9

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Inheritance of Abdominal Fat in Egg Layers

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BASED on sire components, the heritability estimates for live body weight, abdominal fat weight and egg number laid during the first 90 days of laying were .89, .61 and .17, respectively. There was a negative correlation between live body weight and number of eggs laid. Abdominal fat weight was closely positively correlated with live body weight, and negatively correlated with number of eggs laid and dressing percentage.

These results suggest that selection should be practiced against abdominal fat during the laying period in females. However, selection for decreased amount of abdominal fat would probably reduce body weight, with a possible correlated effect on egg weight.

KEY WORDS (Inheritance, abdominal fat, egg layers)

There is quite a lot of studies on the inheritance of abdominal fat in chickens. Differences in fat deposition between breeds (Edwards and Denman, 1975) and strains within breeds (Ehinger and Seemann, 1982) indicate the importance of genetic factors in fat deposition.

Several estimates of the heritability of abdominal fat have been published. A genetic variation within strain in the total amount of fat was found by Friars *et al.* (1983). They estimated the heritability of total percentage body fat to be 0.48. Gyles *et al.* (1984) reported the heritability of the absolute amount of abdominal fat was 0.67 in males and 0.24 in females calculated from sire component In the experiment of Friars *et al.* (1983) the degree of heritability estimated from the dam component of variance is higher than that estimated from the sire component.

On the other hand, Ricard and Rouvier, 1967 and 1969 found that the heritability estimated from the sire component of variance is considerably higher than that estimated from the dam component.

The phenotypic correlations between live body weight and absolute amount of abdominal fat was 0.55 in females (Friars *et al.*, 1983). The corresponding value between live body weight and abdominal fat as percentage of body weight was 0.18.

This study was conducted to estimate the heritability of live body weight, abdominal fat and some other traits in laying hens, to calculate the phenotypic correlations between the various traits and to assess the value of using abdominal fat traits, age at first egg, oviduct length and width of pubic bones to predict egg number.

MATERIAL and METHODS

The data used in this study were obtained from the flock of Alexandria chickens maintained at the Alexandria University, Poultry Research Center. In the 1984 breeding season, twelve individual male breeding pens were made up by assigning one male at random to each pen and likewise allotting from 9 to 10 females to each pen. A total 1265 of chicks were produced in three consecutive hatchs. A hatch consisted of eggs collected over a 2-week interval. All pullets were reared to five months of age in floor pens and fed the standard University of Alexandria growing ration to 8-week of age and the standard rearing ration from 8 to 20 weeks of age. They were then placed in individual cages and provided with the University of Alexandria laying ration. All diets and water were available *ad libitum*. .. . ..

Age at sexual maturity was assessed as the age in days at first egg and daily egg production records were obtained during the first 90 days of laying for each hen.

A total of 130 hens from 32 dams and 6 sires were used in this study. When the birds were 14 months of age the live body weight was obtained and the width of pubic bones was measured. They were then slaughtered according to Islamic regulation by cutting the jugular vein across the throat at the base of the skull by a sharp knife. The feathers were manually removed. Weights of the warm eviscerated carcasses including the neck but excluding the giblets (gizzard, heart and liver) were taken. The abdominal fat surrounding the gizzard and that which lay between the abdominal muscles and the intestines were removed and weighed. The length of oviduct without vagina was measured. The actual weights of abdominal fat, eviscerated carcass and giblets expressed as a percentage of live weight were computed.

Before statistical analysis, percentages were subjected to arcsine transformation in accordance with Snedecor and Cochran (1967).

The estimates of heritability for all traits were determined by means of the variance component, analysis following the method outlined by Becker (1968) for the one way nested classification. The statistical model for the component analysis was

$$Y_{ik} = U + S_i + e_{ik}$$

where Y_{ik} is the measurement of a trait on the k^{th} bird of the i^{th} sire,
U is the overall mean of the population,
S_i is the effect of the i^{th} sire, and
e_{ik} is the random error.
All terms in the model except U were assumed to be random. Heritability was estimated from the formula

$$h^2 = \frac{4\, O_S^{-2}}{O_S^{-2} + O^{-2}_W}$$

Phenotypic correlations between various traits were calculated. Multiple regression analysis was used to assess the value of using abdominal fat weight (X_1), % abdominal fat/live weight (X_2), age at first egg (X_3), oviduct length (X_4) and width of pubic bones (X_5) to predict egg number. All the computations were carried out using a Hewlett Packrd Computer at the Faculty of Agriculture Computer Unit.

Results and Discussion

Means, standard errors and coefficients of variation for studied traits are given in Table 1. The coefficient of variation in abdominal fat weight was high (53.4%), perhaps because of the manual removal of the abdominal fat by two operators. Expressing abdominal fat weight as percentage of body weight decreased the coefficient of variation.

TABLE 1. Means (X') standard errors (S.E.) and coefficients of variation (C.V) for studied trais.

Trait	Number of birds	X'	S.E	C.V %
Live weight (g)	130	1836.1	52.1	32.5
Abdominal fat weight (g)	130	53.9	2.5	53.4
Abdominal fat/live weight (%)	130	2.4	0.1	47.5
Carcass weight/live weight(%)	130	61.9	1.9	14.9
Giblet weight/live weight (%)	130	11.3	0.1	10.1
Age at first egg (day)	130	176.4	0.8	5.2
Egg number to 90 days (egg)	130	53.9	1.0	21.1
Length of the oviduct (cm)	130	54.1	0.5	10.5
Width of public bones (cm)	130	4.5	0.1	25.2

In broilers, the coefficient of variation of amount of abdominal fat is 25 to 30%, while the coefficient of variation of the total fat content (abdominal fat included) varies between 15 and 20% (Leenstra, 1984).

