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Genetic and phenotypic parameters for egg production and egg quality traits in guinea fowl

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ABSTRACT

Laying behaviour, inheritance pattern of egg production and related traits were studied in indigenous guinea fowl. Observations were made on clutch length, oviposition time, egg production rate, total and part egg production. Good layers revealed definite rhythm more frequently than poor layers and about 45% eggs were laid during morning hours. Moderate to high heritability values were obtained for age at first egg (0.56 ± 0.19), total egg production (0.43 ± 0.13), 90 days egg production (0.47 ± 0.18), egg weight (0.75 ± 0.21), shell thickness (0.44 ± 0.18), and Haugh unit (0.80 ± 0.21). Information on genetic and phenotypic correlations between reproduction traits and also between internal egg quality traits is presented. High genetic correlation was observed between total egg production and egg production during first 90 days.

Guinea fowl is an important alternate poultry species with promising future for rural poultry production. Besides being a valuable source of meat, it also produces substantial number of eggs. Literature on egg production and egg quality traits of guinea fowl revealed extremly sparse information on inheritance of these traits (Marks, 1990; Singh, 1991). This investigation was undertaken to estimate genetic and phenotypic parameters of egg production and related traits in indigenous guinea fowl stocks.

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MATERIALS AND METHODS

Present study was made on production records of guinea fowl population maintained at the Central Avian Research Institute, Izatnagar. In each generation, 500-600 pullets were obtained by random mating of 15 to 20 sires with 5 to 6 dams. All keets were brooded and reared on floor following standard feeding and management practices and subsequently subjected to selection for body weight at 12-week age. At about 32 weeks of age, selected pullets were housed in individual cages and eggs produced during first laying period (March to September) were recorded. Clutch size and time of oviposition were assessed in a small experimental group of 116 layers and eggs were collected at an hourly intervals from 7 AM to 4 PM during April and August. Over the three years, 1310 eggs were evaluated for interior quality using standard methods described by Mahapatra *et al.* (1987). Average of 3 or more consecutively laid eggs represented each female.

Egg production data of 245 half-sib progenies of 59 sires raised between 1989 to 1991 were used for the present analysis. Least squares analyses of variance and covariance following the method-3 of Henderson (1953) as outlined by Harvey (1987) were utilised to obtain between sire variance and covariance components. The model included the fixed effects of years and sires within year as random effect. Heritability and genetic correlations were estimated by half-sib correlation method.

RESULTS AND DISCUSSION

Guinea fowl reproduction cycle consists of a distinct breeding season extending from March to September and non-breeding season between October and February. About 80 to 85% guinea fowl hens commence laying in spring (March/April) but rare birds may start laying early in January/February. Initiation of egg production and subsequent attainment of peak egg production around June and July indicated intricate role of increasing day light hours, rising temperature and environmental humidity (Table 1). Perhaps extreme hot-arid weather conditions adversely affect egg production as 16 to 20% hens

Table 1. Mean climatic variations and monthly egg production in guinea fowl

Months	Monthly rainfall (inch)	Vapour pressure (mm)	Temperature (°C)		Monthly egg production		
			Maximum	Minimum	Pearl (N=85)	Lavender (N=48)	White (N=45)
January	0.20	8.86	15.4	5.6	0.0	0.0	0.0
February	1.20	10.16	24.6	11.2	0.0	0.0	0.0
March	0.60	11.38	27.7	15.5	10.0	11.4	10.5
April	0.05	11.99	33.6	18.8	13.3	13.0	13.6
May	0.00	12.71	34.0	25.6	16.2	16.3	17.7
June	0.77	19.90	32.8	23.0	20.5	20.6	18.0
July	2.94	23.62	36.4	23.4	19.7	20.0	17.7
August	12.61	24.53	31.9	21.9	14.3	13.2	16.3
September	10.82	22.74	31.7	20.7	6.0	5.5	6.2
October	0.00	15.66	32.2	15.4	0.0	0.0	0.0
November	0.73	11.88	24.3	10.7	0.0	0.0	0.0
December	0.42	10.93	21.8	8.7	0.0	0.0	0.0

which commenced laying early showed long pauses during peak summer to be resumed with onset of rainfall. Similar observations were reported by Ogwuegbu *et al.* (1988) for the Nigerian stocks, where delay in arrival of rains prolonged the resting period of guinea fowl. A positive but low correlation between egg production and relative humidity was also reported.

