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Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

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Growth Performance of Indigenous X Exotic Crosses of Chicken and Evaluation of General and Specific Combining Ability under Sudan Condition

Mekki Dafaalla Mohammed[1, 2], Yousif Ibrahimm Abdalsalam [3],
Abdel Rahman Mohammed kheir[2], Wang Jin-yu[1] and Musa Hassan Hussein[1]
[1]Deptartment of Animal Genetics, Breeding and Reproduction,
Yangzhou University, Yangzhou, 225009, China
[2]Deptarment of Animal Science, Faculty of Natural Resources and Environmental Studies,
University of Kordofan, Sudan
[3]Deptartment of Genetics and Animal Husbandry, Faculty of Animal Production,
University of Khartoum, Sudan

Abstract: Two thousand three hundred and fourty six chickens, line X tester crosses were obtained from fifteen consecutive hatches at weekly interval. Testers were exotic cockerels; Rhode Island Red (RIR), Bovans (BO) and Egyptian Fayoumi (FO), while lines were indigenous hens; large Baladi (LB), Bare-neck (BN) and Betwil (BT). The nine genetic groups of crosses were reared up to 18 weeks of age in litter opened-house system. Significant differences (DMRT 5%) for average body weight of different crosses were obtained at hatching, 2, 14, 16 and 18 weeks of age. Biweekly average weight gain showed similarity in growth pattern of the various crosses. Sex affected body weight insignificant at hatching, whereas the differences were significant ($P<0.05$) at 2 weeks of age and highly significant ($P<0.01$) for the subsequent ages. Hatching effect was found to be highly significant ($P<0.01$) on body weight at various ages; however, sex X hatch interaction was found to be significant ($P<0.05$) at day old and disappeared thereafter. The average live weight at 18 week of age for the nine groups was adjusted for hatching and sex effects. There were significant differences ($P<0.05$) of lines and testers, however, line X tester interaction was not significant for 18 weeks body weight. The estimated general combining ability (gca), thus the additive gene effect, was relatively high for both lines (-42.03, 19.90 and 22.13) and testers (-36.74, 10.74 and 26.00). On the other hand the specific combining ability (sca), which involves dominance, over dominance and epistasis effects, was found to be minor in both positive and negative values for the nine groups, ranging from -14.66 to 17.37. The general combining ability estimated was of high value and seemed to be much important than specific combining ability for body weight at 18 weeks of age.

Key words: Indigenous types, general combining ability, specific combining ability

Introduction

Indigenous fowl, like exotic breeds has a sigmoid growth pattern (Ismail, 1997), however its level of production and growth is quite low, relative to that of exotic ones (Nowsu, 1979). Oluyemi *et al.* (1979) stated that, the indigenous fowl is extremely well adapted to the tropics, resistant to poor management and feed restrictions, where it has been naturally selected for centuries. To utilize these good characteristics of the indigenous to possibly exploit the phenomenon of heterosis to evolve a more resistant hybrid chick, crossbreeding programmes are more appreciable including upgrading local types with suitable exotic ones. The exploitation of genetically diverse stocks for improving economic traits, such as body weight is one of the approaches in the breeding programmes of chickens. The combining ability analyses help to identify desirable combiners that may be utilized to exploit heterosis. General combining ability (GCA) is a consequence of additive genetic effects, while specific combining ability (SCA) is a consequence of non-additive genetic effects (Etso and Nordskog, 1961). The latter, commonly referred to as nicking ability, which may involve dominance, over dominance and epitasis. Many reports showed that general combining ability and therefore, additive variations were high and important to specific combing ability for body weight at different ages (Wearden *et al.*, 1965, Hill, 1959, Kumar, 1979, Kim *et al.*, 1977 and Singh *et al.*,1983).

