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USE OF PHENOTYPIC TRAITS TO PREDICT COCKS FERTILITY
2. THE ORNAMENTAL AND NON-ORNAMENTAL TRAITS

By

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Abstract: *Selection for economic traits (like growth rate and yield) may have been negatively associated with the expression of phenotypic traits. The modifications of (ornament and non-ornament) traits may result in lower fertilizing efficiency. It is hypothesized that the expression of male morphometric should correlate positively with some measures of fertilizing efficiency.*

A total of forty mature Bandarah strain males were classified into two equal groups according to the secondary sexual traits. The first group: males with large comb and wattle (GL), and the second group: males with small comb and wattle (GS). Males were randomly housed in individual cages, semen was evaluated during five periods of cock's age (31-34 wk), (35-38 wk), (39-42 wk), (43-46 wk), and (47-50 wk). Comb and wattle for each male were measured at 31 and 50 wk. Trait size did not change with age (P>0.05) thus mean trait size was calculated and used for statistical analysis. At 50 wk, spur length, body weight, keel length, tarsometatarsal dimensions, testicular weight and testicular weight asymmetry were measured.

1. *Results showed that GL males were more-expressed in ornamental and non-ornamental traits than GS males. In general, GL males had a highest semen evaluation.*
2. *Both of comb area and comb width were positively correlated with ejaculate volume, sperm out put, number of motile sperm, and number of live sperm. Interestingly, wattle area was significantly negative correlated with sperm concentration. Significant positive correlation was noticed between spur length and sperm concentration.*
3. *Significant positive correlation between body weight and ejaculate volume was observed. No significant relationship was observed between bone measurements and semen characters, except between*

tarsometatarsal length and percentage of live sperm which was significantly negative.

4. *Significant positive correlation was noticed between average testes weight and comb measurements. Both of them were positively correlated with sperm out put, number of motile sperm, and number of live sperm. Also, a positive relationship was found between testicular weight asymmetry and wattle measurements. In conclusion, ornamental traits may be a useful tool for predicting males with high fertilizing ability.*

INTRODUCTION

Females of many species choose males with high quality ejaculates, which are more likely to fertilize a high proportion of the female's eggs (Sheldon, 1994).

There is many morphometric traits (ornament and non-ornament) correlate with semen quality. In males of many species, one or more ornamental traits affect a female's choice of mates (Ligon, 1999). Male attractiveness should correlates with fertility if the phenotypic-linked fertility hypothesis is to explain female preferences. The ornaments that have been compared to sperm quality in birds include song quality in sedge warblers (Birkhead *et al.,* 1997), tail attractiveness in peafowl (Birkhead and Petrie, 1995), and combs and wattles in chicken (Pizzari *et al.,* 2004; Bilcik and Estevez., 2005 and Galal, 2007). The non-ornaments which are correlated with semen quality in male chickens: body weight (Galal *et al.,* 2002) and shank length (Galal, 2007).

Testicular weight has been shown to correlate with comb area and with fertility (McGary *et al.,* 2002). Also, De Reviers and Williams (1984), and Pizzari, *et al.,* (2004) reported that larger testes produce more sperm. Not only testicular weight, but also the degree of fluctuating asymmetry (FA) of testicular weight traits may be indicative of male quality. The theory of fluctuating asymmetry suggests more symmetrical males benefit from greater reproductive success than those males exhibiting a high degree of asymmetry (Møller and swaddle, 1997).

It was hypothesized that male phenotypic traits such as ornamental and non ornamental traits, would correlate with semen quality, these traits could be incorporated into the genetic selection regimen with the intent of improving fertilizing efficiency of the male.

