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308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

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Effects of Body Weight of Semi-Heavy Cocks on Reproductive Indices and Yields of Incubation

J.P.F. Rufino[1], F.G.G. Cruz[1], R.D. Melo[1], J. da C. Feijo[1], R.O. da Silva[1], A.B.T. Brandao[2] and B. Berenchtein[2]
[1]Federal University of Amazonas, College of Agrarian Sciences, Sector of Poultry, Manaus, Amazonas, Brazil
[2]Federal University of Amazonas, Institute of Social Sciences, Education and Animal Science, Parintins, Amazonas, Brazil

Abstract: The study aimed to evaluate the reproductive traits in poultry breeder with different weight ranges of two semi-heavy lineages. The experimental method was completely randomized design in factorial arrangement (3 x 2) with two factors: reproductive methods (artificial insemination and natural mating) and two semi-heavy strains (Plymouth Barred Rock and Rhode Island Red). All birds used in this experiment were subjected to identical conditions of nutritional management and breeding. Were evaluated the phenotypic characteristics of breeders andrological analysis of semen, performance of females inseminated and biometrics of chicks from males selected and ranked by lineages and weight ranges. The lineages evaluated showed significant differences how much your reproductive characteristics observed best results for lineage Rhode Island Red, where this shown highest efficiency of improving the productive and reproductive yields, can this has a tendency for relationship with the performance of the progeny. Cocks with 3 kg of body weight showed best body condition for semi-heavy breeding of both lineages, with superiority results for indices evaluated, featuring a direct influence between body weight and the reproductive rates of semi-heavy cocks.

Key words: Weight ranges, sperm concentration, fertility, biometric yields

INTRODUCTION

The matrices start the critical point for the begin of animal production, being in poultry industry the figure of the cock the icon representing of this sector in which the genetic material of the male reproducer may be largely responsible for the maintenance of fertility rates, hatchability, hatching among other variables that demonstrate the evolution of production. For a full exploitation in productivity of matrices, the determining of ideal reproducer goes since from the phenotypic characteristics and quality of his semen to potential of its genetic material reflected in the progeny, suggesting that any changes in production or semen quality may cause losses not only in poultry productivity, but also in the quality of chicks (Maciel, 2011).

Although the proportion of males represents only 10% compared to females, males contribute 50% with their genetic load which is crucial for the egg's fertilization, as claimed Bongalhardo *et al.* (1994) on his studies, seminal characteristics determined positive correlations between cocks seminal characteristics and fertility eggs. It has been observed, however, a decline in reproductive variables in recent years that could be attributed to a lack of attention in the selection of the cock and it's fertility (Celeghini *et al.*, 2001).

The sperm concentration, motility and viability are the most commonly used variables to determine the fertilization potential of semen donors cocks, since these variables affect the total number of available sperm to fertilize an egg (McDaniel *et al.*, 1998) and show a reflection about the potential of an expert breeder. Among the physiological factors responsible for influencing the male reproduction rates, stands out body weight along with feeding management. Both are very important for the total reproductive functions development. According to Brake (1998), if the cock doesn't receive sufficient amount of energy for its maintenance, it will mobilize their body reserves. If this situation persists and the reserves come to a end, there will be a reduction in reproductive activity since testosterone levels will drop dramatically.

Despite this relationship developed between body weight and reproductive index, there is not much material related to overweight birds, so this study was performed in order to check how the body weight acts when associated with reproductive rates of semi heavy cocks lineages, during the process of eggs incubation, artificially inseminated with semi heavy matrices using the genetic material of these birds. Thus, this study

Corresponding Author: F.G.G. Cruz, Federal University of Amazonas, College of Agrarian Sciences, Sector of Poultry, Manaus, Amazonas, Brazil. E-mail: frankgcruz@gmail.com

aimed to measure the reproductive traits for evaluation in the poultry breeder with different weight ranges of two semi-heavy lineages.