Materials and Methods

The study was conducted in Elobeid, 13° 30´ N and 30° 30´ E of North Kordofan state. The flock was established by purchasing ninety pullets of each local type, large Baladi, Bare-neck and Betwil, colleted from rural area of Nuba Mountains, while the exotic cockerels were Rhode Island Red (RIR), Fayoumi (FO) And Bovans (BO). The parent stock was kept for adaptation period of four weeks, during which they were vaccinated against New castle and Fowl pox diseases, they were also treated

Table 1: Crosses live weight ($\bar{x}$+ s.d) g per genetic group for different ages

Age (weeks)	Crosses live weight (x± s.d) gram								
	RIR x BN	FO x BN	BO x BN	RIR x BT	FO x BT	BO x BT	RIR x LB	FO x LB	BoxLB
Bw_0	28.0 ± 2.6^{ab}	29.8 ± 5.3^{a}	26.9 ± 2.2^{bc}	28.0 ± 2.7^{ab}	26.0 ± 1.0^{bc}	26.7 ± 2.1^{bc}	27.3 ± 3.1^{bc}	25.8 ± 3.2^{c}	27.8 ± 3.7^{ab}
Bw_2	54.3 ± 21.3^{ab}	56.6 ± 14.1^{a}	45.7 ± 11.7^{abc}	47.5 ± 1.5^{abc}	44.3 ± 11.0^{c}	47.5 ± 6.4^{abc}	49.6 ± 9.7^{abc}	44.7 ± 4.2^{bc}	52.1 ± 12.2^{ab}
Bw_4	104.1 ± 39.2^{a}	107.8 ± 34.3^{a}	94.6 ± 34.7^{a}	94.6 ± 34.7^{a}	100.0 ± 34.6^{a}	87.4 ± 18.7^{a}	93.4 ± 16.3^{a}	91.7 ± 18.7^{a}	97.6 ± 18.9^{a}
BW_6	181.8 ± 50.3^{a}	182.0 ± 45.3^{a}	171.2 ± 54.5^{a}	156.0 ± 34.5^{a}	170.0 ± 72.1^{a}	158.6 ± 48.5^{a}	166.4 ± 35.5^{a}	156.4 ± 53.2^{a}	167.6 ± 39.3^{a}
BW_8	249.2 ± 73.9^{a}	266.0 ± 67.9^{a}	256.2 ± 85.3^{a}	255.4 ± 93.5^{a}	218.5 ± 49.7^{a}	230.0 ± 104.4^{a}	233.3 ± 76.4^{a}	244.2 ± 55.9^{a}	251.4 ± 52.0^{a}
BW_{10}	351.5 ± 86.8^{a}	330.0 ± 112.4^{a}	344.0 ± 121.4^{a}	284.0 ± 62.1^{a}	300.2 ± 147.9^{a}	304.6 ± 96.4^{a}	327.8 ± 69.2^{a}	345.7 ± 70.6^{a}	336.0 ± 91.0^{a}
BW_{12}	429.0 ± 98.6^{ab}	412.5 ± 122.7^{ab}	420.1 ± 121.9^{ab}	353.0 ± 71.8^{b}	396.6 ± 205.5^{ab}	388.3 ± 111.3^{ab}	414.4 ± 78.4^{ab}	445.7 ± 98.9^{a}	404.0 ± 104.1^{ab}
BW_{14}	513.1 ± 114.4^{ab}	490.0 ± 133.5^{ab}	502.7 ± 129.9^{ab}	429.0 ± 79.0^{b}	476.6 ± 215.7^{ab}	470.6 ± 120.4^{ab}	485.7 ± 105.3^{ab}	551.4 ± 117.9^{a}	492.0 ± 119.8^{ab}
BW_{16}	621.5 ± 139.8^{ab}	520.6 ± 234.5^{bc}	595.4 ± 139.7^{abc}	508.5 ± 92.5^{c}	603.3 ± 234.5^{abc}	545.6 ± 129.1^{abc}	581.0 ± 136.2^{abc}	661.4 ± 138.1^{a}	592.6 ± 142.0^{abc}
BW_{18}	725.0 ± 154.1^{ab}	611.8 ± 295.2^{bc}	697.5 ± 149.6^{abc}	$600.5\pm109+4^{c}$	693.3 ± 276.1^{abc}	644.6 ± 104.1^{bc}	651.5 ± 212.0^{abc}	782.8 ± 151.7^{a}	697.3 ± 161.6^{abc}

* (RIR), (FO) and (BO) are the exotic testers Rhode Island Red, Fayoumi and Bovans, respectively. ** (BN), (BT) and (BN) are the indigenous lines, Bare-neck, Betwil and Large Beladi, respectively. *** BW0,BW2,BW4,BW6,BW8,BW10,BW12,BW14,BW16 and BW18 are age at hatch,2,4,6,8,10,12,14,16 and 18 weeks, respectively. **** Figures with same subscripts in the same raw are not significantly different (DMRT 5%).