Time of oviposition varied greatly among guinea hens kept in natural light period (14-15L; 9-10D). Majority of eggs (35-45%) were laid in late morning hours but a second less pronounced peak was also observed during early afternoon hours (Fig. 1). It indicated that both light hours and light intensity positively influenced the egg production. Guinea fowl laying pattern revealed a distinct similarity with chicken where 60 to 65% eggs were laid in morning hours depending on the latitude, length of day and season of year (Jull, 1972). In turkey and Coturnix quails most layings occurred around mid-day and late afternoon hours respectively (Stockton and Asmundson, 1950; Wilson and Huang, 1962). Guinea layers exihibit varying rhythms of egg sequence interspread with irregular skips. Egg number in a clutch ranged from 1 to 17 and good layers had higher percentage of long sequences in their egg laying cycle. Table 2 present the percentage of clutch sizes for guinea fowl hens with different level of productivity.

Average values : Indigenous guinea fowl stocks were inherently

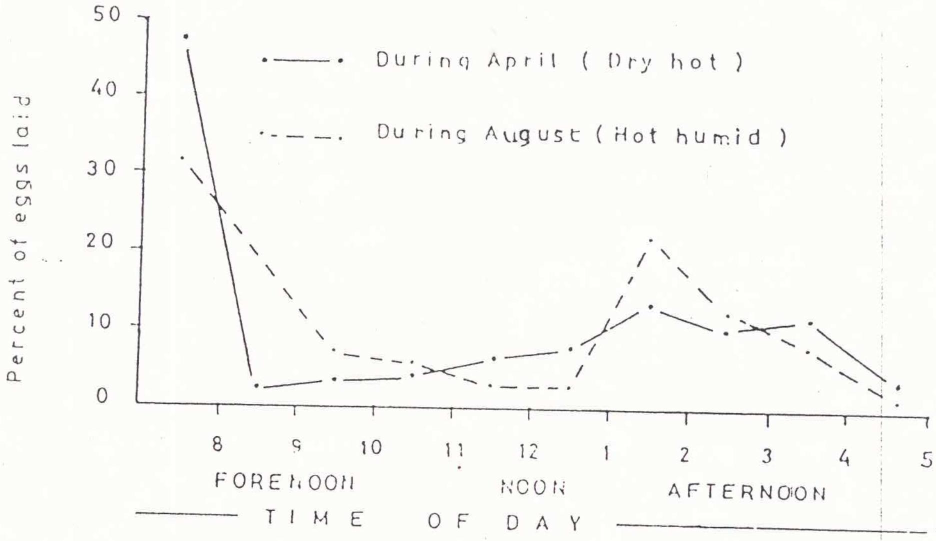

Fig. 1. Time of oviposition for indigenous guinea fowl

Table 2. Clutch size distribution among guinea fowl

Hen productivity	N	Clutch size 1	2	3	4	5	6	7	8	9	10	Average sequence length (days)
100 or more eggs	30	27.1	20.2	19.1	16.1	8.2	5.1	1.6	1.6	0.5	0.5	3.6
80 - 100 eggs	25	42.2	27.1	14.0	9.7	2.1	1.0	2.1	0.6	0.6	0.6	2.2
60 - 80 eggs	20	47.2	20.0	18.5	0.4	5.1	2.0	1.4	-	0.7	0.7	2.1
Below 60 eggs	20	53.2	20.5	14.1	8.0	1.2	2.0	-	-	-	1.0	1.9
1st clutch (overall distribution)		46.0	18.3	12.8	2.7	10.0	2.7	2.7	2.7	1.0	1.0	1.8

slow maturing birds characterised with low egg productivity (Table 3) but individual differences were highly significant. Hen housed egg production was 48.7%. About 30.0% birds laid more than 100 eggs while 14.3% laid less than 25 eggs. Flock means for egg production, egg weight and related egg quality traits (Table 3) showed good agreement with earlier reports for guinea fowl (Sandhu and Brah, 1982; Ayeni *et al.*, 1983; Mahapatra *et al.*, 1987). Compared to chicken eggs, the guinea fowl eggs showed significantly low albumen index but high Haugh unit score and thicker and stronger egg shells.

