Egypt. J. Anim. Prod. 19, No. 1, pp. 101-113 (1979)

Genetical Studies on Semen Characteristics of Cocks

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Cockerels progeny from mating of 20 males each with 10 females in two breeds of chicken (Fayoumi and R.I.R.) were evaluated for semen characteristics at maturity. The number of tested Cockerelson the basis of two ejaculate each male were 680 for Fayoumi and 281 for Rhodes. The best semen characteristics were obtained in February for Fayoumi and in July for Rhodes.

Age at testing was significantly affecting traits like volume, concentration, total sperm and live sperms per ejaculate. Repeatabilities of moderate or high magnitude were observed in Fayoumi for semen volume and for concentration in Rhodes. Lower values and repeatabilities observed for motility in Fayoumi and for pH in Rhodes. The heritability estimates ranged from 0.4 for semen volume in Fayoumi to 0.81 for live sperm per ejaculate in Rhodes.

The influence of male fertility on net chick production per laying hen and hence on chick cost, is of considerable importance in poultry production. Many factors were reported to be affecting the fertilizing ability of cocks. Cooper and Rowell (1958) reported that cock fertilizing ability is mainly determined by percent of live spermatozoa and motility of semen. Kamar (1960a), Soller Schindler and Bornstein (1965) Boone (1968) Pilipei (1970,1971) reported a positive correlation between sperm concentration and motility with egg fertility. Raimo (1943) and Sampson and Warren (1939), reported a negative significant correlation between percentage of abnormal sperms and fertility. McKenzie and Berliner (1937) and Kamer and Badreldin (1959b) found that male sterility occurs when total abnormalities increase over 25% Age of cock, time of mating and breed of chicken were also reported by Parker *et al.* (1942), Lorenz and Lerner (1946), Williams and McGibbon (1956,b), Kamar (1960b), McDaniel and Graig (1962) and Gleichauf (1974) to influence male fertility.

The effect of selection on semen characteristics and the genetic parameter of semen traits were reported by number of investigators, Jones and Lamareux (1942), Soller Snapier and Schindler (1965), Marini and Goodman (1969) Chalov (1970), Pingel and Loebel (1970) and Kurbatov *et al.* (1973).

This work was to investigate the effect of date of hatch, month of ejaculate and age of cock at testing time on semen characteristics. Estimates of genetic parameters for semen traits were also obtained.

Material and Methods

Twenty males and 200 females were randomly chosen from each of two breeds (Fayoumi and Rhode Island Red), one male mated to ten females and ten hatches were obtained for the first shift which continued from October 1 till December 24. A second shift started on January 14 of the following year and ended on April 7. Semen characteristics of male progeny were examined. The total number of male progeny evaluated in Fayoumi was 680 and 281 in Rhodes.

Chicks were reared in floor brooders till three months of age. Cockerels were kept in the rearing houses till sexual maturity. Age and date of ejaculate for each cock were recorded. Two ejaculates within one week were collected from each cockerel that attained sexual maturity by massage method without milking the copulatory organs (Kamar, 1958).

Characteristics measured for each ejaculate were volume (v) to nearest 0.01 ml, motility (M) rating following Kamar (1960a) scheme of classification; concentration (CN) measured according to Smith and Mayer (1955), live percentage (L) and types of abnormalities as described by Kamar (1959a), pH and sperm to plasma (S/ P) percent were also measured.

The linear model chosen in representing each random variable in the statistical analysis was:

$y_{ijki} = M + s_i + D_{ij} + p_{ijk} + I_{ijkl}$ where $_{ijkl}$ is the observation from the I th ejaculate of the K cock M from the Jth dam mated to the i th sire; M is commoneffect to all observations; S_i the effect of the si i th re D_{ij} is the effect of the j th dam mated to the i th sire P_{ijk} is the effect of the k th cock from the dam mated to the i th sire and I_{ijkl} is the peculiar effect to the Y_{ijkl} observation. Method II of Henderson (1953) was used to estimate fixed effects (hatch, month and age) then correcting the data in accordance with these estimates and then applying method I for the corrected data to estimate genetic parameters according to the above model. The standard errors of heritabilities were obtained using the method suggested by Woolf (1961). Genetic correlations standard errors were computed by Robertson's (1959) approximation method.