Table 2: Combined least squares analysis of variance for various factors affecting body weight at different ages

Source of Variation	d.f	Mean squares of body weight									
		BW_0	BW_2	BW_4	BW_6	BW_8	BW_{10}	BW_{12}	BW_{14}	BW_{16}	BW_{18}
Hatch	14	51.3*	1241.5**	3604.8**	61581.0**	18086.3**	34700.7**	35284.0**	37150.7**	44132.4*	62359.2*
Sex	1	0.3	447.9*	10316.5**	41049.1**	91290.6**	153341.3**	254369.2**	358090.8**	651428.4**	884707.7**
Hatch X sex	14	11.1*	75.6	505.7	1600.5	2464.5	4498.7	7285.5	7990.3	14350.4	20138.9
Error	130	5.8	95.9	549.6	1516.8	3775.6	5770.5	7245.5	9646.2	16720.7	23657.4

* $p<0.05$. ** $p<0.01$. BW_0, BW_2, BW_4, BW_6, BW_8, BW_{10}, BW_{12}, BW_{14}, BW_{16} and BW_{18} are body weight at hatch, 2, 4, 6, 8, 10, 12, 14, 16 and 18 weeks of age.

against ectoparasite and received multivitamins, antibiotics and piprazine prophylactic doses. Lighting programme was 14 hrs. Light and the flock was fed commercial layer ration *ad libitum*. Eighty of each type and fifteen cockerels of each breed were weighted, leg banded and randomly distributed, the cockerels to the individual ground mating pens (50X50X50 cm) and the pullets in individual cages of single deck batteries. Each three pullets, one of each type was assigned randomly to be mated with one cockerel of each breed (line X tester; 3 x 3 mating) in rotational system. Eggs were collected twice a day for incubation, given the specific dam number and transferred to automatic turning device incubator in weekly intervals. 2867 chicks were obtained from fifteen consecutive batches at weekly intervals. The chicks were released from hatchery individual boxes separately, wing banded, weighted at hatching and subsequently at weekly intervals up to 18 weeks of age. During brooding period (day old - 8 weeks) and rearing period (8-18 weeks of age) chicks were fed commercial starter and grower ration *ad libitum* respectively. The average mortality rate during the experimental period was 18%. Duncan's multiple Range Test and combined least squares analysis of variance for various factors affecting body weight at different ages were conducted. Line X tester analysis (Kempthorne, 1957) was used for sex and hatch effects adjusted live weight at 18 weeks of age to provide information about general and specific combining ability of the parents and their crosses.

Results and Discussion

Significant differences (DMRT < 0.05) for average live body weight of different crosses were obtained at hatching, 2, 14, 16 and 18 weeks of age, Table 1. Betwil crossbreds has lighter average body weight, since male and female hatched from dwarf dam eggs are lighter than those from normal dam eggs (Gupta *et al.,* 1988). Biweekly average weight gains showed a similarity in growth pattern of the various crosses, where the peaks of the two-multiphasic growth cycles were attended at 8-10 and 14-16 weeks of age respectively. The result is in agreement with those reported by Grossman (1988) for Rhode Island Red, Oluyemi (1979) for Nigerian native fowl and Anthony *et al.* (1990) for Japanese quail.

Combined least squares analysis, Table 2 showed that, sex affected body weight insignificantly at hatching where, the differences at 2 weeks of age was significant (P<0.05) and highly significant (P< 0.01) for the subsequent ages. These results are supported by Singh *et al.* (1990), Sanchez *et al.* (1987), Singh *et al.* (1983) and Sefton and Seigal (1974). Many avian species, like chickens, showed marked dimorphism in body weight, with males being substantially heavier than females that could be due to the effective male growth hormones compared with female hormones (Singh et at, 1982).

Hatching effect was found to be highly Significant (P<0.01) on body weight at various ages. This could be due to the relatively large number of hatches and the effect of brooding and rearing conditions, which confirms earlier studies of singh *et al.* (1983) and Singh *et al.* (1990). However, sex X hatch interaction was found to be significant (P<0.05) at day-old and disappeared thereafter. The average body weight at 18 weeks of age for the nine genetic groups was adjusted for hatching and sex effects. Covariance analysis for correction of sex and hatching effects on body weight was used. These adjusted average body weight were used in statistical analysis for general and specific combining ability, Table 3.

