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Effects of Feed Restriction on Compensatory Growth Period, Nutrient Digestibility and Economics Of Japanese Quails (*Coturnix coturnix japonica*)

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Abstract

The experiment was to study the effects of feed restriction on compensatory growth, nutrient digestibility and economics in Japanese quails. 150 Japanese quail chicks (2 weeks of age) were selected randomly from a single flock and divided into 5 homogenous groups of 30 quails with three replicates, designating as AL i.e. *ad libitum* feeding group, and as R90, R80, R70 and R60 for 10%, 20%, 30% and 40% restriction of *ad libitum* group respectively. The quails were housed in wire mesh cages and commercial broiler starter feed (DM 88.6%, CP 24.78%, EE 2.93%, CF 5.3%, TA 5.77%, calcium 3.1% and phosphorous 0.77%) was used for feeding. Feed was restricted from 2nd to 5th week of age and thereafter all the groups were fed *ad libitum*. Drinking water was provided *ad libitum*. No vaccination and deworming were done. Feed intake reduced significantly (P<0.5) for feed restriction negatively affecting body weight gain. However, average gain: intake ratio was comparable in AL and R90 during feed restriction period. Body weights were comparable at 8th weeks of age in both *ad libitum* and feed restricted groups after refeeding started at 6th weeks of age indicating compensation of deficit growth within 3 weeks. The DM digestibility decreased with increased feed restriction, whereas CP digestibility was significantly (P<0.05) better in feed restricted groups. At 8th week significantly (P<0.05) better feed efficiency was recorded in feed restricted groups. Similar trend was also observed for feed cost per kg body weight gain indicating that without significantly (P<0.05) affecting the growth, feeding cost can be reduced by feed restriction. It was concluded from the findings that 10% feed restriction is possible without any effect in growth, and growth can be compensated with improved feed efficiency within 3 weeks when feed is restricted @ 10-40% from 2nd to 5th week in Japanese quails.

Keywords *:* Compensatory growth, feed restriction, Japanese quail.

INTRODUCTION

Modifying growth pattern at early age by feed restriction and subsequent compensatory growth not only reduces the maintenance and managemental requirements but also improves feed efficiency in meat type poultry. The chicks may overcome growth depression of early feed restriction by compensatory accelerated growth [1] before attaining maturity. The chicks usually perform well on low protein high energy starter diet but invariably results increased carcass fat deposition. Feed restriction controls fat deposition as fat cell numbers increase most rapidly in very young birds [2]. Compensation obviously become longer with high levels of nutrients or feed restriction and may achieve without loss of feed efficiency [3] as birds utilise nutrients more efficiently during the period of compensation. The early under nutrition for qualitative or quantitative feed restriction and subsequent beneficial compensatory growth results in no overall loss of market weight and thus has the potential to improve feed utilization [4] economising the enterprise. Considering the above points in view, the present investigation was made to assess the compensatory growth period and effects of quantitative feed restriction on nutrient digestibility and economics in terms of feed efficiency and feed cost per kg body weight gain in Japanese quails (*Coturnix coturnix japonica*) during early growth period.

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MATERIALS AND METHODS

Experimental design

One hundred and fifty Japanese quail chicks (age two week, male female ratio 1:1) were selected randomly from single flock maintained at Instructional Poultry farm of College of Veterinary Sciences and A.H., Central Agricultural University, Aizawl, Mizoram, India (Initial body weights of male and female were ranging from 25.5-25.9 g and 25.3-25.9 g respectively). The chicks were divided into five homogenous groups and assigned four different levels of feed restriction i.e. 10% (R90), 20% (R80), 30% (R70) and 40% (R60) of *ad libitum* feed intake of the control group (AL) respectively. There were three replicates in each experimental group with 10 nos. of Japanese quail chicks.

Housing and feeding management

The experimental quails were housed in specially designed wired meshed cages providing floor space of 3 square inches per quail and having feeding and watering facilities separately. The quails were fed in groups using commercial broiler starter mash (DM 88.60%, CP 24.78%, EE 2.93%, CF 5.30%, Total ash 5.77%, Ca 3.1%, Available P 0.47%) during the experimental period. The feeding was done two times daily i.e. 7.00 AM in the morning and 1.00 PM in the evening.

Drinking water was provided *ad libitum*. No artificial light was provided. By measuring the previous day leftover feed of *ad libitum* fed group (AL), amounts to be offered to the feed restricted groups were measured @ 90%, 80%, 70% and 60% of that amount and provided respectively. No deworming and vaccination was done to the experimental quails during the study period. Other managements were as per standard practice followed in a scientific poultry farm. Feed restriction was imposed from 2nd to 5th week of age after which all the experimental quails were fed *ad libitum*.

Data collection, metabolic trails and analysis of samples

Daily feed intake and body weight gain at weekly interval were recorded up to 8th week of age. Daily mortality, if any, was also recorded throughout the experimental period.

At the end of 5th week, a metabolic trial for five days was conducted. Six birds from each group (three male and three female) were taken for the trial and daily feed intake, faeces voided were collected for analysis. For analysis for crude protein, the representative samples of faeces from each group were preserved in 40% concentrated H_2SO_4. The representative samples of broiler starter feed were collected, mixed thoroughly and grinded so as to pass through 1.00 mm sieve and stored for further analysis. Proximate compositions of feed and faeces were analyzed as per AOAC [5]. Calcium and phosphorous were estimated according to the method of Talapatra *et al.* [6].

Statistical analysis

Data were analyzed following one way ANOVA according to the method described by Snedecor and Cochran [7].

Table.1. Average daily feed intake in g/quail (DFI) and weekly body weight gain in gm (WBW) of Japanese quail under *ad libitum* and restricted feeding

Week	Para-meter	Treatment groups				
		AL	R90	R80	R70	R60
2nd	DFI	13.05^{a} ± 1.08	10.52^{b} ± 0.76	9.46^{b} ± 0.65	8.53^{bc} ± 0.34	7.34^{c} ± 0.29
	WBW	25.55^{NS}±0.88	25.85^{NS}±0.63	25.55^{NS}±0.62	25.85^{NS}±0.59	25.60^{NS}±0.61
3rd	DFI	16.66^{a}±0.27	15.56^{a}±0.24	14.19^{c}±0.55	13.66^{c}±0.21	12.55^{d}±0.20
	WBW	55.00^{a}±2.43	51.50^{a}±2.59	44.10^{b}±1.51	45.25^{b}±1.54	30.35^{c}±0.68
4th	DFI	18.65^{a}±0.23	17.09^{b}±0.33	15.22^{c}±0.39	14.35^{d}±0.24	12.73^{e}±0.18
	WBW	87.50^{a}±4.23	91.60^{a}±4.77	84.00^{a}±2.92	68.20^{b}±2.90	69.80^{b}±1.80
5th	DFI	19.46^{a}±0.59	17.45^{b}±0.33	16.23^{c}±0.21	15.53^{cd}±0.24	14.72^{d}±0.21
	WBW	129.50^{a}±4.04	123.50^{a}±5.39	100.50^{b}±3.63	80.90^{c}±3.53	78.40^{c}±4.39
6th	DFI	21.27^{a}±0.30	22.09^{ab}±0.45	23.25^{b}±0.37	23.13^{b}±0.38	22.70^{b}±0.51
	WBW	168.10^{a}±6.19	167.00^{a}±6.73	126.95^{b}±3.67	118.35^{b}±1.92	116.75^{b}±1.84
7th	DFI	24.41^{a} ± 0.38	24.63^{ab} ± 0.20	24.85^{ab} ± 0.25	25.47^{b} ± 0.37	25.03^{ab} ± 0.36
	WBW	203.10^{a}±7.04	191.40^{ab}±7.82	189.80^{ab}±4.83	78.35^{b}±3.15	176.80^{b}±4.48
8th	DFI	25.13^{NS} ± 0.25	25.24^{NS}±0.35	25.03^{NS} ± 0.38	26.06^{NS} ± 0.33	25.76^{NS} ± 0.42
	WBW	242.75^{NS}±8.40	241.90^{NS}±7.18	242.40^{NS}±5.87	242.00^{NS}±6.95	240.00^{NS}±6.44

Means bearing different superscripts (a, b, c, d, e) in a row differ significantly (P<0.05)
NS=Non-significant.

