6 Egypt. J. Anim. Prod., 17, No. 1, pp. 47-53 (1977)

Genetic Studies of Egg Quality of Different Breeds and Crosses in the Subtropics

F.K.R. Stino, M.A.M. Kicka and G.A.R. Kamar

Department of Animal Production, Faculty of Agriculture, Cairo University, Giza, Egypt.

A STUDY was conducted to determine breed differences in egg quality in chickens under a subtropical environment. Crosses between these breeds were used to obtain information on the nature of gene action. Data indicated that the native breeds, the Fayoumi (F) and white Baladi (B) had higher egg yolk and shell percentages but lower egg white percentages than the Rhode Island Red (RIR) breed. The eggs from the RIR were also more rounded than the eggs of the native breeds. The eggs of the F had the highest shell thickness and specific gravity, while those of the RIR were the lowest in shell thickness and specific gravity. There were no differences between breeds in the yolk shape index. However, the Haugh Units of eggs from the RIR were higher than either native breed. Yolks of the B breed were significantly darker than either the RIR or the F breed. It can be concluded that heterosis was apparent in yolk percentage. Dominant gene action was present in egg white percentage, shell percentage, and egg shape index. Sex-linked genes were involved in shell thickness and specific gravity. Maternal effects were prevalent for Haugh Units and yolk colour.

Several investigations have studied the egg quality of different breeds of chickens under subtropical conditions. The yolk percentage of Egyptian native breeds is usually higher than that of standard breeds. El-Boushy (1961) and Kicka (1968) reported a range from 31 to 35 percent in native breeds, while ranging from 29 to 31 % in standard breeds under the subtropical conditions of Egypt (El-Gammal, 1965). Egg white was reported to comprise 53% of the Fayoumi (F) egg (Kicka, 1968), 61 % in Rhode Island Red (RIR), and 55 % in Baladi (B), (El-Boushy, 1961). The Fayoumi is characterized by a higher shell percentage than in any other standard breed, ranging from 12 to 14 % (Kicka, 1968). Shell percentage in RIR, White Plymouth Rock, and New Hampshire (NH) under subtropical conditons was reported to be 9, 11, and 11 % respectively (El-Gammal, 1965 and Amer, 1959).

The average annual shape index was 74 and 69 % for F and RIR respectively (El-Samra, 1970). The egg shape index of RIR was lower than that of the native fowl (F and B) which were approximately equal ; however, crossbreds were intermediate between their parents (Samkari, 1962). Shell thickness of F eggs was highest (0.358 mm) followed by White Leghorn (WL) (0.314 mm) and RIR (0.288 mm) (El-Samra, 1970). Potts and Washburn (1974) concluded that the specific gravity of the egg was the most reliable method of determining egg shell strength.

RIR and WL had higher Haugh units than native breeds (El-Samra, 1970). Yolk shape index was 44 to 46 % in F and 44 to 45 % in B eggs (El-Boushy, 1961) and 46 % in NH (El-Gammal, 1965). The average annual yolk colour values were 6.17, 6.59, and 6.65 for WL, RIR, and F respectively (El-Samra, 1970).

The purpose of this study was to determine the nature of gene actions involved in the inheritance of egg quality through reciprocal crossing.

Material and Methods

Data were collected on two native Egyptian breeds, the Fayoumi (F) and white Baladi (B), and compared to a standard breed, the Rhode Island Red (RIR), and their six reciprocal crosses. These crosses and their general managements were the same as reported by Stino (1974) and Kicka *et al.* (1976). In discussing the crosses the male abbreviation will be listed first *i.e.*, FR means Fayoumi male × Rhode Island Red female.

About 120 eggs were broken during February from each breed and cross to determine their egg quality with an average of three to five eggs per hen. Individual data were collected from each egg of each hen. The eggs were broken within 24 hr of being laid to study the following traits; yolk, albumen and shell percentages ; shape index; shell thickness (Brant and Shrader 1952); yolk colour using the colour chart method); yolk shape index (Funk, 1948) and Haugh Units (Haugh, 1937). Specific gravity was determined by the saline solution floating method saline solutions representing a range of specific gravity from 1.065 to 1.110 were prepared with an increment of 0.005. Thus, ten different classifications were obtained.