Heritability estimates : Egg production and egg quality traits in indigenous guinea fowl population revealed moderate to high heritability estimates based on paternal half sib correlations (Table 3). Heritability values for age at sexual maturity and egg production during first 90 days (0.56 ± 0.09 and 0.47 ± 0.19) seem to be relatively high for the traits closely associated with reproductive fitness. Egg weight was also found to be highly heritable (0.75 ± 0.21). The sire families used in this study comprised of full sibs and half sibs, therefore relatively high estimates were not unexpected. However, similar estimates of heritability for these traits have been reported in chicken and quail (Singh and Chaudhary, 1982; Singh *et al.*,

Table 3. Overall means and heritability values for reproduction and egg quality traits in guinea fowl

Traits	Mean (N=345)	S.D.	Heritability
Age at Ist egg (days)	263.8 ± 4.33	26.87	0.56 ± 0.19
Hen weight at Ist egg (g)	1529.3 ± 10.3	117.27	0.73 ± 0.18
Egg production-90 days (n)	57.7 ± 1.17	12.74	0.47 ± 0.18
Total egg production (n)	92.8 ± 1.92	25.64	0.43 ± 0.13
Egg weight (g)	39.6 ± 0.26	3.44	0.75 ± 0.21
Shape index	76.0 ± 0.36	–	0.23 ± 0.16
Shell thickness (mm)	0.4 ± 0.01	0.18	0.44 ± 0.18
Shell weight (g)	5.7 ± 0.08	1.79	0.81 ± 0.21
Albumen height (mm)	6.1 ± 0.06	1.19	0.66 ± 0.20
Albumen index	0.1 ± 0.01	–	0.78 ± 0.21
Albumen weight (g)	20.7 ± 0.17	2.89	0.47 ± 0.19
Yolk weight (g)	13.0 ± 0.10	1.44	0.46 ± 0.18
Yolk index	0.4 ± 0.04	–	0.23 ± 0.22
Haugh unit	76.7 ± 0.73	–	0.80 ± 0.20

Table 4. Genetic correlations (below diagonal) and phenotypic correlations (above diagonal) between reproduction traits of guinea fowl

	Age at Ist egg	Hen weight at 1st egg	Egg weight	Total egg production	Egg production (90 days)	Egg shell thickness
Age at 1st egg (days)	–	0.02	–0.01	–0.15	–0.08	–0.01
Hen weight at 1st egg (g)	–0.01 ± 0.21	–	0.08	0.01	0.05	0.08
Egg weight (g)	–0.41 ± 0.41	0.02 ± 0.22	–	0.08	0.11	0.15
Total egg production (H)	–0.21 ± 0.22	–0.10 ± 0.23	0.33 ± 0.22	–	0.71	0.04
Egg production (90 days)	0.02 ± 0.21	–0.18 ± 0.22	0.12 ± 0.22	0.86 ± 0.67	–	0.01
Shell thickness (mm)	–0.04 ± 0.25	0.18 ± 0.25	0.45 ± 0.22	–0.05 ± 0.27	–	–

1988; Praharaj *et al.*, 1990). The moderate to high heritability values observed for egg quality traits in guinea fowl are consistant with heritability estimates reported in some chicken and quail populations (Singh *et al.*, 1988; Praharaj *et al.*, 1989; Brah *et al.*, 1991). Similar moderate estimates were also obtained for shell thickness in chicken by Rao *et al.* (1977).

