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Tohoku Journal of Agricultural Research
Vol. 26, No. 2, December 1975
Printed in Japan

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VI. Hatching Weight and Water Content in Chicks from Partially Albumen-Removed Eggs*

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(Received August 9, 1975)

Newly hatched chicks were obtained by removing a large quantity of albumen during incubation. Experiment was carried out to investigate the general effects of albumen removal on chick weight and on water content of the chick. The quantities of albumen removed amounted to 7.1–7.7 g which would be equivalent to 22–24 per cent of the whole albumen. Chicks hatched from White Leghorn eggs (Experiment 1) and White Leghorn eggs with Rhode Island Red semen (Experiment 2).

1. Hatchability for the experimental eggs fell down to about a half of the control (Experiment 2).
2. