ISSN 1682-8356
ansinet.org/ijps

INTERNATIONAL JOURNAL OF

POULTRY SCIENCE

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International Journal of Poultry Science 12 (7): 396-400, 2013
ISSN 1682-8356

Growth Performance of Quails (*Coturnix coturnix*) Fed on Diets Containing Either Animal or Vegetable Protein Sources

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Abstract: This study aimed at comparing two proteins sources on the performance of quail bred in Benin. Six groups of 45 quails from common breed, without sex discrimination, received diets containing either soybean meal (20 and 25%), fishmeal (20 and 25%), or their mixture (20 and 25%). The feeding period lasted six weeks. Quail weights were similar at the onset of experimentation but important variations according to feed were observed from the second week. At the end of fattening, the effect of the protein source on growth was noticed in favor of animals fed on soybean meal. The quail fed on soybean meal based diets showed higher weights compared to those which received fish flour diets. The mixture of both protein sources at 25% was more interesting than the mixture at 20%. The animals performance (Weight, DWG and FCR) were the lowest with fishmeal diet, suggesting the low quality of this protein source largely utilized as animal feed in Benin. Our results suggest that soyabean meal represents the best source of protein for quails and its optimal incorporation level in their diet is 20%.

Key words: Benin, nutrition, soyabean meal, fishmeal

INTRODUCTION

In most tropical countries like Benin, rural household incomes do not still allow to cover the essential household's needs such health care, education and especially food supply. Many families in the tropics must assume a major role in the production of their own foodstuffs (Martin *et al*., 2012). In Benin, several development projects promoted small-scale keeping of small animals such as poultry, duck and rabbit as a strategy to diversify rural household livelihoods. However, the potential of some other small animals' resources, for instance quails (*Coturnix coturnix*), remains under exploited. Raising quail can provide resource for poor families with meat and eggs. Quails do not request large space and can be kept in backyard either in cages or on floor. Keeping quail also does not require an important investment and presents several advantages in comparison with many other small animals. Indeed, quails are rustic and breed easily. The females are very prolific because they begin laying eggs on average at six weeks and can lay between 250 and 300 eggs a year (Lucotte, 1974). Their eggs incubation lasts on average 17 days (Lucotte, 1974) against 21 days for hen (Gawande *et al*., 2007) and 28 days for guinea fowl (Dahouda *et al*., 2007). According to several reports (Genchev, 2012; Punya Kumari *et al*., 2008) quail's egg is poorer in cholesterol and richer in protein, vitamins and other nutrients compared to hen's egg. Despite these numerous advantages, quail keeping is not commonly practiced in Benin and one of the major constraining factors may be its higher feed protein requirement compared to other domestic birds (Lee, 1977; Shim and Vohra, 1984). While quails require high quality protein with adequate balance in amino acids, their excessive protein intake also results in high nitrogen excretion and low feed efficiency for egg production (Soares, 2003). Quail's nutritional requirements have been developed for animals raised in climatic conditions different from those prevailing in Benin, preventing the establishment of an adequate and locally-adapted feeding recommendation and program to support the local production. Hence, it is important to determine more precisely the nutritional requirement of quails raised in Benin. Consequently this study aims at (i) determining quails growth fed with two proteins sources (animal or vegetable protein) in tropical breeding conditions (ii) assessing the optimal proteins requirement of quails for a better growth.

MATERIALS AND METHODS

Experimental design: The experiment was conducted at the Songhai Center in Benin (Porto-Novo). The climate is of sub-equatorial type characterized by two rainy seasons (from April to July and from September to

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Table 1: Feed and nutrient contents of experimental diets

Ingredients	FM 20%	FM 25%	SM 20%	SM 25%	FM+SM 20%	FM+SM 25%
Corn	46	40	46	40	46	40
Fish meal	21	38	0	0	10.5	19
Cotton cake meal	11	10	11	10	11	10
Soybean meal	0	0	21	38	10.5	19
Wheat bran	13	4	13	4	13	4
Oyster shell	3	2	3	2	3	2
Salt	0.2	0.2	0.2	0.2	0.2	0.2
Premix	5	5	5	5	5	5
Lysine	0.2	0.2	0.2	0.2	0.2	0.2
Méthionine	0.2	0.2	0.2	0.2	0.2	0.2
Sulfate de fer	0.4	0.4	0.4	0.4	0.4	0.4
Total	100	100	100	100	100	100
Chemical composition						
Crude protein (%)	20.47	25.01	20.47	25.01	20.47	25.01
ME (kcal/kg)	2537.01	2491.85	2517.48	2456.51	2527.25	2474.18
Crude fiber (%)	3.99	3.04	5.17	5.17	4.58	4.10
Lysine (%)	1.58	2.21	1.24	1.60	1.41	1.91
Methionine (%)	0.76	0.98	0.55	0.61	0.66	0.8
Méthionine+cystine (%)	0.81	1.13	0.62	0.79	0.72	0.96
Calcium (%)	2.47	2.77	1.69	1.37	2.08	2.07
Phosphate digestible (%)	0.75	1.09	0.34	0.34	0.54	0.72
Sodium (%)	0.57	0.76	0.32	0.30	0.44	0.53
Chlore (%)	0.51	0.76	0.2	0.20	0.35	0.48

SM: Soybean meal; FM: Fish meal; ME: Metabolizable Energy

November) and two dry seasons. The average annual rainfall is 1200 mm. Ambient temperature varies between 23 and 32°C. The quails used in the experiments were kept in pens built according to the standards of tropical breeding. Supplementary heat was supplied electrically to the birds during the first three weeks. Shutters are punctually opened according to the pen temperature. To stimulate feed intake, lighting were maintained throughout the night in the house. Feed and water were supplied *ad libitum*. Wood shavings were used as litter (15 cm). The amounts of all feeds offered and their refusals were recorded daily and allow for the calculation of feed intakes.

Animals and management: The experiment lasted two months. Hatching was obtained using a COVATUTTO incubator. After hatching, chicks were raised together during one week and fed with starting diet. They were then divided into six groups of 45 chicks each. Animals were individually marked. Diets were composed with local available feedstuff such as corn, cotton cake and offered as mash (Table 1) and were randomly assigned to each treatment.

The experiment included six treatments: (i) FM: two treatments with two Fish Meal based diets incorporated at 20 and 25%; (ii) SM: two treatments containing respectively 20 and 25% Soybeam Meal and (iii) FM+SM: two diets containing the mixture of fish meal and soybean meal at 20 and 25%.

Feed were formulated using the linear programming approach in Excel software by minimizing the prices and by fitting the recommended daily allowance for quails. They were elaborated from the theoretical requirement reported in the feed requirement tables for the quails (Larbier and Leclercq, 1992). The amounts of feed offered to animals were gradually increased and adjusted weekly according to birth requirements. Forages were offered daily *ad libitum*. All animals were treated for internal parasites with Anticox® (Sulfamidine, Laprovet France, 4 g/20 L of water during 3 days) and Alfamizol® (levamisol, Alfasan Holand, 1g/1, 5L of water per day) prior to the experiment. The materials were cleaned every day. Quails were weighed weekly and feed intakes were calculated as difference between feed offered and refusals.

Statistical analysis: Effects of dietary treatments on feed intake, live weight changes and feed conversion were tested using analysis of variance in a completely randomized design. The difference between mean values was calculated using the Least Significant Difference (LSD) method with a 5% level of significance. All analyses were performed in SPSS for Windows Release (version 12.0, SPSS Inc., Chicago, IL, USA).

RESULTS

Feed intake and feed conversion: Feed intakes varied according to protein sources and levels of inclusion (Table 2). Mean feed intake was higher for SM and SM+FM at 20% compared to the 25%. However, diet containing FM at 25% was more ingested by quails than that at 20%. It was noted that diets with the mixture

Table 2: Means (±standard error) of feed intake and means (±standard error) of body weight of quails

Variable	Age (week)	SM+FM (20%)	SM+FM (25%)	FM (20%)	FM (25%)	SM (20%)	SM (25%)	P<F
Feed intake (g/day)	1	16.86^{c}	16.34^{d}	18.00^{a}	14.79^{f}	17.65^{b}	15.2e	<0.000
	2	22.2^{e}	20.9^{f}	22.5^{c}	22.8^{d}	23.2^{b}	23.3a	<0.000
	3	22.7^{d}	21.55^{f}	22.7^{e}	24.6^{a}	23.8^{b}	22.9c	<0.000
	4	23.4^{d}	22.22^{f}	22.9^{e}	26.6^{a}	24.2^{b}	24.6c	<0.000
	Mean	21.3^{e}	20.27^{f}	21.5^{c}	22.2^{b}	22.2^{a}	21.5d	<0.000
Mean weights (g)	1	53.0	52.9	52.4	48.6	52.5	50.9	>0.318
	2	79.2^{b}	88.9^{a}	80.9^{b}	74.8^{b}	89.5^{a}	87.2a	<0.000
	3	108^{cb}	117^{ba}	104^{c}	105^{c}	119^{a}	117ba	<0.000
	4	134^{b}	144^{a}	134^{b}	131^{b}	151^{a}	146a	<0.000
	Mean	93.6^{b}	101^{a}	92.7^{b}	89.7^{b}	103^{a}	100a	<0.000

SM: Soybean meal; FM: Fish meal. The means between the classes of the same line followed by different letters differ significantly with the threshold of 5%; SE: Standard Error

Table 3: Means of day weight gain and means of feed conversion rate of quails

Variable	Age (week)	SM+FM (20%)	SM+FM (25%)	FM (20%)	FM (25%)	SM (20%)	SM (25%)	P<F
DWG (g/day)	1	3.8	4.2	4.1	3.6	3.84	3.95	>0.480
	2	3.8^{b}	5.1^{a}	4.1^{b}	3.7^{b}	5.29^{a}	5.18^{a}	<0.000
	3	4.1^{a}	4.0^{a}	3.3^{b}	4.3^{a}	4.17^{a}	4.27^{a}	<0.006
	4	3.7^{b}	3.8^{ba}	4.3^{b}	3.7^{b}	4.60^{a}	4.08^{ba}	<0.007
	Mean	3.9^{b}	4.3^{a}	3.9^{b}	3.8^{b}	4.47^{a}	4.37^{a}	<0.000
FCR	1	4.7	4.1	4.6	4.7	4.84	4.25	<0.501
	2	6.2^{a}	4.3^{b}	5.7^{a}	6.4^{a}	4.57^{b}	4.70^{b}	<0.000
	3	5.8^{b}	5.5^{b}	7.2^{a}	6.1^{b}	6.08^{b}	5.52^{b}	<0.000
	W4	6.5^{b}	5.9^{b}	5.6^{b}	7.55^{a}	5.60^{b}	6.37^{b}	<0.000
	Mean	5.6^{a}	4.8^{b}	5.6^{a}	5.9^{a}	5.02^{b}	4.97^{b}	<0.000

SM: Soybean meal; FM: Fish meal. The means between the classes of the same line followed by different letters differ significantly with the threshold of 5%

SM+FM were less ingested than those containing either SM or FM alone. The amounts of feed intake daily per quail ranged between 20.3 and 22.2 g.

During the first week of the growing period, Feed Conversion Ratio (FCR) values were similar within experimental diets (Table 3). In general, FCR was better in SM diet than in FM. Differences appeared from week two of the growing period and birds in SM and SM+FM groups were markedly heavier than those in FM group. At the 3th week, FCR was similar between 20 and 25% SM+FM based diets. The same trend was observed in SM based diets. Highest FCR value was recorded in diet containing FM at 25%.

Animal growth: The results indicated that quails growth was influenced by the experimental diets during fattening (Table 2). Quail weights were similar at the onset of the experiment (Table 2). However, from the second week of the experiment, we noticed that the diets containing SM at 20 and 25% and the diet containing 25% of the mixture SM+FM allow similar growth. However, growths obtained with SM at 20 and 25% were better than FM diets at 20 and at 25% and the mixture SM+FM at 20%. From the 3th week to the end of the fattening, neither the FM nor SM incorporation level did not influence quails growth with the exception of protein mixture based diet. Indeed, growth in group FM+SM at 25% were better than that in FM+SM at 20%. When comparing the treatments at the same level of protein incorporation, we observed that at 20% the SM diet allows a better growth compared to FM diet and to the mixture FM+SM. However, at 25% of incorporation, growths in SM and SM+FM based diets were similar.

At the end of fattening period, we observed that quails fed with SM (20%) and SM (25%) presented better growth compared to those in FM group. The mean weights at the end of this period were between 89.7 and 103 g, respectively.