MATERIALS AND METHODS

Animal housing and experimental set up: The experiment was conducted at the incubator on the Poultry Sector, Department of Animal and Vegetable Production, College of Agrarian Sciences of the Federal University of Amazonas, Manaus, Amazonas, Brazil. Thirty cocks with 53-week-old were used, duly identified and separated by lineage and the pre-established weight range, being organized into six boxes (9 m^2) with containing five cocks each box. The shed was an opened model with 8 x 25 m^2 separated into boxes with tubular feeders and water fountains commuting.

In order to maintain homogeneity, the cocks were subjected to identical conditions and feeding, receiving during the study 16 h of lighting program (12 h of natural light and 4 h of artificial light) and isonutrients diets containing 2800 of Metabolizable Energy Kcal/kg, 15% of Crude Protein, 4.0% of Calcium and 0.45% of available phosphorus according the recommendations of Rostagno *et al*. (2011).

The experimental design used was completely randomized in factorial range (3 x 2) composed for two factors: three weight ranges (2.5, 2.75 and 3 kg) and two semi-heavy lineage (Rhode Island Red and Plymouth Rock Barred), totaling 6 treatments with 5 cocks each, analyzed in three periods of fourteen days.

Forty-eight semi-heavy female matrices were used also with 53 weeks in cages to determine the reproductive index relationship the incubation phase and evaluation of the progeny of cocks. The birds were organized into six blocks of four cages (being the blocks corresponding to the treatments) with 1.0 x 0.45 x 0.50 m containing eight birds in each block of cages. The six blocks were separated into two rows as follows: three blocks of cages in the right row with matrices inseminated with semen from cocks with average weights 2.5, 2.75 and 3.0 kg of the Rhode Island Red and the identical structure applied for the lineage Plymouth Rock Barred.

Phenotypic analysis: The cocks were separated into boxes as the determinations of the treatments, being first made a phenotypic characterization analysis of the body conformation. The scores used for this analysis were: condition of feet: 1 = no injury, 2 = mild lesions in the footpad and/or fingers, 3 = moderate injury in the footpad and/or fingers, 4 = severe damage in the footpad and/or fingers; Cinnamon coloration: 1 = pale, 2 = light yellow, 3 = intense yellow and/or red; Crest and wattles coloration: 1 = pale and/or wilting or cyanotic, 2 = moderate red with mild prominence to the side, 3 = intense red and/or firm; Chest conformation: 1 = very prominent keel, 2 = slightly prominent keel, 3 = no prominent keel; Coloration of the cloaca: 1 = pale, 2 = red lighter, 3 = intense red; Cloaca diameter: Using a precision caliper (0.05 mm by measuring the average internal diameter of the cloaca position; Cloacal Reversion: 1 = not reverted, 2 = extremely difficult to revert; 3 = moderately easy, 4 = very easy. Taking into account the above scores, it was determined the carcass conformation conditions determined in breeders cocks.

Andrological analyses: The semen collections were done individually, totaling 30 samples for each period. Semen was collected by abdominal massage technique, according Bakst and Bahr (1995), which consisted of gentle massage on the abdomen, rhythmic movements in the ventral and also on the tail feathers. Data collection was obtained by the same technician to avoid variation in the results and analyzed in laboratory for evaluate the andrological indices. In the morphology sperm evaluation, semen was placed in an eppendorf tube properly identified containing sodium citrate formulated on 4%. A drop of this was placed on a microscope slide and submitted to a Panoptic kit procedure that is divided into three steps. After this process, we counted 200 sperm per semen sample (Wilson, 1988) in cells increased 640x, by this it was possible to notice any abnormal forms, which were classified in head defects, tail defects, absence of head and tail.

Incubation yields and biometrics of chicks: Semen samples were collected constituting a pool of semen for each treatment and the method for the semen collection was under the methodology proposed by Etches (1996), using abdominal massage on the back, movements on the sides of the cloaca and in the end the semen was stored.

Immediately after semen collection, the same procedure was used to reverse the female's cloaca and the semen was deposited on its oviduct (arranged previously for each treatment) using a pipette attached to a 0.025 ml volume. 240 hatching eggs cleaned and disinfected were used the semi-heavy matrices. Each treatment consisted of 40 eggs, considering an egg for each repetition.

