Studies on the Effect of the Alteration in the Internal Environment of Poultry Egg on Embryonic Growth V. Effect of Albumen Removal on Embryonic Growth in Chickens

Tohoku Journal of Agricultural Research
Vol. 29, No. 1, May 1975
Printed in Japan

Studies on the Effect of the Alteration in the Internal Environment of Poultry Egg on Embryonic Growth

V. Effect of Albumen Removal on Embryonic Growth in Chickens*

Kanta ARAI,** Yutaka MIZUMA and Shusaku NISHIDA***

Department of Animal Science, Faculty of Agriculture, Tohoku University, Sendai, Japan.

(Received, 16 May 1975)

Summary

An experiment was carried out to clarify the effect of partial albumen removal during incubation on chicken embryo weight. Hatching eggs were obtained by inseminating twenty White Leghorn dams with a sire of the same breed.

The eggs used weighed 55.4 g on the average, and the quantity of albumen removed was 7.5 g which was equivalent to about 23 per cent of the total albumen. Body weights were observed at six critical points, 6, 10, 13, 16 and 19 days of incubation and hatching. The results are as follows.

1. The high significant differences in embryo or chick weight between the experimental and the control were found at three points after 16 days of incubation.
2. The effects of egg weight and the effect of albumen removal on embryo or chick weight were examined by analysis of covariance. The heights of regression lines were highly significantly different between the experimental and the control groups at three points after 16 days of incubation.
3. Embroyo or chick weights as a percentage of the initial egg weight were also highly significantly different between the two groups at three points after 16 days of incubation.
4. Unassimilated yolk weights tended to be smaller for the experimental than for the control at the later incubation periods invesitigated, though the differences were not significant.

It is common knowledge that egg weight influences the hatching weight of the chick. On the other hand, it was reported already that egg albumen formed 50 to 59 per cent of the total egg (1) and that, in analytic report, egg albumen also highly influenced the hatching weight (2).

* The oral presentation of this report was given at the Fall Meetg. of the Japan Poultry Science Association, Japan Branch of W.P.S.A., Sapporo, September 1965.

** Present Address: Akita Prefectural Colledge of Agriculture.

*** Professor Emeritus.

The present experiment was carried out to clarify the effect of partial albumen removal during incubation on embryonic growth.

Experimental Procedure

Twenty White Leghorn hens in individual cages were inseminated artificially every four days by a sire of the same breed. These birds were reared at the Laboratory of Animal Breeding, Tohoku University.

Hatching eggs were layed by these hens for 12 days between the 22nd of June and the 3rd of July, 1965. Experimental and control eggs were allocated on alternate days, according to the date of laying. These eggs were set in an incubator to obtain embryos or chicks at six critical points, 6, 10, 13, 16, and 19 days of incubation and hatching.

The albumen was removed after 72 hours of incubation. The quantity removed was determined to be 7.5 g. The operative procedure was conventional (3). Speaking more specificaly, the present operation was carried out with utmost care so that the differences in egg weight just before- and after the operation were minimal. Consequently, the mean quantity removed was 7.51 g. The eggs from which embryos or chicks were obtained weighed 55.4 g on the avarage and the quantity of albumen removed was estimated to be equivalent to about 23 per cent of the total albumen (1).

Other procedures not described here were referred to in a series of this study already reported.

Results and Discussion

Table 1 shows the mean embryo or chick weight. The control was consistently heavier than the experiment, and the latter reduced the growth with progressive incubation time. High significant differences were found at the three points investigated after 16 days of incubation. Though the difference in weight at hatching time approximated the quantity removed, the former did not arrive at the latter.

Though mean egg weight amounted to 55.4 g as described in the previous section, the mean for each group and each incubation time fluctuated considerably: 53.8 g in 19 days to 59.1g in 6 days for the experimental and 53.8 g at hatching to 57.4 g in 19 days for the control. Therefore, analysis of covariance (4) were carried out to exameine the effect of egg weight and the treatment on embyro or chick weight. The model was: $Y_{ij}=\alpha_i+\beta_i X_{ij}+ß_{ij}$, where i=1, 2 represented the control and the experiment, resperctively.

The results were summarized in Table 2. Compared by the two-tailed F-test, the difference in the residual mean squares was significant only after 16 days of incubation. Therefore, it can be thought that the mean squares between the two groups showed no sign of a real difference. The regression coefficient between

TABLE 1. *Mean Embyro or Chick Weight (Grams)*

Age	Mean		Difference
	Removed	Control	
Embryo 6 days	0.4178±0.0346[a)]	0.4234±0.0469	0.0056
10	2.7247±0.0806	2.7315±0.0985	0.0068
13	8.0491±0.6385	8.2367±0.4090	0.1876
16	16.1531±0.7584	17.3029±1.0930	1.1498**
19	23.3952±3.8027	29.3268±2.1196	5.9316***
Hatched	32.23 ±3.35	38.71 ±4.94	6.48***

a) Means±S.D. * Significant at 5% level. ** Significant at 1% level. *** Significant at 0.5% level.