RESULTS

Body weight gain in Japanese quail decreased significantly (P<0.05) with increased feed restriction level (Table.1) indicating a negative correlation between extent of restriction and feed efficiency and thus economics at the age of marketing. However, no significant difference (P>0.05) was observed for weekly body weight gain between *Ad libitum* and 10% restricted group during 2nd to 5th week of feed restricted period. Similar trend was also recorded between 20% and 30% feed restricted groups. When *ad libitum* feeding was started at the age of 6th week, weekly body weight gain was significantly higher (P<0.05) in feed restricted groups as compared to the *ad libitum* one and increased with increased restriction level. At 8th week of age, no significant differences (P>0.05) were observed for body weight gain in the experimental quails. Average feed intake (gm/quail) was significantly higher at 6th and 7th week in R80, R70 and R60 as compared to AL and R90 when *ad libitum* feeding was started. It was observed that average feed consumption in AL and R90 was comparable throughout the experimental period.

Dry matter (DM) digestibility (Table.2) decreased with increased level of feed restriction and hence percent nitrogen free extract (NFE) and organic matter (OM) digestibility. Ether extract (EE) digestibility was significantly lower (P<0.05) in R70, however no significant differences were recorded between other experimental groups. Crude protein (CP) digestibility values for AL, R70 and R60 were comparable, but were significantly lower in R90 and R80. Percent crude fibre (CF) digestibility was similar for AL, R90, R80 and R70 treatment groups.

At 8th week of age significantly better feed efficiency (FE) was recorded in feed restricted groups although body weight gain was similar and statistically non-significant. However, FE was statistically non-significant in feed restricted groups at 8th week of age. Feed cost/kg of body weight gain decreased with increasing level of feed restriction (Table.3).

Table. 2. Digestibility (%) of nutrients of Japanese quail under *ad libitum* and restricted feeding

Nutrient	Treatment groups				
	AL	R90	R80	R70	R60
Dry matter	$70.42^{a} \pm 0.14$	$65.93^{a} \pm 0.11$	$64.05^{ab} \pm 1.56$	$57.31^{bc} \pm 2.93$	$49.76^{c} \pm 3.83$
Crude protein	$83.88^{a} \pm 0.07$	$69.86^{b} \pm 0.10$	$74.86^{c} \pm 1.10$	$80.32^{a} \pm 1.35$	$82.26^{a} \pm 1.34$
Ether extract	$72.44^{a} \pm 0.13$	$71.85^{a} \pm 0.10$	$74.23^{a} \pm 1.12$	$64.16^{b} \pm 2.46$	$71.76^{a} \pm 2.14$
Crude fibre	$49.33^{a} \pm 0.24$	$57.64^{a} \pm 0.14$	$51.91^{a} \pm 2.09$	$58.59^{a} \pm 2.84$	$31.14^{b} \pm 5.21$
NFE	$72.82^{a} \pm 0.13$	$70.70^{a} \pm 0.09$	$67.78^{a} \pm 1.39$	$55.72^{b} \pm 3.03$	$48.93^{b} \pm 3.86$
Organic matter	$74.16^{a} \pm 0.12$	$69.79^{a} \pm 0.10$	$68.81^{ab} \pm 1.35$	$62.09^{bc} \pm 2.60$	$56.70^{c} \pm 3.27$

Means bearing different superscripts (a, b, c) in a row differ significantly (P<0.05)

Table.3. Body weight (g), feed conversion ratio (FCR) and feed cost/kg body weight gain at 8th of age of Japanese quails under ad libitum and restricted feeding

Parameter	Treatment groups				
	AL	R90	R80	R70	R60
Body weight (g) at 8th week	242.75^{NS}+8.40	241.90^{NS}+7.18	242.40^{NS}+5.87	242.00^{NS}+6.95	240.00^{NS}+6.44
FCR at 8th week of age	4.86^{a}+0.21	4.64^{ab}+0.14	4.47^{ab}+0.11	4.46^{ab}+0.10	4.23b+0.11
Feed cost/kg body weight gain♣ (Rs.)	121.45^{a}+5.27	116.08^{ab}+3.55	111.72^{ab}+2.77	111.58^{ab}+2.66	105.62^{b}+2.85