Genetic and phenotypic correlations : The phenotypic correlations between production and reproduction traits and among different egg quality traits (Tables 4 and 5) showed low standard errors ranging between 0.03 to 0.06 and are in good agreement with those of Singh (1991). But small number of pullets per sire included for some families in this analysis caused high standard errors in case of some genetic parameters. The positive genetic correlations between total egg production and part production during first 90 days indicated that these two traits were governed by same additive genes and suggested scope for early selection. Results revealed negative genetic correlations for age at 1st egg with egg production (90 days) and egg weight. But these observations in a population which was not bred for egg production indicate contradictory situation and need further confirmation as similar studies in chicken suggested that the early sexual maturity was correlated with smaller birds, small sized eggs and lower egg production (Jull, 1972).

In addition to good egg size and uniform shape, breeders are also interested in high percent thick albumen and good yolk size, but guinea fowl stocks showed considerable variations in these egg quality traits. The existence of negative genetic relationship was observed between albumen quality (Haugh unit), egg weight and shell weight (Table 5). In chicken and quails divergent genetic correlation trends were also reported for egg quality traits (Rao *et al.*, 1977; Singh *et al.*, 1988; Praharaj *et al.*, 1989; Brah *et al.*, 1991). In another study Rodda *et al.* (1977) showed that entire set of genes controlling egg compositional traits at one period might not be responsible for the control of these traits at another period. Besides genetic influences, the significant effects of factors like age, season, feed and management, etc. highlight the complexity of the problems involved when improvement of interior quality traits is attempted.

Present observations indicate that the higher shell quality of guinea fowl eggs might have interesting future application. Existence of considerable amount of additive genetic variations for egg production and related traits suggest distinct possibilities for

Table 5. Genetic correlations (below diagonal) and phenotypic correlations (above diagonal) between egg quality traits of guinea fowl

Traits	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
Albumen height (X_1)	–	0.12	0.89	-0.94	–0.04	0.22	–0.14	–0.03	0.14	0.01
Albumen weight (X_2)	0.44 ± 0.21	–	-0.05	–0.35	0.14	0.11	0.19	0.19	0.84	0.12
Albumen index (X_3)	0.62 ± 0.14	0.16 ± 0.26	–	0.79	–0.08	0.22	0.20	0.11	-0.01	–0.05
Haugh unit (X_4)	–0.90 ± 0.36	–0.14 ± 0.32	–0.54 ± 0.27	-	–0.14	–0.23	0.03	–0.12	–0.39	–0.06
Yolk weight (X_5)	0.24 ± 0.27	–0.05 ± 0.31	–0.03 ± 0.27	-0.37 ± 0.28	–	0.08	0.22	0.23	0.91	0.21
Yolk index (X_6)	0.55 ± 0.18	–0.54 ± 0.21	–0.01 ± 0.20	-0.51 ± 0.19	0.02 ± 0.24	–	0.13	–0.04	0.15	0.06
Shell thickness (X_7)	–0.19 ± 0.27	0.55 ± 0.28	0.55 ± 0.28	0.39 ± 0.27	0.29 ± 0.29	0.26 ± 0.23	–	0.44	0.34	0.13
Shell weight (X_8)	0.23 ± 0.23	0.58 ± 0.21	0.06 ± 0.22	–0.99 ± 0.23	0.60 ± 0.21	–0.03 ± 0.20	0.71 ± 0.17	–	0.52	0.13
Egg weight (X_9)	0.54 ± 0.20	0.76 ± 0.11	0.12 ± 0.23	–0.81 ± 0.27	0.64 ± 0.18	0.32 ± 0.19	0.67 ± 0.19	0.74 ± 0.13	–	–0.19
Prod. 90 days (X_{10})	–0.09 ± 0.28	0.01 ± 0.31	–0.39 ± 0.28	–0.03 ± 0.26	0.46 ± 0.28	0.04 ± 0.23	0.50 ± 0.29	–0.15 ± 0.26	0.35 ± 0.24	-

further genetic improvement of indigenous guinea fowl germplasm.

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