TABLE 2. *Regression lines of Embyro or Chick Weight on Egg weight* (Grams)

Incubation Time	Removed	Control	$\sigma_1^2 \neq \sigma_2^2$	$\beta_1 \neq \beta_2$	$\alpha_1 \neq \alpha_2$
6 day	$\hat{Y}=0.4069-0.000184X$	$\hat{Y}=0.2948+0.002342X$			
10	$\hat{Y}=2.573+0.002734X$	$\hat{Y}=2.257+0.008684X$			
13	$\hat{Y}=6.040+0.03585X$	$\hat{Y}=7.081+0.02113X$			
16	$\hat{Y}=9.513+0.1188X$**	$\hat{Y}=11.06+0.1148X$	*		***
19	$\hat{Y}=-4.845+0.5253X$**	$\hat{Y}=14.39+0.2602X$****		*	***
Hatched	$\hat{Y}=-6.547+0.7053X$****	$\hat{Y}=-1.682+0.7509X$****			**

* Significant at 5% level. ** Significant at 1% level. *** Significant at 0.5% level. **** Significant at 0.1% level.

the groups was significantly different at 19 days of incubation. However, when plotting embryo weight on egg weight on graph paper with reference to this difference, a relatively small embryo from a very large egg will be found in the control at 19 days of incubation. The egg weighed 70.5 g from which the 30.7 g embyro was obtained. As this large egg is predicted to have a considerably large quantity of albumen and accordingly, to have a large ratio of albumen to yolk weight, such an ill-balanced nutrition may caused the extremely disproportional and relatively small deviant though surviving at the last stage of incubation. Rejecting the deviant, the regression equation became $Y=9.335+0.354^{****}X$ and the difference in the coefficient between the experimental and the control did not reach a significant level. In addition, a difference in the height of the regression lines was still ensured at 0.5% level.

Assuming parallel lines and homogeneous variance, the differences in the height of regression lines between groups were examined at all points after 16 days of incubation. The results were highly significant as shown in Table 2. This agreed with the periods when differences in embryo or chick weight were apparent as shown in Table 1.

Removing 7.5 g albumen from about 55 g egg, the ratio of albumen to yolk in weight would change from 2.0 in the normal egg to 1.5 in the removal. This value 1.5 would show that significantly less albumen quantity than in the normal White

TABLE 3. *Mean Embyro or Chick Weight as a Percentage of Egg Weight*[a)]

Age	Mean		Difference
	Removed	Control	
Embryo 6	0.72±0.10	0.78±0.10	0.06
Days 10	4.94±0.40	5.02±0.32	0.08
13	14.4 ±1.0	15.1±1.3	0.7
16	29.0 ±1.6	31.9±2.4	2.9***
19	43.4 ±2.2	51.4±3.2	8.0***
Hatched	58.6 ±2.2	71.9±3.3	13.3***

a) At calculation, only hatched chicks contained unassimilated yolks.
b) Means±S.D. *** Significant at 0.5% level.

TABLE 4. *Mean Unassimilated Yolk Weight* (Grams)

Incubation Time	Mean		Difference
	Removed	Control	
16 days	11.01±1.52[a)]	13.07±2.18	2.06
19 days	6.79±1.92	8.27±1.46	1.48
Hatched	4.34±0.60	4.95±0.98	0.61

a) Means±S.D.

TABLE 5. *Unassimilated Yolk Weight as a Percentage of Embryo Weight*[a)]

Incubation Time	Mean		Difference
	Removed	Control	
16 days	40.5±3.8[b)]	43.1±4.2	2.6
19 days	22.2±3.2	22.5±1.8	0.3
Hatched	12.0±0.5	12.0±1.9	0

a) Unassimilated yolk wt./(Embyro or chick wt. plus unassimilated yolk wt.)
b) Means±S.D.

Leghorn eggs was supplied to the experimental embryos. On the contrary, the control embryo may exhibit its maximum potency of growth under an abundant supply of nutrition. The differences in the embryo weight between two groups were apparent at the 16 days of incubation. On the other hand, McNary *et al.* (5), Bray and Iton (6), Coleman *et al.* (7) and Zervas and Collins (8) reported that genetic differences on embryo weight were apparent at near 16 days of incubation. Therefore, it would appear that partial albumen removal during early embryonic life could result in embryo phenocopy of a small sized breed of chicken.

Table 3 shows embryo or chick weight as a percentage of the initial egg weight. The differences between the two groups were found at three points after 16 days of incubation. This also agreed with the periods when differences in embryo or chick weight were apparent. At hatching the previous results were reaffirmed (2).

Four to five unassimilated yolks were sampled for each group and each day at all periods investigated after 16 days of incubation and the mean weights are shown in Table 4. The experimental embryos seems to have absorbed more yolk materials by 16 days of incubation ($P<0.25$ at both 16 and 19 days). The matter admits in principle the results of our experiment (9). The percentage of unassimilated yolk weights in Table 5 were not significantly different from each other over all the periods investigated. The difference was zero at hatching. This would support the observations that both actual embryo or chick weight and unassimilated yolk weight became smaller for the experimantal than for the control.

References

1) Arai, K., Mizuma, Y., and Nishida, S., *Proc. Commemorating 15th Yr. of Foundation of Lab. of Anim. Breed., Tokyo Univ. of Agr., p.* 55 (1965) (in Japanese, with English summary)
2) Mizuma, Y., and Hashima, H., *Tohoku J. Agr. Res.*, **12**, 221 (1961)
3) Arai, K., Mizuma, Y., and Nishida, S. *Tohoku J. Agr. Res.*, **25**, 137 (1974)
4) Snedecor, G.W., and Cochran, W.G., "Statistical Methods", 6th ed., The Iowa State University Press, Ames, p. 432 (1967)
5) McNary, H.W., Bell, A.E., and Moore, C.H., *Poultry Sci.*, **39**, 378 (1960)
6) Bray, D.F., and Iton, E.L., *Brit. Poultry Sci.*, **3**, 175 (1962)
7) Coleman, J.W., Siegel, H.S., and Siegel, P.B., *Poultry Sci.*, **43**, 453 (1964)
8) Zervas, N.P., and Collins, W.W., *Poultry Sci.*, **44**, 631 (1965)
9) Arai, K., Mizuma, Y., and Nishida, S., Unpublished data.