MATERIALS AND METHODS

1. Design and management

This experiment was carried out at El-Sabahia Poultry Research Stations, Animal Production Research Institute, Ministry of Agriculture from January to May 2005. Forty Bandarah cocks at 31 wk of age, were classified according to their phenotypic traits into two equal groups: first group of males with well-developed secondary sexual characteristics, such as large comb and wattle (GL), and second group of males with not well developed secondary sexual characteristics, like small comb and wattle (GS). Each male was randomly housed in individual cages. Feed and water were allowed *ad libitum.* All the experimental diets were planned to cover the nutritional requirements of cocks according to NRC (1994). A lighting programme of 16L-8D was provided.

Semen parameters were weekly estimated for each male during the five periods of age: period 1 (31 to 34 wk), period 2 (35 to 38 wk), period 3 (39 to 42 wk), period 4 (43 to 46 wk), and period 5 (47 to 50 wk).

2. Semen physical characteristics

Semen samples were collected by abdominal massage technique. All samples were evaluated immediately for semen weight (SW) according to Sexton *et al.,* (1989), ejaculate volume (EV), sperm concentration (SC) using spectrophotometer at wave length 535 nm according to El-Sahn and Khalil (2005), percentage of forward motility (PFM) using light microscopically at 4000 magnification, percentage of live sperm (PLS), sperm out put (SOP) = (SC) X (EV), the number of motile sperm (NMS) = (PFM) X (SOP), and the number of live sperm (NLS) = (PLS) X (SOP).

3. Morphometric traits

Ornamental traits (Comb, wattle and spur length) and non ornamental traits (body weight, keel length, tarsometatarsal length and width, testicular weight, and testicular weight asymmetry) were measured in each male in each group according to Kimball et al., (1997). From digital pictures of the left and right sides of males' heads and using Scion Image analysis software (Scion Corporation, Frederick, MD), the comb and wattle area (CA, WA), length (CL, WL), and width (CW,WW) were measured using the method by McGary *et al.,* 2003). Comb and wattle for each male were measured at 31 and 50 wk of age. Trait size did not change with age (P>0.05) thus mean trait size was calculated and used for statistical analysis. At 50 week of age, males were weighed and were slaughtered to complete bleeding. A cloth measuring tape was used to measure keel length

(KL) which defined as the maximum distance from the anterior and of the sternum to the posterior end of the xyphoid process. Caliper was used to measure tarsometatarsal length (TL, from the tibia-tarsal joint to the joint of the hallux) and tarsometatarsal width (TW, the width of leg above the spure). Spur length (SL) was defined as the distance between the base of the spur and its distal end. The epididymal region was removed from the left and right testes, which were then individually weighed. Values were reported as average of testis weight (TSW). The degree of testicular weight asymmetry FA TSW between the two testes was calculated according to the following formula [L-R]/(L+R) according to Møller and swaddle (1997).

4. Statistical analysis

Data were subjected to a two-way analysis of variance with group and period effect using General Linear Models (GLM) procedure of SAS users Guide, 2001 and their interaction. Physical characters differences were analyzed by the t-test. Pearson correlations were used to determine relationships between semen characters and physical traits. Concerning the correlation analyses, mean of semen parameters for period 4 and 5 for each individual male were used because the reduction in semen parameters which were found in these two periods.

RESULTS AND DISCUSSION

1. Morphometrical measures

Table (1) showed that (GL) males were more-expressed in ornamental and non-ornamental traits than (GS) males, especially in CW, CA and TSW ($P<0.01$). These findings were in agreement with El-Sahn, (2007).

2. Semen parameters

The current results confirm that GL males had a highest semen evaluation except for PLS (Table 2 and 3), these results were in agreement with El-Sahn (2007) who found that GL males had a highest fertility.

Age * group interaction was not significant. EV, SC, SOP, NMS, and NLS were declined with the advantage cock's age. This finding was in agreement with previous results of El-Sahn (2007) who found a reduction in Bandarah male fertility associated with age. A closer evaluation of older males may be warranted as the reduction in fertility associated with age may, in some case, be associated with decreasing in testicular sperm production and not an intrinsic loss in sperm fertilizing ability.