Results and Discussion

The least-squares overall means of semen characteristics are presented in Table 1 for Fayoumi and Rhode Island Red. The overall mean of volume (V) in R.I.R. is higher than its corresponding figure in Fayoumi (0.14vs

0·10). The same trend is also true with respect to the mean of the total sperms (TS) and live sperms per ejaculate (LS). The picture was not the same for the overall means of concentration (CN) and normal sperms per ejaculate (NS), where Rhodes showed lower means compared to the Fayoumi. It can be concluded that majority of semen characteristics in Rhode (a heavy breed), were higher than Fayoumi (a light breed). Williams and McGibbon (1956 a and b)stated that cocks with heavier body weights produced larger volume of semen with statistically significant correlation beween body weight and semen volume. They suggested that the heavy cocks are supposed to have larger reproductive organs that will produce large amounts of semen. The sperm motility in both breeds were similar (7·66 and 7·63). The pH value for Fayoumi was closer than Rhodes to the optimum pH value for semen reported in the literature. Lardy and Phillips (1943) reported a pH of 7·25 to the best value for cock semen. The lower sperm to plasma percent in Rhodes can be attributed to the larger semen volume in this breed compared to Fayoumi. The total abnormalities in Fayoumi was higher than that of Rhodes. Kamar (1959b) reported that Fayoumi males produced a high pecentage of total abnormalities with respect to other breeds (White Leghorn and White Baladi). Most of sperm abnormalities for the two breeds (Fayoumi and Rhodes) were those of coiled tails.

The same observation was reported by Kamar (1960a) in Fayoumi cocks. Total tail abnormalities in this study showed higher values in Rhodes than Fayoumi, while head abnormalities showed the opposite with higher head abnormalities in Fayoumi than Rodes.

Effect of hatch month and age on semen characteristics

The test of significance for the two breeds (Table2) showed a significance effect for date of hatch on CN, TS, NS and LS in Fayoumi. Khalifa (1977) observed a gradual increase in semen volume for the later hatches in both Fayoumi and Rhodes. The better semen characteristics obtained from males mature at an earlier age in Fayoumi. Jones and Lamareux (1942), reported that cockerels of high fecundity strain, which reach sexual maturity at earlier ages, yield greater quantities of semen than the cockerels from the low fecundity strain which mature late.

Types of abnoramalities of semen characters showed a significant difference for hatch effect in case of ruptured head (RH), and other head abnormalities (OH) in Fayoumi and coiled tail (CT) Rhodes. Kamar (1960b) found that cocks of late hatches may be delayed in sexual maturity. He also reported that within the same breed of Fayoumi, the late maturing cockerels produce semen with the least abnormalities.

The effect of month of ejaculate on semen volume in Fayoumi showed a decline from a highest value during February to the lowest value during September. In the case of the Rhode Island Red, the highest semen volume was during July and the lowest values obtained in February and March.

Other semen traits as CN, TS, NS and LS in Fayoumi attains its maximum on March followed by a gradual decline till september. In other studies in Missouri (35N°) with New Hampshire cocks reached the peak in semen production during April, while the lowest values obtained in September (Parker *et al.*, 1942). In another experiment, at the same latitude, semen characteristics showed seasonal decline from their highest values during late winter to the lowest values in mid-summer (Munro, 1938; Burrows and Titus, 1939 and Whealer and Andrews, 1943). The results of Fayoumi in this study, suggest that the production of sperms by a cock is subjected to annual cycles similar to that observed in egg production. Sperm production declines during late spring and summer months in correspondence of what occurs in egg production. Parker and Mespadden (1943), found that the decline in fertility, late in the season, is probably related to this seasonal slump in sperm production. The lowest semen quantity in Rhodes was obtained in winter, where a climate of low temperature and short day length is prevalent. Lamareux (1943) and Parker and McSpadden (1943), obtained a similar trend as that the shorter the day length, the smaller the quantity of semen produced.

Results also revealed that pH, TA, CH, HH, RH and OH were all affected significantly by the month of ejaculate. The poorest semen characters observed during summer months when environmental temperatures were high, days are long and the weather is dry. It seems that at a location like the Giza area, semen would be subjected at the time of collection, to two climate shocks; one is the intense light and the other is the relatively high temperature.

The partial regression coefficient of age of cock at testing time on CN, TS, NS and LS were statistically significant in Fayoumi. The values for Rhode Island Reds were lower in magnitude and not statistically significant.

For semen volume in Rhodes most of the variability was attributed to age of male and the contribution of hatch and month were of a limited effect. According to these results, it can be suggested that correcting semen volume for month effect has to be done for Fayoumi, while correction for age at testing is needed in Rhodes. The normal and live sperms per ejaculate seem to be independent of any seasonal or hatch or age effects. The variation in sperm motility in both Fayoumi and Rhodes were mainly attributed to month effect.