The data were then analysed by the Least-Squares method (Harvey, 1960) using the individual hen averages. Separation of means was carried out according to Duncan (1955).

Results and Discussion

Egg components

Yolk percentage

The yolk percentage of the native breeds was higher than that of the RIR breed (Table 1). This may be due to the larger egg of the RIR breed (Kicka *et al.*, 1976). These results agree with El-Boushy (1961). The B with RIR crosses were almost similar in yolk percent to the B breed. However, the F with RIR crosses had a lower yolk percentage and were similar to the RIR breed. Crossing the two native breeds together resulted in the highest yolk percentage indicating heterosis.

Egg white percentage

As expected, the breeds and crosses that had the highest yolk percentage had the lowest albumen percentage (Table 1). The RIR breed had significantly higher albumen percentage than the native breeds. Crossing the RIR with F resulted in an albumn percentage similar to that of the RIR breed indicating dominant gene action. However the RIR with B crosses were intermediate in their egg white percentage indicating additive gene action. Crossing the two native breeds together resulted in an albumen percentage similar to both native breeds.

TABLE 1. **Egg components of different breeds and crosses $\overline{X} \pm SE$.**

Breeds and crosses	*of eggs	Yolk %	Albumen %	Shell%
RIR.	98	31.7 ± 0.5 bc*	55.8 ± 0.6 a	12.5 ± 0.2 b
BR	103	33.1 ± 0.5 b	54.4 ± 0.5 ab	12.5 ± 0.2 b
FR	92	31.8 ± 0.6 bc	56.0 ± 0.6 a	12.2 ± 0.2 b
RB	107	33.1 ± 0.5 b	54.4 ± 0.5 ab	12.5 ± 0.2 b
RF	135	32.0 ± 0.4 bc	55.8 ± 0.4 a	12.2 ± 0.2 b
BB	101	33.4 ± 0.5 ab	53.1 ± 0.5 b	13.5 ± 0.2 a
FF	138	32.9 ± 0.4 b	53.5 ± 0.4 b	13.6 ∓ 0.2 a
FB	122	33.8 ± 0.4 a	52.5 ± 0.4 b	13.7 ± 0.2 a
BF	132	33.3 ± 0.4 ab	53.2 ± 0.4 b	13.5 ± 0.2 a

* Values within columns with different superscript differ significantly ($P \leq .01$) from each other (Duncan, 1955).

Shell percentage

Table 1 shows that the RIR breed had a significantly lower shell percentage than the native breeds. These results agree with those of Amer (1959). Crossing the RIR breed with either of the native breeds resulted in eggs with shell percent similar to that of the RIR breed with no difference between the reciprocal crosses. This would suggest the presence of dominant genes responsible for this characteristic present in the RIR breed and possibly few in number. On the other hand, crossing the two native breeds together resulted in a high shell percentage similar to both parents. Both native breeds appear to carry the recessive gene (s) for this characteristic with no apparent overdominance.

Shell quality

Shape index

The RIR eggs were significantly more rounded than the B egg with F intermediate (Table 2). These differences could not be due to the difference in egg weight since a low correlation between shape index and egg weight was reported (Asmundson, 1931). Crossing the RIR breed with either of the native breeds resulted, in most cases, in a more elongated egg. However, crossing the two native breeds together resulted in a rounded egg similar to that of the F breed. This would suggest that the F breed carries some dominant gene(s) responsible for a more rounded egg, while the B carries their recessive alleles.