After cooling, the eggs were weighed and passed through pre-heating six hours of incubation room before being appropriately incubated. Was used an incubator model 168 Petersime regulated to maintain a constant dry bulb temperature at 37.8°C and relative humidity of 60%. With 19 days of incubation, candling was performed and clear eggs were removed for identification of infertile or dead embryos and weighed to measure the weight loss of eggs during transfer. The eggs then were transferred to hatching trays, which were randomly placed in one hatcher Petersime model 168

with thermostat set to maintain dry bulb temperature 36.6°C and relative humidity of 65%. After the birth, were slaughtered five chicks from each treatment by cervical dislocation in order to do the biometrics of the progeny carcass, in that the following variables were evaluated: length of the digestive system, heart weight, weight of proventriculus+gizzard, liver weight and weight of the yolk sac.

Statistical analyses: The data collected during all stages of this study were submitted to analysis of variance. For measure comparison of the estimated average, it was applied the Tukey test at 5% probability using the computer program Statistical Analysis System SAS (2008). In the analysis of variance, due to the experimental design be characterized as a factorial, was determinated the presence of significance between individual factors and in the interaction of this factors.

RESULTS

The results for phenotypic analysis are showed in Table 1. Significant differences were observed for condition of feet and conformation of the chest ($p<0.05$) between weight ranges and crest coloration ($p<0.05$) between lineages. About this results, were evidenced a direct relationship between the increasing of body weight of breeder with a short consequent prominence of the keel bone, giving a greater conformation of the chest and also an increase in the index of foot lesions of the same. Spite of not showing significant differences ($p>0.05$) the staining of cinnamon, staining of the cloaca, diameter and the coefficient of cloaca's reversion follow the same trend line of the variables where determined to be significant differences between the means starting of the weight influence. Among lineages is observed an overlapping of Rhode Island Red strain in the index of body's breeder conformation. In counterpart, the Plymouth Rock Barred lineage shows better results in the evaluation of pericloacal region and a reversal of the cloaca, index which indicates a relevance to the aspect of reproductive birds.

The results for andrological test are showed in Table 2. Significant differences were observed in motility and spermatic vigor ($p<0.05$) between weights and lineages and sperm concentration ($p<0.05$), only among weight ranges, showing a positive relations between the factors. The heaviest cocks showed better results for motility, vigor and concentration that do predictions according to ideal weight for semi-heavy lineages in relations to the breeder matrices index. Don't be observed significant differences in the interactions of this factors.

For the remaining variables, the heaviest cocks had higher ejaculate volume, higher sperm density and most shades of color and texture accented. The Rhode Island lineage showed superior results when compared to the Plymouth Rock Barred, being observed for better performing in reproductive analyzes from andrological test, except for the spermatic concentration.

The means of results for pathologies in semen are showed in Table 3. It wasn't observed significant differences ($p>0.05$) for the pathological analysis variables of sperms for weight ranges, lineages and in the interaction of this factors. It's been observed, meanwhile, cocks with higher body weight have showed an increasing of normal percentage of sperms, which may indicate close proximity to these weight ranges from weight to ideal weight for semi heavy of breeder male lineage.

The results of egg weight in relationship to chick weight and yields of incubation are shown in Table 4. According to the determined results were observed significant differences ($p<0.05$) for weight of eggs only between lineages, where the Rhode Island Red females that weight is balanced received the sperms of cocks from the same lineage showed more heavy eggs. In other case, the variable of egg's loss during a period of incubation and the chick weight at birth, despite do not have significant differences ($p>0.05$), demonstrate positive relation between the results. Don't be observed significant differences ($p>0.05$) between the averages for fertility, hatchability and hatching. However, heavier birds showed higher fertility rate and these characteristics can be relate to the phenotypic and andrological examinations results conducted earlier.