3. Relation between semen parameters and morphometrical measures:

A correlation analysis was carried out to examine the relation between male morphometry and semen parameters:

a. Ornamental traits:

Male red junglefowl, Gallus gallus, possess a number of phenotypic traits that appear to be ornamental in nature. Ligon *et al.*, (1998) found that comb size, the only male trait shown to be used by females. El-Sahn (2007) have previously shown a strong positive correlation between Bandarah comb area and fertility. Galal (2007) found that within Dandarawi-Nova, there was significantly positive relationship between CL and packed sperm volume (PSV). Conversely, there was a negative significant correlation between WL and PSV. This paper seem to support the previous investigations, as it appears that both of CA and CW were significantly positive correlated with EV, SOP, NMS, and NLS. Interestingly, WA and WW were significantly negative correlated with SC (Table 4).

Spur length (SL) was chosen because it may reflect male fighting ability and influence female choice in their copulation parteners (Badyaev *et al.*, 1998). Although the functional significant of male spurs remains unresolved in the fowl (Pizzari *et al.*, 2004), Bilcik and Estevez, (2005) found that males with the highest mating frequency had a tolest SL. Vonschantz *et al.*, (1995) reported that females preferred males with largest SL. In this study, SL was significantly negative correlated with SW and PLS. Inverse correlation was noticed between SL and SC (Table 4).

b. Non-ornamental traits

Significant positive relationship between BW and EV was observed. This result was supported by several authers (Siegal and Dunnington 1990 and Galal 2007).

No significant relationship was observed between bone measurements and semen parameters, except a significant negative relationship was between TL and PLS. (Table 4). These results were in agreement with Galal (2007), who observed a significantly positive correlation between shank length and dead sperm percentage.

Since androgen-mediated morphometric traits, such as CA and TSW, have been shown to correlate with fertility (McGary *et al.*, 2002), an additional goal of this study was to determine if males with greater TSW and/or larger combs displayed a higher semen quality. It was found a positive correlation between TSW and comb measurements (Table 5). Also, both of them were positively correlated with SOP, NMS, and NLS (Table

4). On the other hand, a positive significant relationship was found between FA STW and both of WA and WW, also all of them were negatively correlated with SC.

It is also interesting to note a significant positive correlation between testis weight and spur length. This result is in agreement with Vonschantz *et al.*, (1995). Inversely, a significant negative relationship was found between FA TSW and SL. These results indicated that not only the weight of testes, but also FA TSW may be indicative of male quality.

In conclusion, this experiment supported the hypothesis that ornamental traits were good indicators of semen quality in Bandarah males. However, how much each of these traits may be contributing with behavioral in natural mating is get unknown.

Table (1): Mean±SE of both GL and GS for comb width (CW), comb length (CL), comb area (CA), wattle width (WW), wattle length (WL), wattle area (WA), Spur length (SL), body weight (BW), keel length (KL), tarsometatarsal length (TL), tarsometatarsal width (TW), testicular weight (TSW) and fluctuating asymmetry of testes weight FA TSW.

	Ornamental traits							Non-ornamental traits					
Traits / Group	CW (cm)	CL (cm)	CA (cm^2)	WW (cm)	WL (cm)	WA (cm^2)	SL (mm)	BW (Kg)	KL (mm)	TL (mm)	TW (mm)	TSW (gm)	FA TSW
GL	4.88± 0.18^a	6.73± 0.24	30.45± 0.95^a	3.84± 0.27	4.29± 0.19	12.52± 0.57	1.83± 0.30	1.79± 0.68	172.0± 3.0	117.77 ±1.5	16.3± 0.34	18.27± 0.34^a	0.05± 0.006
GS	2.36± 0.19^b	6.13± 0.26	12.77± 0.64^b	2.95± 0.19	3.95± 0.25	8.35± 0.60	1.50± 0.19	1.64± 0.60	169.3± 3.5	114.0± 1.9	15.4± 0.37	14.19± 0.5^b	0.08± 0.003

GL: Males with large comb and wattle.
GS: Males with small comb and wattle
Means with different superscripts within column are significantly different at ($P<0.01$).