Heritability estimates from the analysis of variance are given in Table 2. The heritability estimate for live body weight was high (.89). This estimate is higher than the .27 estimate of Shebl (1986) who worked on the same flock.

Heritability of abdominal fat weight was .61 which is somewhat lower than but in the range of the .70 estimate of Ricard and Rouvier (1969) calculated from sire component for abdominal fat in 59-day old Cornish chicken. However, it is higher than .32 and .24 estimates of Friars *et al.* (1983) and Gyles *et al.* (1984) in broiler females. The high heritability suggest it may be possible to select for or against abdominal fat in laying hens. The amount of abdominal fat relative to body can be reduced by selection through progeny testing or sib selection (Leclercq *et al.*, 1980), selection for feed efficiency (Pym and Solvyns, 1979) and selection based on the concentration of triglycerides in blood plasma (Griffin and Whitehead, 1982).

Phenotypic correlation coefficients between traits are given in Table 2. The correlation between live body weight and abdominal fat weight was .47 but decreased to a non-significant value when abdominal fat was expressed

TABLE 2. Heritabilities (h^2) and phenotypic correlations between traits

Trait	$h^2 \pm$ S.E. ∅	Abdominal fat weight	% Abdominal fat/live weight	% Carcass weight/live weight	% Giblet weight/live weight	Age at first egg	Egg number	Oviduct length	Width of pubic bones
Live weight (g)	.89±.52	+ .47**	+ .19**	- .[illegible]**	- .[illegible]	+ .18	- .31**	+ .14	.34
Abdominal fat weight (g)	.61±.41		+ .93	- .74**	- .[illegible]	- .01	- .50*	- .10	- .32
Abdominal fat/live weight (%)	.38±.27			- .56	- .30	- .06	- .43	- .20	- .22
Carcass weight/live weight (%)	.37±.40				+ .4[illegible]	- .01	+ .21	- .01	+ .15
Giblet weight/live weight (%)	.49±.57					- .33	- .04**	+ .28**	+ .05
Age at first egg (day)	.18±.21						- .47	+ .47	- .40**
Egg number to 90 days (egg)	.17±.21							+ .60	+ .61
Oviduct length (cm)	.28±.31								+ .19
Width of pubic bones (cm)	.91±.53								

* Significantly different from zero ($P < .05$).

** Highly significantly different from zero ($P < .01$).

∅ Observations on 130 birds were included in the estimates of heritability as percentage of live weight. The same results were reported by Friars *et al.* (1983). Gyles *et al*, (1982) found a highly significant ($P \leq .01$) positive correlations between body weight and the three measures of fatness (fat weight, % fat/live weight and % fat/carcass weight). Ricard and Rouvier (1969) found phenotypic correlation between body weight and abdominal fat in female chickens to be .41.

There was a negative phenotypic correlation between live weight of adult females and numbers of eggs laid in the first 90 days of laying. However, Shebl (1986) found a positive phenotypic correlation (.25) between live weight of females at age at sexual maturity and number of eggs laid in the first 90 days of laying.

There was a highly significant ($P \leq .01$) negative correlation between number of eggs to 90 days and abdominal fat weight.

These results suggest that selection should be practice against abdominal fat during the laying period in females. The purpose of this selection would be to decrease abdominal fat, increase egg production and increase the feed efficiency of egg production. However, selection for decreased amount of abdominal fat would probably reduce body weight with a possible correlated effect on egg weight.

The regression equation of abdominal fat on live weight was :

$$Y_1 = 34.45 + 0.48\ X \quad (r^2 = 0.23)$$

where

Y_2 = abdominal fat weight (g) and X = live body weight (g). A significant regression coefficient is an indication that abdominal fat should be regression coefficient is an indication that abdominal fat should be regressed on body weight when comparing diets, strains, or other experimental procedures.

The multiple regression equation of egg number on the independent variables was :

$$Y_1 = 56.714 - .137\ X_1 + .426\ X_3 - .207\ X_4 + 6.397\ X_5$$

Egg number was significantly influenced ($P \leq .01$) by width of pubic bones, age at first egg, oviduct length and abdominal fat weight. R^2, the amount of variability in abdominal fat weight as explained by these four independent variables was 0.61. Based on the results of the multiple regression equation, width of pubic bones may be a better prediction of egg number than the other independent varaibles.

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وراثة دهن الاحشاء فى دجاج البيض

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كانت تقديرات المكافىء الوراثى على أســـاس مكونات التباين الأبوية ٨٩ر٠ و ٦١ر٠ و ١٧ر٠ لصفات وزن الجسم الحى عند عمر ١٤ شهر ووزن دهن الاحشاء وعدد البيض الموضوع خـــلال التسعين يوم الأولى من وضـــع البيض على التوالى ٠

وكان معامل التلازم بين وزن الجسم الحى وعدد البيض ســالبا ٠ ومن ناحية أخرى كان معامل التلازم بين وزن دهن الاحشاء ووزن الجسم الحى موجبا بينما كان معامل التلازم بين وزن دهن الاحشاء وكل من عدد البيض الموضوع ونسبة التصافى سالبا ٠

وهذه النتائج تقترح ضرورة اجراء انتخاب ضد دهن الاحشاء خـــلال فترة الوضع فى الاناث ٠ الا أن الانتخاب لخفض كميـــة دهن الاحشاء من المحتمل أن يؤدى الى خفض وزن الجسم مع احتمال وجود تأثير مرتبط عـــلى وزن البيضة ٠