The mortality rate showed a significant difference ($p<0.05$) between the weight ranges, where the semen of heavier cocks led to a higher incidence of mortality in the progeny, which encourages relationships between genetic characteristics and potentially transmitted physiology reproduction of semi-heavy cocks used in genetic improvement programs.

The results of biometrics of chicks are shown in Table 5. Significant difference are observed ($p<0.05$) for length of the digestive system and weight of proventriculus+ gizzard only between lineages, where the lineage Rhode Island Red showed higher absolute values for both, confirming overlay this on lineage Plymouth Rock Barred. In others variables in the analysis between weights, although no significant difference ($p>0.05$) between the averages, it was observed that chicks from the semen of heavier cocks had higher yolk sac, heavier pro-ventricle and gizzard, shorter length of the digestive system and lower weight of the heart, which can associate these characteristics the genes responsible for transfer of genotypes that make up the digestive system.

DISCUSSION

In the poultry industry, the cocks selection is not normally performed by their reproductive characteristics but by physical characteristics such as aspects crest and

Table 1: Means of phenotypic analysis and body score of semi-heavy cocks of different weight ranges and lineages

	Variables						
Factors	Feet[1]	Cinnamon[2]	Crest[2]	Chest[1]	Cloaca[2]	Cloaca diameter	Cloacal reversion
Cocks weight							
2.5 kg	1.77[a]	1.80	2.47	1.65[b]	1.25	16.22	2.57
2.75 kg	1.70[a]	1.65	2.45	2.10[a]	1.75	16.96	2.25
3.0 kg	2.50[b]	1.45	2.52	2.25[a]	1.87	17.25	2.80
Lineage							
Rh. Isl. Red	2.05	1.80	2.71[a]	2.06	1.48	16.48	2.95
Ply. R. Barred	1.93	1.46	2.25[b]	1.93	1.76	17.15	2.80
Effects	p-value						
Cocks weight	0.01*	0.30[ns]	0.92[ns]	0.02*	0.11[ns]	0.19[ns]	0.13[ns]
Lineage	0.60[ns]	0.07[ns]	0.01*	0.32[ns]	0.26[ns]	0.16[ns]	0.58[ns]
Interaction	0.14[ns]	0.24[ns]	0.09[ns]	0.09[ns]	0.12[ns]	0.22[ns]	0.20[ns]
CV (%)	20.44	20.65	16.90	18.13	21.90	7.64	25.58

CV: Coefficient of variation; *Average followed by lowercase letters in the column, differ itself by the Turkey's test on 5% ($p<0.05$); ns: non significant. [1]Score that evaluated condition or conformation. [2]Score that evaluated coloration

Table 2: Results of a ndrological test of semen of semi-heavy cocks of different weight ranges and lineages

	Variables						
Factors	Texture	Coloration	Volume	Motility	Vigor	Density	Concentration
Cocks weight							
2.5 kg	2.33	2.16	0.51	94.16[a]	4.50[a]	3.58	2.57[b]
2.75 kg	2.66	2.58	0.50	79.16[b]	3.83[b]	3.41	2.56[b]
3.0 kg	2.58	2.58	0.55	93.33[a]	4.58a	3.75	2.78[a]
Lineage							
Rh. Isl. Red	2.72	2.66	0.50	93.33[a]	4.61[a]	3.66	2.54
Ply. R. Barred	2.33	2.22	0.53	83.33[b]	4.00[b]	3.50	2.73
Effects	p-value						
Cocks weight	0.62[ns]	0.35[ns]	0.85[ns]	0.01*	0.03*	0.67[ns]	0.03*
Lineage	0.19[ns]	0.11[ns]	0.65[ns]	0.01*	0.01*	0.58[ns]	0.58[ns]
Interaction	0.06[ns]	0.35[ns]	0.14[ns]	0.19[ns]	0.35[ns]	0.23[ns]	0.20[ns]
CV (%)	24.10	22.83	25.25	8.10	11.38	17.75	25.58

CV: Coefficient of variation; *Average followed by lowercase letters in the column, differ itself by the Turkey's test on 5% ($p<0.05$); ns: non significant