Table (2): Semen parameters (mean±SE) across the five age periods for GL and GS

Semen parameter	SW			EV			SC			PFM		
Group / Period	GL	GS	overall mean	GL	GS	overall mean	GL	GS	overall mean	GL	GS	overall mean
1	271.8 ±18.0	245.1 ±25.3	259.1 ±15.0^{B}	0.27 ±0.02	0.25 ±0.03	0.26 ±0.02^{A}	1.18 ±0.08	1.06 ±0.06	1.16 ±0.05^{A}	87.87 ±1.36	88.21 ±1.25	88.05 ±0.90
2	436.8 ±41.5	428.5 ±28.9	432.1 ±23.3^{A}	0.33 ±0.03	0.27 ±0.04	0.3 ±0.02^{A}	0.69 ±0.04	0.66 ±0.02	0.64 ±0.03^{B}	91.77 ±1.86	90.75 ±1.82	91.26 ±1.27
3	163.0 ±27.5	139.0 ±16.8	151.6 ±16.0^{C}	0.27 ±0.03	0.23 ±0.02	0.25 ±0.02^{A}	0.58 ±0.05	0.64 ±0.03	0.61 ±0.03^{BC}	93.0 ±1.34	84.0 ±1.24	88.59 ±1.36
4	226.4 ±18.6	194.6 ±24.2	210.4 ±15.3^{B}	0.19 ±0.02	0.11 ±0.01	0.16 ±0.01^{B}	0.52 ±0.03	0.47 ±0.03	0.49 ±0.02^{C}	88.66 ±1.05	89.50 ±1.08	89.1 ±0.75
5	163.8 ±22.8	134.5 ±23.4	148.4 ±16.3^{C}	0.13 ±0.01	0.12 ±0.01	0.12 ±0.01^{B}	0.55 ±0.05	0.55 ±0.04	0.55 ±0.03^{C}	91.33 ±1.43	88.0 ±1.52	89.58 ±1.09
Overall mean	241.39 ±13.7	220.4 ±18.8		0.25 ±0.01^{b}	0.12 ±0.01^{a}		0.74 ±0.04	0.69 ±0.03		90.03 ±0.60^{b}	88.23 ±0.63^{a}	

GL: Males with large comb and wattle, GS: Males with small comb and wattle, SW: Semen weight (mg), EV: Ejaculate volume (ml), SC: Sperm concentration ($x10^9$/mL) and PFM: Percentage of forward motility (%),
Means with different superscripts within column (Capital) or within rows are significantly different at ($P<0.05$).

Table (3): Semen parameters (mean±SE) across the five age periods for GL and GS

Semen parameter	PLS			SOP			NMS			NLS		
Group / Period	GL	GS	overall mean	GL	GS	overall mean	GL	GS	overall mean	GL	GS	overall mean
1	89.4 ±1.77	95.6 ±1.02	92.65 ±1.20	0.32 ±0.03	0.27 ±0.04	0.30 ±0.03^{A}	0.26 ±0.03	0.28 ±0.03	0.25 ±0.03^{A}	0.31 ±0.06	0.31 ±0.06	0.31 ±0.04^{A}
2	93.12 ±1.58	96.1 ±1.35	94.61 ±1.07	0.21 ±0.02	0.17 ±0.03	0.19 0.02^{B}	0.20 ±0.03	0.17 ±0.03	0.18 ±0.02^{B}	0.2 ±0.02	0.17 ±0.03	0.18 ±0.02^{B}
3	94.11 ±1.87	93.0 ±1.72	93.55 ±0.83	0.16 ±0.02	0.15 ±0.02	0.16 ±0.02^{B}	0.15 ±0.03	0.13 ±0.02	0.14 ±0.02^{B}	0.15 ±0.03	0.14 ±0.02	0.15 ±0.01^{B}
4	92.6 ±1.02	96.3 ±0.68	94.56 ±0.66	0.10 ±0.01	0.05 ±0.01	0.08 ±0.01^{C}	0.09 ±0.01	0.05 ±0.01	0.07 ±0.01^{C}	0.09 ±0.01	0.05 ±0.01	0.07 ±0.01^{C}
5	94.7 ±1.53	96.0 ±0.85	95.35 ±0.86	0.07 ±0.01	0.07 ±0.01	0.07 ±0.01^{C}	0.06 ±0.01	0.66 ±0.01	0.06 ±0.01^{C}	0.069 ±0.01	0.06 ±0.01	0.07 ±0.01^{C}
Overall mean	92.82 ±0.63^{b}	95.55 ±0.45^{a}		0.18 ±0.02	0.15 ±0.02		0.16 ±0.01	0.13 ±0.01		0.15 ±0.01	0.13 ±0.01	