The partial regression coefficient of hooked head (HH) on age at testing in either Fayoumi or Rhodes were lower and not significant. The coiled head in Rhodes was the only trait affected by age of male at the time of testing concerning all types of abnormality traits (Table 3).

Genetic parameters of semen characteristics

In Fayoumi L, S/P and TA showed higher repeatability values compared to moderate values for CT, and BT. The lowest estimates of repeatability in Fayoumi were for TL, CH and M. The results in Rhodes were not in agreement

with that of Fayoumi and repeatability estimates for V, SP, LS, M and L were greater than the theoretical limit (Table 4). Repeatability estimates did not change significantly either in sign or magnitude before or after correction for hatch, month and age effects (Khalifa, 1977).

Estimates of heritabilities for volume of semen in the literature ranged between 0.1 to 0.4. Soller, Snapier and Schindler (1965) and Kopylovskaya and Chalov (1972) estimated h_s^2 for different breeds as 0.40. The combined estimate for heritability in Fayoumi in this study agree with the upper limit of published reports. The combined estimate for Rhodes in case of concentration was 0.35. Siegel *et al.* (1960) reported a heritability estimate for this character in an unselected and selected line of birds ranged between 0.01 to 0.46.

Pingel and Loebel (1970) reported an estimate of 0.675 for heritability of total sperms per ejaculate in turkeys. The above estimate is closer to that estimated from Rhodes data for the same trait. The combined h^2_{s+d} in Fayoumi for motility was 0.15 while Rhodes gave a higher than one value. Soller *et al.* (1965) reported heritabilities with range between 0.29 to 0.80 for semen volume, concentration and sperm motility in their unselected and selected line of birds.

The wide difference in heritability estimates in this study and in the literature would have to be examined in light of breed used, season of collection and type of calculation carried out.

It seems adequate (from present study and previously reported ones) to say that motility is at least 20-25% influenced by additive genetic variance.

The disagreement between Rhodes and Fayoumi results could be attributed to the heterogenity ofthe Rhodes families. The Rhodes used in this study Were brought to the breeding farm two years before the experiment from the Ministry of Agriculture Farms. The Fayoumi flock was bottle necked at the breeding farm at Giza since 40 years ago.

All heritabilities of tail abnormalities in Fayoumi breed were much higher than comparable values of Rhodes.

Combined genetic correlations between V, CN, TS, NS, LS were allimaginary in Fayoumi. The combined estimates between volume and CN in Rhodes were positive and of higher magnitude (Table 5). The phenotypic correlations for these traits were of the same range in either Fayoumi or Rhodes. The genetic correlations between motility and live percentage were positive and of high magnitude in the two breeds.

In general, both genetic and phonotypic correlations in the present work were of higher magnitude than those reported in literature (Table 5 and 6). Pingle and Loeble (1970), observed positive genetic correlations between volume

with CN, and V with TS, and TS with CN with the corresponding figures 0.17, 0.77 and 0.75 respectively . Marini and Goodman (1969) reported negative significant phenotypic correlations between motility and total abnormality percentage ranging from-0.2 to - 0.3.

The high repeatability values suggest that two ejaculations, are sufficient enough in evaluation of cock idex for different semen characteristics.

The high positive genetic correlation observed between most of semen characteristics, would suggest a positive response to selection not only for traits directly selected for, but also to other correlated ones. These results would indicate that selection for some easily measured traits such as volume and total sperm, *etc.* would indirectly improve other semen characteristics. In some cases, one could expect more improvement from indirect selection than direct selection. In this study, (as an example), if one select TS, the expected indirected improvement in CN is greater than selecting for CN directly.

TABLE 1. Least-squares overall means (± S. E.) for all semen characteristics in Fayoumi and Rhode Island Red.