Table 3: Pathological analysis of the semen of semi-heavy cocks of different weight ranges and lineages

	Variables				
Factors	Head defects (%)	Absence of head (%)	Absence of tail (%)	Tail defects (%)	Normals (%)
Cocks weight					
2.5 kg	2.87	1.50	2.25	1.87	91.50
2.75 kg	1.75	1.50	2.37	1.12	93.25
3.0 kg	3.62	1.00	1.62	1.62	92.12
Lineage					
Rh. Isl. Red	2.83	1.00	2.25	1.66	92.25
Ply. R. Barred	2.66	1.66	1.91	1.41	92.33
Effects	p-value				
Cocks weight	0.07[ns]	0.73[ns]	0.38[ns]	0.25[ns]	0.16[ns]
Lineage	0.78[ns]	0.28[ns]	0.47[ns]	0.49[ns]	0.90[ns]
Interaction	0.29[ns]	0.27[ns]	0.10[ns]	0.20[ns]	0.27[ns]
CV (%)	26.46	25.78	27.15	28.89	1.27

CV: Coefficient of variation; ns: non significant

wattles, cloaca, feathering, feet and body weight. Despite these physical characteristics possibly not having high correlation with male fertility (Rutz *et al*., 2007) may be indicative of testicular development, since the secondary sexual characters are stimulated by testosterone produced by the interstitial cells of Leydig.

Even though this body's conformation analysis doesn't have a high level of precision to indicate the reproductive performance of those cocks, this showed that the weight of these influenced on reproductive ability, what justified the heavier birds used in this study possibly can have ideal body weight for semi-heavy breeder. Also using the scores of body evaluation of breeder, Harris *et al*. (1984) observed that body weight was significantly correlated with the percentage of cocks that were producing semen at 48 weeks of age and this was correlated with the score of wear of the feathers around the cloaca and the score for cloacal reversion. Lee (1999) demonstrated yet that the level of facility collecting of semen is a good indicator of the quality of the breeder cock.

Regarding to genetic selection has been a trend in the market focused on the potential of transmitting the genes in males gain more and more pronounced weight, thus bypassing the problem of visibility in breeder be physically able to complete the amount, leading to a reduction in reproductive efficiency (Robinson *et al*., 1993) if do not a nutritional management to monitor the development of the breeder corporal performance.

Results obtained during andrological examination confirm the possible proximity of the heaviest breeders used (cocks with 3 kg of body weight) with the ideal weight for semi-heavy breeders, checking from the overlap of these indices evaluated in relation to indices obtained in cocks with lower body weights mainly on the results of motility and concentration indices most commonly used to determine the fertilization potential of

Table 4: Relation of egg weight with chick weight and yields incubation of matrices inseminated with semen of semi-heavy cocks of different weight ranges and lineages

	Variables						
Factors	Eggs weight (g)	Weight loss (%)	Chick weight (g)	Fertility (%)	Hatchability (%)	Hatching (%)	Mortality (%)
Cocks weight							
2.5 kg	53.80	13.51	38.04	87.50	85.70	78.75	0.00^{a}
2.75 kg	53.21	11.92	37.70	87.50	80.21	66.25	2.00^{ab}
3.0 kg	52.75	13.59	38.12	91.25	88.40	81.25	4.48^{b}
Lineage							
Rh. Isl. Red	54.61^{a}	12.19	38.46	94.16	84.54	80.00	3.08
Ply. R. Barred	51.90^{b}	13.83	37.44	83.33	85.00	70.83	1.23
Effects	p-value						
Cocks weight	0.23^{ns}	0.42^{ns}	0.84^{ns}	0.77^{ns}	0.51^{ns}	0.20^{ns}	0.04*
Lineage	0.01*	0.16^{ns}	0.11^{ns}	0.06^{ns}	0.93^{ns}	0.20^{ns}	0.12^{ns}
Interaction	0.08^{ns}	0.07^{ns}	0.06^{ns}	0.12^{ns}	0.21^{ns}	0.07^{ns}	0.40^{ns}
CV (%)	2.23	21.55	4.04	9.48	11.49	15.22	8.97