TABLE 2. **Shell quality of different breeds and crosses $\bar{X} \pm SE$.**

Breeds and crosses	Shape index	Shell thickness (mm)	Specific gravity
RIR. . . .	78.2 ± 0.6 a*	0.315 ± 0.008 b	1.0858 ± 0.0015 c
BR	75.6 ± 0.5 cd	0.341 ± 0.006 a	1.0921 ± 0.0013 ab
FR	76.5 ± 0.7 abcd	0.347 ± 0.008 a	1.0935 ± 0.0017 a
RB	74.2 ± 0.5 d	0.318 ± 0.006 b	1.0878 ± 0.0013 bc
RF	75.9 ± 0.5 bcd	0.319 ± 0.006 b	1.0882 ± 0.0012 bc
BB	75.0 ± 0.6 d	0.321 ± 0.007 ab	1.0915 ± 0.0014 abc
FF	77.3 ± 0.4 abc	0.329 ± 0.005 ab	1.0933 ± 0.0011 a
FB	77.7 ± 0.5 ab	0.335 ± 0.006 ab	1.0933 ± 0.0012 a
BF	77.5 ± 0.5 abc	0.344 ± 0.006 a	1.0950 ± 0.0011 a

* Values within columns with different superscripts differ significantly ($P \leq .01$) from each other (Duncan,1955).

Shell thickness

F breed had the highest shell thicknes of any of the pure breeds (Table2). This was followed by the B then the RIR breeds. Crossing the RIR breed with both native breeds resulted in a significant paternal effect associated heterosis. This would indicate that genes responsible for this characteristic are carried on the Z chromosome. Crossing the two native breeds together resulted in an apparent heterosis with no differences between the reciprocal crosses.

Specific gravity

The same trend present with shell thickness was also present in specific gravity (Table 2). These results agree with most reported literature on the association between shell thickness and specific gravity of the egg. Specific gravity is easy to measure and the egg does not need to be broken to find its specific gravity. Regression analysis of specific gravity on shell thickness indicated that most of the variation between breeds in shell thickness can be attributed to its specific gravity.

Interior quality

Yolk shape index

This is one of the characteristics that, together with Haugh Units, determine the egg grade. The yolk index of the different breeds and crosses ranged from 46.5 to 48.6 (Table 3). However, these differences were not statistically significant. This may be due to breaking the egg to determine its quality within 24 hr after laying.

TABLE 3. **Interior egg quality of different breeds and crosses $\bar{X} \pm SE$.**

Breeds and crosses	Yolk index	Haugh units	Yolk colour
RIR.	46.6 ± 0.8 a*	78.5 ± 2.0 ab	8.2 ± 0.3 b
BR	46.9 ± 0.6 a	77.8 ± 1.7 ab	8.4 ± 0.3 b
FR	48.1 ± 0.8 a	82.3 ± 2.2 a	8.3 ± 0.3 b
RB	47.2 ± 0.6 a	73.2 ± 1.7 bc	8.9 ± 0.2 ab
RF	48.6 ± 0.6 a	74.9 ± 1.5 abc	8.0 ± 0.2 b
BB	47.4 ± 0.7 a	69.4 ± 1.9 c	9.7 ± 0.3 a
FF	46.9 ± 0.5 a	72.1 ± 1.4 bc	8.0 ± 0.2 b
FB	47.7 ± 0.6 a	71.0 ± 1.5 c	8.8 ± 0.2 ab
BF	46.5 ± 0.6 a	73.7 ± 1.5 bc	8.5 ± 0.2 b

* Values within columns with different superscript differ significantly ($P \leq .01$) from each other (Duncan ,1955).

Haugh units

RIR breed had higher Haugh Units than both native breeds (Table 3). The B breed had the lowest Haugh Units with F intermediate. Crossing the RIR with both F and B resulted in an apparent maternal effect. Also when crossing both native breeds the same maternal effect was observed.

Yolk colour

The B breed had a significantly darker yolk than either of the pure breeds (Table 3). This difference in colour could not be attributed to a lower laying intensity of the B breed since it laid as many eggs as the F breed and only 2 eggs per month less than the RIR breed (Kicka *et al.*, 1976). Crossing the B breed with either of the two other breeds resulted in a progeny with intermediate yolk colour. The reciprocal crosses differ from each other in their yolk colour indicating a maternal effect. Similar unpublished data also indicate that the B breed also has a very dark yellow skin colour. This would indicate that the B mothers carry gene (s) which enable them to deposit more pigment in their yolk or skin. This also would suggest that those gene(s) had a pleiotropic effect, affecting both the skin and yolk colour.