Table 3: The adjusted average live weight of the crosses at 18 weeks of age

Crosses	Live weight at 18 weeks of age (gm)
RIR X BN	727.98^{a} (242)
RIR X BT	644.29^{ab} (277)
RIR X LB	711.92^{a} (213)
FO X BN	730.37^{a} (282)
FO X BT	684.36^{ab} (306)
FO X LB	715.22^{a} (218)
BO X BN	659.99^{ab} (266)
BO X BT	597.21^{b} (217)
BO X LB	648.51^{ab}(325)

*(RIR), (FO) and (BO) are the exotic cockerels, Rhode Island, Fayoumi and Bovans, respectively. *(BN), (BT) and (BL) are the indigenous hens, Bare-neck, Betwil and Large Baladi, respectively. *The figures with same subscript are not significantly different (DMRT 5%). *Figures between brackets are chick's number

There were significant differences (P<0.05) of lines and testes Table 4, however; line X testes interaction was not significant for 18 weeks body weight. The results are similar to the findings of Kim *et al.* (1977) for bodyweight at mature age and Sato *et al.* (1990) for Japanese quail body weight at age of maturity.

Table 4: Line X tester analysis of variance for 18 weeks body weight of the Crosses

Source	d.f	SS	MS
Total	150	3792436.690	
Tester	2	96379.223	48189.612*
Line	2	119366.809	59683.435*
Line X tester	4	17142.160	4285.540

Significant differences at (P<0.05)

The estimate of general combining ability, and therefore additive genetic variance were relatively high for both lines and testers Table 5. On the other hand the general combining ability estimated for Bovans tester and Betwil line were found to be negative, which indicate the inferior performance of these breeds in their hybrid combination for body weight at 18 weeks of age. The general combining ability estimated was much more important and of high value than specific combining ability Table 5

Table 5: Estimation of general combining ability effect for 18 weeks live weight for testers and lines

Tester / Line	General combining ability effects (GCA)
For testers:	
g_3 (Rhode Island Red)	10.745
g_4 (Fayoumi)	26.001
g_5 (Bovans)	-36.746
For lines:	
g_6 (Bare-neck)	22.13
g_7 (Betwil)	-42.03
g_8 (Large Baladi)	19.90

Table 6: Estimation of specific combining ability effects (sca) for live body weight at 18 weeks of age for different crosses

Crosses	Specific combining ability effects (SCA)
RIR X BN	11.124
RIR X BT	-8.410
RIR X LB	-2.709
FO X BN	-1.708
FO X BT	16.408
FO X LB	-14.664
BO X BN	-9.378
BO X BT	-7.996
BO X BL	17.375

(RIR), (FO) and (BO) are the exotic cockerels, Rhode Island Red, Fayoumi and Bovas, respectively. Where (BN), (BT) and (LB) are the indigenous hens, Bare-neck, Betwil and Large Baladi, respectively.

This is in agreement with those of Wearden *et al.* (1965) for 5 and 10 months body weight, Hazel and Lamareaux (1947) and Singh *et al.* (1983) for body weight at sexual maturity. These results might be due to the fact that amongst the genetic factors, body weight is mainly affected by additive genetic effects (Wearden *et al.* (1965). Fayoumi breed has highest GCA (26.001) followed by Rohde Island Red (10.745) and the lowest was for Bovans tester (-36.746). On other hand the best dam according to GCA was Bare- neck (22.13), large Baladi (19.90) and Betwil (-42.03). The superiority of Fayoumi and Rohde Island Red upon Bovans might be resulting from that, Bovans is a highly inbred population for egg production. The relatively poor nutritional and management conditions may restraint Rhode Island Red, as a heavy breed, to express its genetic potentiality through its progenies. The Betwil negative value of GCA could be attributed to the effect of sex – linked recessive dwarfing gene "dw" that found to reduce body weight by 33% and feed consumption by 20-25% (Merat, 1990) compared with normal chicken. Since body weight trait is characterized by higher heritability estimate, the effect of SCA which involve dominance, over dominance and epitasis effect is expected to be minor Table 6, this is in typical agreement with the results obtained and its similar to those pointed by Wearden *et al.* (1965) and Singh *et al.* (1983). Specific combining ability effects upon individual performance are relatively higher than its influence on family performance. This non-additive hereditary interaction may by an important source of variance among individuals without major influence upon family performance.

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