CV: Coefficient of variation; *Average followed by lowercase letters in the column, differ itself by the Turkey's test on 5% ($p<0.05$); ns: non significant

Table 5: Biometric yields of chicks from semi-heavy cocks of different weight ranges and lineages

	Variables				
Factors	Digestive system length (g)	Proven-triculus+ gizzard (g)	Heart (g)	Liver (g)	Yolk sac (g)
Cocks weight					
2.5 kg	38.57	2.03	5.12	0.97	0.28
2.75 kg	38.88	2.04	4.69	1.01	0.29
3.0 kg	37.64	2.04	4.56	0.98	0.32
Lineage					
Rh. Isl. Red	39.37^{a}	2.11^{a}	4.76	0.98	0.29
Ply. R. Barred	37.35^{b}	1.96^{b}	4.82	0.99	0.30
Effects	p-value				
Cocks weight	0.43^{ns}	0.98^{ns}	0.51^{ns}	0.88^{ns}	0.25^{ns}
Lineage	0.01*	0.04*	0.88^{ns}	0.86^{ns}	0.60^{ns}
Interaction	0.22^{ns}	0.21^{ns}	0.21^{ns}	0.18^{ns}	0.37^{ns}
CV (%)	5.72	9.96	21.21	18.73	23.40

CV: Coefficient of variation; *Average followed by lowercase letters in the column, differ itself by the Turkey's test on 5% ($p<0.05$); ns: non significant

semen donors cocks, as these variables influence the total number of sperm available to fertilize an egg (McDaniel *et al*., 1998). Additionally, cocks with lower body weight showed greater susceptibility to abnormalities in the reproductive cells formation corroborate with the results observed for Kelso (1997) that concluded which possible variations in body weight of the breeder may compromise the sperm morphology. Regarding the relationship between egg weight and chick weight, the eggs that received semen from heavier birds showed lower absolute weight, however, originated heavier chicks. The influence of egg size on chick weight at hatching is well documented in the scientific literature and the latest studies have shown that chick weight is between 66-71% of egg weight (Michalsky, 2005), is the weight and chick quality depend on several other factors like the age of the matrix and the weight of the egg of origin (Peebles *et al*., 2000). However, this specific condition should be taken into account the transfer of genetic traits related to body weight and weight gain of the progeny relative to parents, which notably shows that the heaviest cocks also can produced progeny most weighed.

Concerning the relationship between the weight of cocks and yields incubation of inseminated matrices, notes the numerical overlap of results using semen of heavier cocks. Bilcik *et al*. (2005) suggest that fertility depends on the reproductive quality of all the cocks within a group, which should be uniform across the breeders of this particular group.

Still on the incubation yields, the Plymouth Rock Barred lineage showed a lower rate of mortality when compared to chicks from Rhode Island Red lineage. Studies of Wishart *et al*. (2005) with the Rhode Island Red lineage compared to the other lineages claim that this fact cannot be attributed only to one specific cause, because in general embryonic mortality during the incubation period increases due to the direct influence of environmental factors and physiological birds.

The biometric yields of progenies between lineages showed better development of digestive system identified in the lineage Rhode Island Red, checking possibly relationships between the coefficients of the composition of the digestive system in the above lineage.

It's also observed that the chicks from cocks with highest weight had larger absolute values for weight of the yolk sac. Wilson (1991) in your study observed the variation of the weight of the yolk sac stating that heavier chicks after birth may have a greater biometric yields and a lower weight of yolk sac due to its great development until the time of hatching, or a less developed carcass and a greater yolk sac that enhances the survival of these for longer periods without food.

Conclusion: this study showed a direct influence that body weight has on the reproductive rates of semi-heavy cocks how phenotypic characteristics andrological analyses and the development of progeny of incubation

at the birth. Semi-heavy cocks with 3 kg body weight showed the best body score for the indexes evaluated. And is also important to mention that can to relate the body score results with the influence of lineage, where the lineage Rhode Island Red demonstrated significantly best results.

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