GL: Males with large comb and wattle, GS: Males with small comb and wattle, PLS: Percentage of live sperm (%), SOP: sperm output ($X10^9$/ejaculate), NMS: number of motile sperm ($X10^9$/ejaculate), and NLS: Number of live sperms($X10^9$/ejaculate).
Means with different superscripts within column (Capital) or within rows are significantly different at ($P<0.05$).

Table (4): Pearson correlation between semen characters and morphometric traits.

Traits	Semen characters							
	SW	EV	SC	PEM	PLS	SOP	NMS	NLS
Ornamental traits								
CA	0.09	0.54*	0.08	0.35	-0.39	0.49*	0.48*	0.46*
CW	0.20	0.56**	0.16	0.31	-0.27	0.53*	0.51*	0.51*
CL	0.22	0.04	0.17	-0.28	-0.32	0.16	0.14	0.14
WA	-0.45	0.12	-0.55*	0.23	-0.31	-0.23	-0.20	-0.26
WW	-0.05	0.05	-0.56*	0.32	-0.39	-0.26	-0.23	-0.29
WL	-0.49	-0.03	-0.26	0.17	-0.32	-0.15	-0.15	-0.18
SL	-0.52*	0.17	0.53*	-0.05	-0.46*	0.44	0.42	0.40
Non-ornamental traits								
BW	0.32	0.47*	0.04	0.01	0.13	0.23	0.23	0.26
KL	0.43	0.06	0.25	-0.09	-0.29	0.28	0.27	0.25
TL	0.24	0.04	0.23	-0.14	-0.59**	0.24	0.22	0.18
TW	0.04	0.16	0.20	0.06	-0.12	0.19	0.17	0.19
TSW	0.40	0.23	0.57**	0.09	-0.23	0.57**	0.56*	0.54*
FA TSW	-0.33	-0.17	-0.55*	0.09	0.04	-0.41	-0.38	-0.42

SW: Semen weight (mg), EV: Ejaculate volume (ml), SC: Sperm concentration (x10^9/mL), PFM: Percentage of forward motility (%), PLS: Percentage of live sperm (%), SOP: sperm output (X10^9/ejaculate), NMS: number of motile sperm (X10^9/ejaculate), and NLS: Number of live sperms(X10^9/ejaculate). NLS: Number of live sperms (%), CA: Comb area (cm^2), CW: comb width (cm), CL: Comb length (Cm), WA: wattle area (cm^2), WW: Wattle width (cm), WL: wattle length (cm), SL: spur length (mm), BW: body weight (gm), KL: keel length (mm), TL: Tarsometatarsal length (mm), TW: tarsometatarsal width (mm), TSW: testis weight (gm), and FA TSW: fluctuating asymmetry of testicular weight. * P<0.05 , ** P<0.01

Table (5): Pearson correlation between ornamental traits and both of TSW and FA TSW.