Traits	Fayoumi	R.I.R.
Volume (v)	0.10±0.01	0.14±0.01
Concentration (CN)	2.86±0.36	2.29±0.20
Total sperms per ejaculate (TS)	343.60±54.80	356.10±60.00
Normal sperms per ejaculate (NS)	266.10±49.30	263.00±47.50
Live sperms per ejaculate (LS)	280.10±43.60	291.10±48.90
Motility rating (M)	7.66±0.44	7.63±0.20
Live percentage (L)	80.40±2.00	78.6±0.82
Sperm to plasma percentage (S/P)	54.40±3.70	53.98±2.70
Total abnormalities percentage (TA)	24.00±1.33	22.63±0.73
pH	7.19±0.13	7.42±0.06
Coiled head percentage (CH)	2.42±0.34	2.28±0.20
Hooked head percentage (HH)	2.10±0.29	2.13±0.15
Ruptured head percentage (RH)	3.02±0.30	2.38±0.15
Other head abnormalities percentage (OH)	3.56±0.29	2.76±0.16
Coiled tail percentage (CT)	5.26±0.51	5.17±0.27
Broken tail percentage (BT)	3.94±047	4.15±0.24
Tailcess percentage (TL)	3.69±0.51	3.78±0.28

TABLE 2. Significance of hatch, month and regression on age effects for all traits in Fayoumi and Rhode Island Red according to F-test.

Traits	Fayoumi			R.I.R.		
	Hatch	Month	Regression	Hatch	Month	Regression
V	NS	**	NS	NS	NS	*
CN	*	**	**	NS	**	NS
TS	*	**	**	NS	*	NS
NS	*	**	*	NS	NS	NS
LS	*	**	**	NS	NS	NS
M	NS	NS	NS	NS	NS	NS
L	NS	NS	NS	*	NS	NS
S/P	NS	NS	NS	NS	NS	NS
TA	NS	**	NS	NS	*	NS
pH	NS	**	NS	NS	NS	NS
CH	NS	**	NS	NS	NS	*
HH	NS	**	NS	NS	*	NS
RH	**	**	*	NS	**	NS
OH	*	**	*	NS	**	NS
CH	NS	NS	NS	*	NS	NS
BT	NS	NS	NS	NS	NS	NS
TL	NS	**	NS	NS	NS	NS

** Significant at the 1% level of probability.
* Significant at the 5% level of probability.

NS Not significant.

TABLE 3. Partial regression* coefficients (± S.E.) of semen characteristics on age at testing in Fayoumi and Rhode Island Red.

Traits	Fayoumi	R.I.R.
V	-0.078±0.194	0.965±0.440
CN	-0.1370±0.053	-0.0052±0.067
TS	-19.85±0.094	27.64±20.042
NS	-15.39±0.395	18.31±15.87
LS	-16.83±6.448	19.53±16.35
M	0.0002±0.006	0.0058±0.007
L	-0.0324±0.029	0.0054±0.028
S/P	-0.0240±0.085	0.0526±0.090
TA	-0.0063±0.019	0.0356±0.024
pH	-0.0011±0.002	-0.0010±0.009
CH	0.0021±0.005	0.0097±0.007
HH	0.0013±0.004	0.0032±0.005
RH	-0.0086±0.004	0.0050±0.005
OH	-0.0083±0.004	0.0128±0.006
CT	-0.0042±0.008	0.0016±0.009
BT	0.0063±0.007	0.0005±0.008
TL	0.0053±0.008	0.0026±0.009

* Holding the hatch and month effects constant.

TABLE 4 : Repeatability* and heritability(a) (±S.E.) estimates of semen characteristics in Fayoumi and Rhode Island Red.

	Repeatabilities		Heritabilities	
	Fayoumi	R.I.R.	Fayoumi	R.I.R.
V	0.59	1.60	0.41±0.12	1.08±0.30
CN	-0.54	0.70	b	0.35±0.19
TS	-0.32	0.91	b	0.70±0.23
NS	-0.35	0.97	b	0.75±0.23
LS	-0.33	1.03	b	0.81±0.23
M	0.22	1.99	0.15±0.06	1.76±0.31
L	0.97	3.27	0.54±0.19	3.34±1.06
S/P	0.65	1.10	0.46±0.12	1.01±0.24
TA	0.87	-0.29	0.73±0.16	b
pH	-4.67	0.43	b	0.44±0.16
CH	0.05	0.04	b	b
HH	-0.25	0.39	b	0.31±0.17
RH	-0.53	-0.63	b	b
OH	1.03	0.73	0.98±0.18	0.68±0.21
CT	0.55	-0.16	0.58±0.15	b
BT	0.44	-0.04	±601 0.13	b
TL	0.20	-0.40	0.08±0.05	b

* Estimates were corrected for date of hatch, month of ejaculate and age at testing.
a Estimates were calculated from combined sire and dam component of variance.
b Heritabilities values were negative.

TABLE 5. Combined genetic correlations* (± S. E.) between semen characteristics in Fayoumi and Rhode Island Red.

