}	9.66^{d}	2.02
Feed cost to POL (E)	166.6^{a}	156.8a	137.2^{b}	127.4^{c}	156.8^{a}	147.0^{b}	127.6^{c}	0.02

[a,b,c,d]Means in the same row with different superscripts are significantly ($p<0.05$) different. * Twenty five percent increased micro-nutrients in diets. POL =Point of Lay. SEM= Standard Error of the Mean

Feed cost-benefit: The feeding of 25% increased micro-nutrient content in the skip-a-day limit-fed pullets resulted in significant ($p<0.05$) differences in the feed cost benefit (Table 3). The daily feed cost/ bird (E/b/d) was highest ($p<0.05$) in the control, 10% plain feed and 10% premixed treatments, while the 30% plain feed and 30% micro-nutrient had the least ($p<0.05$) feed cost. It was statistically more expensive to produce a kg/mass gain in the control and 10% plain fed group than others, while the 30% pullets with added premix was the cheapest. The same trend was observed for total feed cost up to point of lay, except the 10% increased premix group which was comparable to the control and 10% normal feed treatments.

The response of pullets in the limit-fed program did not affect cost kg^{-1} feed because the feed ingredients were identical in all the diets. However, the observed differences in daily feed cost/ bird could be attributed to the variation recorded in daily feed intake, obviously due to the feed restriction. The disparity in feed consumption which brought about the exorbitant cost kg^{-1} mass gain of the control and 10% plain feed pullets, evidently supported that increased micro-nutrient in diet could ameliorate the effect of feed restriction (Isika *et al*., 1998).

The obvious general view of feed-cost benefit conveys reduced feed intake, satisfactory mass gain and least cost /bird and kg mass gain. It makes more economic sense therefore, for a farmer to use least cost management program or feeds which translate to lesser financial input in growing pullets up to point of lay than the conventional methods. This agrees (Richard and Jacqueline, 2000) that limit-feeding should not be ignored when egg producers look for a way to lower feed and total production cost.

CONCLUSION

The growing of pullets from 9-week old on skip-a-day limit-feeding program with increased micro-nutrient content in diets up to point of lay has optimal advantage in growth performance at 20% feed restriction severity. The least cost kg^{-1} mass gain and total feed cost of pullets up to point of lay on the 30% micro-nutrient fortified diets had economic superiority in pullets production. The limit-feeding program which addressed the animal welfare concern, with economic viability is recommendable, while further investigations on the feed restriction beyond 30% severity and the limit of premix tolerance could enrich information on the concept.

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