DISCUSSION

Feed intake and feed efficiency: When considering feed intake values recorded, it can be noticed that feed consumption varied with the source of protein and with its level of inclusion in the diet. Feed intake was higher for SM and SM+FM at 20% compared to the 25%. Barque *et al.* (1994) also found that birds fed on 20% protein consumed more feed than those fed on 26% protein. Indeed, quails average daily feed intake varied between 20.3 and 22.2 g. At the same age, these values were higher than the average feed intake of 14.4 g /quail/day reported by Djouvinov and Mihailov (2005). Animal feed intake varies with many factors such as their age (Almeida *et al.*, 2002), the feed chemical composition (Verdelhan, 2006) and the ambient temperature (Lebas, 2004). It might also be related to feed presentation (mash or granulate) (Gidienne and Lebas, 2005) and to

the animal physiological status (Lebas, 2004). These findings might explain differences observed between our results and others.

In general, average feed efficiency of FM based diets (5.6 to 5.9) were higher than that of SM (5.0). Thus, feed conversion increases with the animal age. According to Rivière (1991), the increase of feed conversion with the age can be associated with the process of fattening which requires much more energy. Value reported by Kerharo (1987) at the second and fifth week of growth (3.7) was lower than the value recorded in the current study. The high values of feed efficiency recorded during the last weeks of the growing period highlight the decrease of the feed conversion with the age.

Animal growth: In this study, the growth performances obtained with all experimental diets at the end of the fattening period were interesting comparatively to values reported by Almeida *et al*. (2002) and Ozbey *et al*. (2006) in selected Japanese quails. The differences between performances show that even at equal age, the quails live weights are very heterogeneous. It could be related to variability of incubated eggs weights. Moreover, numerous authors such as Farooq *et al*. (2001) and Petek *et al*. (2005) found that quails live weight at 42 days old and its eggs weight were strongly correlated. The genetic variability within strains could also explain such differences.

In general, soybean meal based diets allowed higher live weights comparatively to fish meal based diets. By comparing the six diets consumed by the quails, the performances in fish meal based diets groups were worse. The low weight obtained in the fish meal groups might be associated to its poor protein content. Indeed, the fish meal protein content which is imported and marketed in Benin is low (between 30 and 35% of CP). This fish meal is probably the result of the processing of fish by-products mostly heads and bones and therefore raises doubts about it contents and it uses as protein source for quails which request higher quality proteins than to chickens. Moreover, we noted that quails growth were not different between groups fed with diets containing 20 and 25% of soybean meal or fish meal. In view of these results, it could thus be concluded that 20% represents the optimal level of protein (animal or vegetable) incorporation in quails' diets. The results are in agreement with those of Vohra and Roudybush (1971) and Tarasewicz *et al*. (2006) who reported that weight gain was not affected by increasing the crude protein level from 20 to 30%. Moreover, the findings of Soares *et al*. (2003) suggested that the levels of 23.08% of crude protein in the diet of Japanese quails are recommended for the rearing period. According to Gheisari *et al*. (2011), feeding Japanese quail during the starting, growing and finishing periods using diets containing 2700 kcal/kg ME and low levels of protein (22, 20 and 18%, respectively) is recommendable to achieve a suitable performance. DWG recorded during fattening period ranged from 3.8 to 4.5 g/day. During the first weeks, growth rates obtained were high and consistent with the value of 4.9 g/day found by Özbey *et al*. (2006). The relatively low DWG in fish meal based diets groups might probably be related to the low crude protein content (35%) of fish meal as protein source comparatively to soybean meal (48% of CP). The results are in agreement with the conclusion of Goho (1990) who found that growth were better with soybean meal than with fish meal. Nevertheless, during the last two weeks, growth rate were markedly reduced and this is in accordance with observations by Rivière (1991) who explained this growth reduction by the fact that the speed of cells production is slowed down at the adulthood. Similar results were reported by Kerharo (1987) and Özbey *et al*. (2006).

Conclusion: The experiment indicated that quail's feed intake was not related neither to the source of the protein nor to its level of inclusion in the diet. This suggests that the source of the protein does not modify the diets appetibility. Moreover, animal performances were good whatever the origin (vegetal or animal) of the protein. However, animal growth rate and feed conversion were better with SM based diets and there was no difference between 20 and 25% SM diets or FM diets. It could be concluded that SM represent better protein source and optimal protein inclusion is 20% in quail's diet. Protein inclusion above this level cannot then be economically and biologically justifiable. These results present considerable advantages which allow recommendations for the improvement of the quail production in the hot climate of Benin. However, further research is required to determine the energy and protein requirements for eggs production.

ACKNOWLEDGEMENT

The authors are indebted to Songhaï Center of Porto-Novo who willingly provided the required animals, feed and house.

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