(a) r_g between V, CN, TS, NS and LS in R.I.R.

	V	CN	TS	NS
CN	1.06±0.03			
TS	0.94±0.03	1.18±0.13		
NS	0.91±0.04	1.16±0.11	1.00±0.00	
LS	0.09±0.04	1.17±0.12	1.00±0.00	1.00±0.00

TABLE 5. (*Cont.*)

(b) r g between M, L. pH, S/P, and TA in Fayoumi and R.I.R.

		M	L	pH	S/P
Fayoumi	L	0.80±0.08			
	S/P	1.71±0.46	1.39±0.15		
	TA	0.87±0.06	1.04±0.01	**	0.87±0.05
R.I.R.	L	1.10±0.04			
	pH	3.33±1.79	2.15±0.86		
	S/P	1.16±0.05	1.46±0.2à	5.18±5.38	

(c) r gbetween OH, CT, BT, and TL in Fayoumi

	OH	CT	BT
CT	0.96±0.01		
BT	0.95±0.02	0.95±0.02	
TL	1.18±0.99	1.15±0.11	0.99±0.00

*Values were corrected for date of hatch, month of ejaculate and age of testing.
**Values omitted from table were imagianry.

TABLE 6. Phenotypic correlations* between semen characteristices in Fayoumi and Rhode Island Red.

(a) r g between V, CN, TS, NS, and LS

	V		CN		TS		NS	
	Fay.	R.I.R.	Fay	R.I.R.	Fay	R.I.R.	Fay	R.I.R.
CN	0.26	0.28						
TS	0.63	0.70	0.83	0.78				
NS	0.64	0.71	0.82	0.76	0.99	0.99		
LS	0.63	0.70	0.83	0.78	0.99	0.99	0.99	0.99

TABLE 6. (*Cont.*)

(b) r p between M, L, pH S/P and TA

	M		L		pH		S/P	
	Fay.	R.I.R.	Fay.	R.I.R.	Fay	R.i.R.	Fay	R.I.R.
L	0.67	0.60						
pH	0.04	0.29	0.06	0.21				
S/P	0.14	0.05	0.13	0.07	0.07	0.14		
TO	-0.36	-0.32	-0.27	-0.20	-0.07	-0.20	-0.08	-0.07

TABLE 6. (*Cont*)

(c) r p between CH, HH, RH, OH, CT, BT, and TL

	CH		HH		RH		OH		CT		BT	
	Fay.	R.I.R.	Fay.	R.I.R.	Fay.	R.I.R.	Fay.	R.I.R.	Fay.	R.I.R.	Fay.	R.I.R.
HH	0.11	0.05										
RH	0.03	0.13	0.12	-0.03								
OH	0.08	0.20	0.10	0.21	0.01	0.12						
CT	0.13	0.30	0.08	-0.01	-0.08	0.05	-0 00	.06				
BT	0.02	0.00	0.10	0.05	0.02	0.14	0.11	0.11	-0.04	-0.14		
TL	0.13	0.14	0.12	0.06	0.12	0.21	0.14	0.10	0.01	0 .06	0.40	0.48

* Values were corrected for date of hatch, month of ejaculate and age at testing.

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دراسات وراثية عن صفات السائل المنوى فى الديوك

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تم فحص عينتين لصفات السائل المنوى للديكة الأبناء الناتجة من تلقيح ٢٠ ديك و ٢٠٠ أنثى من كل من الفيومى والرود أيلندرد على اساس ديك لكل ١٠ أناث ـ وكان عدد الديكة الابناء المختبرة ٦٨٠ للفيومى و٢٨١ للرود وقد وجد أن أحسن النتائج تم الحصول عليها كان فى شهر فبراير بالنسبة للفيومى وشهر يوليو بالنسبة للرود وذلك لصفات كمية السائل المنوى ، يؤثر العمر تأثيرا معنويا على صفات كمية السائل المنوى ، كذلك كان العامل التكرارى متوسط أو عاليا لصفة كمية السائل المنوى فى الفيومى وصفة تركيز الحيوانات المنوية فى الرود بينما المعامل التكرارى كان منخفضا لصفة حركة الحيوانات المنوية فى الفيومى وتركيز ايونات الايدرجين فى الرود ، بتراوح العمق الوراثى لصفات كمية السائل المنوى من ٤٠ر كجم للسائل المنوى فى الفيومى الى ٨١ر للحيوانات المنوية الحية فى القذفة بالنسبة للرود .