	CA (cm^2)	CW (cm)	CL (cm)	WA (cm^2)	WW (cm)	WL (cm)	SL (mm)
TSW (gm)	0.583**	0.550*	0.550*	-0.40*	-0.392	-0.127	0.565**
FA TSW	0.442	-0.454*	-0.459*	0.575*	0.588*	0.329	-0.605**

Comb area (CA), comb width (CW), comb length (CL), wattle area (WA), wattle width (WW), wattle length (WL), spur length (SL) testis weight (TSW), and fluctuating asymmetry of testicular weight (FA TSW). * P<0.05, ** P<0.01.

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الملخص العربى

استخدام الصفات المظهرية للتنبؤ بخصوبة الديوك

2. الصفات الجمالية و الغير جمالية

امانى عادل الصحن

معهد بحوث الإنتاج الحيوانى – مركز البحوث الزراعية – وزارة الزراعة – مصر

الإنتخاب للصفات الإقتصادية (مثل زيادة النمو) ربما يساهم سلبيا في التعبيرعن الشكل المظهري، وكذا التغيرات في الصفات الجماليه والغير جمالية والتي ربما من نتيجتها تقليل القدرة الإخصابية.

من المفترض أن التعبير عن الشكل المورفولجى للديك لابد أن يرتبط إيجابياً ببعض المقاييس الخاصة بالقدرة الإخصابية.

تم إستخدام عدد 40 ديك من سلالة البندرة تم توزيعهم بالتساوى الى مجموعتين وفقاً لصفات الجنس الثانوية: المجموعة الأولى: ديوك ذات عرف و دلايات كبيرة (GL). و المجموعة الثانية: ديوك ذات عرف و دلايات صغيرة (GS) . تم تسكين الديوك فى اقفاص فردية. و تم تقييم السائل المنوى خلال 5 فترات عمرية هى (31: 34 أسبوع)، (35: 38 أسبوع)، (39: 42 أسبوع)، (43 :46 أسبوع)، (47: 50 أسبوع) . تم قياس العرف والدلايات عند عمر 31 و50 أسبوع وبما ان تقدم العمر لم يؤثر معنويا على هذه الصفات لذا فانه تم حساب متوسط كل صفة لادخالها في التحليل الاحصائي. عند عمر 50 أسبوع تم تسجيل طول المهماز ، طول عظمة القص، أبعاد عظمة الرسغ مشطية، وزن الخصية و عدم تناسق وزن الخصية.

١. النتائج اظهرت ان الديوك (GL) كانت أكثر تعبيراً عن الصفات الجمالية و الغير جمالية عن الديوك (GS) ، و عموماً كانت الديوك GL اعلى فى صفات السائل المنوى.

٢. مساحة العرف و كذلك عرضه أظهرتا إرتباطاً معنوياً موجباً مع حجم القذفه، العدد الكلى للحيوانات المنوية، العدد الكلى للحيوانات المنوية المتحركة، العدد الكلى للحيوانات المنوية الحية و من الملاحظ ان مساحة الدلايات لها علاقة سلبية معنوية مع تركيز الحيوانات المنوية. كما لوحظ وجود علاقة معنوية موجبة بين طول المهماز و تركيز الحيوانات المنوية.

٣. وجدت علاقة معنوية موجبة بين وزن الجسم و حجم القذفة و لا توجد علاقة بين مقاييس العظم و صفات السائل المنوى ماعدا علاقة معنوية سلبية بين طول عظمة الرسغ مشطية والنسبة المئوية للحيوانات المنوية الحية.

٤. وجدت علاقة معنوية موجبة بين وزن الخصية و مقاييس العرف و كل منهما له علاقة مع العدد الكلى للحيوانات المنوية و العدد الكلى للحيوانات المنوية المتحركة و العدد الكلى للحيوانات المنوية الحية. أيضاً كان هناك علاقة ايجابية بين عدم تناسق وزن الخصية و مقاييس الدلايات.

الخلاصة: من المفيد إستخدام الصفات الجمالية للديوك كدليل على القدرة الإخصابية العالية.