References

Amer, M.F. (1959) *A study of egg size in Fayoumi and some imported breeds of poultry.* Ph. D. Thesis, Ain Shams Univ.

Asmundson, V.S (1931) The formation of the hen's egg. *Sci. Agr.*, **11**, 590, 662, 775, in Hutt, F.B., "*Genetics of the Fowl*", 1949, McGraw-Hill, New York.

Brant, A.W., and Shrader, H.L. (1952) How to measure the interior quality of the eggs. USDA, PH 202.

Duncan, D.B. (1955) Multiple range and multiple F tests. *Biometrics* **11**, 1.

El-Boushy, A.R. (1961) *A study of fertility and hatchability in the fowl.* M.Sc. Thesis, Univ. of Cairo.

El-Gammal, A.M. (1965) *Studies on some egg qualities of some breeds of poultry in U.A.R.* M.Sc. Thesis, Univ. of Cairo.

El-Samra, S.H. (1970) *A study on the major factors affecting egg quality of some breeds of poultry.* MSc. Thesis ,Univ. of Cairo.

Funk, E.M. (1948) The relation of the yolk index determined in natural position to the yolk index as determined after separating the yolk from the albumen. *Poultry Sci.* **27**, 367.

Harvey, W.R. (1960) Least squares analysis of data with unequal subclass numbers. USDA, ARS 20-8.

Haugh, R.R. (1937) The haugh units for measuring egg quality. *Poultry Magazine*, **43**, 552.

Kicka, M.A.M. (1968) *The effect of some managerial treatments on egg production in the Fayoumi fowl.* M.Sc. Thesis, Univ. of Cairo.

———————, **Stion, F.K·R. and Kamar, G.A.R.** (1976) Genetical studies on some economical traits of chickens in the subtropics. *Egypt. J. Anim. Prod.* (in press).

Potts, P.L., and Washburn, K.W. (1974) Shell evaluation of white and brown egg strains by deformation, breaking strength, shell thickness, and specific gravity. 1. Relationships to egg characteristics. *Poultry Sci.* **53**, 1123.

Samkari, M.K. (1962) *A comparative study of some economical characteristics in Rhode Island Red, Fayoumi, and their crosses.* M.Sc. Thesis Univ. of Cario.

Stino, F.K.R. (1974) Effect of crossing and diet on chicken growth in the subtropics. *Proc. XV World Poultry Congress,* 32-33.

دراسة الصفات الوراثية لصنف البيض لبعض الأنواع الهجين تحت الظروف الشبة حارة

فريد كمال رمزى استينو ، مختار عبد الفتاح محمد قيقه ومحمد جمال الدين قمر

قسم الانتاج الحيوانى ، كلية الزراعة ، جامعة القاهرة

اجرى هذا البحث لدراسة صنف البيض فى الفيومى والبلدى الابيض والرود آيلند وخلطانها تحت الظروف الجوية المحلية الشبة حارة لمعرفة طبيعة تأثير الجنين .

ولقد أظهرت النتائج أن النوعين المحليين ، الفيومى والبلدى الأبيض تفوقوا على نوع الرودآيلند الأحمر فى نسبة الصفار والقشرة اما نسبة البياض فلقد كانت أعلى فى الرودآيلند الأحمر وباطن الرودآيلند الأحمر بيضا أكثر استداره من بيض الأنواع المحلية .

وتتميز بيض الدجاج الفيومى بقشرة اسمك وبكثافة نسبية أعلى من كلا النوعين لآخرين فى حين كان بيض الدجاج الرودآيلند الأحمر أقلهم فى كلا الصفتين . كذلك فلم يكن هناك فرق بين الأنواع الخلطان فى دليل الشكل للصفار . أما بالنسبة لوحدات Haugh لتقدير جودة البياض فقد كان بيض الدجاج الرود آيلند الأحمر أجود هذه الأنواع كذلك فان لون صفار بيض الدجاج البلدى الأبيض كان أكثر جودة (درجة اللون كانت أعلى) من كلا النوعين وكانت الفروق معنوية .