♣Calculated on the basis of feed cost @ Rs.25.00/kg broiler starter feed
Means bearing different superscripts (a, b) in a row differ significantly (P<0.05

DISCUSSION

Success of feed restriction programme depends on compensatory growth which is a recovery from growth deficit due to reduced nutrient intake. This unique ability of poultry to compensate growth can best be utilised to enhance feed efficiency i.e. improvement in feed: gain ratio at marketing age. Slowing weight gain during early period also reduces mortality for excessive growth rates and skeletal disorders. Temporary feed restriction is economically desirable not only to reduce feed cost but also to curtail mortality rate and to have a good body finish at marketing age. In the present experiment, weekly body weight gain was significantly reduced (P<0.05) for 20-40% feed restriction during 2nd to 3rd week of age. Offiong *et al.* [8] also reported that body weight gain declined progressively as the severity of deprivation increased in broiler chickens. Similar observations were also recorded by Hassan *et al.* [9] for Japanese quails. However, in the present study, body weight gain was comparable between *ad libitum* and 10% feed restricted groups indicating possibility of feed restriction up to 10% level during early growth period in Japanese quails. Reduction in body weight gain in R80, R70 and R60 may be due to lower nutrient available for quantitative feed restriction as also reported by Mahmud *et al.* [10] and Zhan *et al.* [11] for commercial broilers.

Both the daily feed intake and weekly body weight gain increased during *ad libitum* feeding period from 6th to 8th weeks of age in all feed restricted groups. Significantly (P<0.05) higher feed intake in R80, R70 and R60 may be an indication of compensatory growth exhibited by greater than normal feed intake relative to body weight as also reported by Zubair and Lesson [12] for broilers. However, no significant differences (P>0.05) were observed between AL and R90 signifying that 10% feed restriction in Japanese quails practically had no effect in average body weight gain. Although more feed consumption was recorded in R80, R70 and R60 during the refeeding period, near full compensatory growth was achieved at 8th week of age which was indicated by non-significant average weekly body weight gain and final body weight at 8th week of age. There were also reports of similar observations in poultry [10, 11, 13, 14 and 15]. However, the results disagreed with the observations of Hassan *et al.* [9] who reported that compensatory growth was possible within 1 week when feed was restricted @ 15% and 30% from 2nd to 5th weeks of age in Japanese quails.

Lower DM digestibility in feed restricted groups may be the effects of initial period of feed restriction negatively influencing the development of the body tissues i.e. growth of the Japanese quails and similar may be the cause for reduced digestibility of CF, NFE and OM in the feed restricted groups than that of control. Significantly ($P<0.05$) higher CP digestibility in R80, R70 and R60 may be the indication of improved nitrogen retention in feed restricted Japanese quails as also reported by Lesson and Zubair [16] for broiler chicken undergoing feed restriction.

Significantly inferior feed efficiency in *ad libitum* group as compared to feed restricted ones at 8th week of age, which was improved with increased feed restriction, indicated better average daily body weight gain and thus feed efficiency in growing Japanese quails. Ocak and Erener [17] also reported that better feed conversion without reduction in carcass weight was possible in Japanese quails when feed was restricted @30% of *ad libitum* from 15-28 day of age and then *ad libitum* feeding from 29-45 day of age. Near similar final body weight, significantly improved FE and reduced feed cost/kg body weight gain in 10-40% feed restricted Japanese quails at 8th week of age as compared to *ad libitum* indicated that compensatory growth is possible under 10-40% feed restriction.

CONCLUSION

It was concluded from findings of the present investigation that compensatory growth period for Japanese quail is 3 weeks if feed is restricted quantitatively @ 10-40% of *ad libitum* level during early growth period of 2nd to 5th weeks of age followed by *ad libitum* feeding. The feed intake and body weight gain data indicated that up to 10% feed restriction is possible without any effect on growth, feed efficiency, and feed cost/kg of body weight gain in Japanese quails.

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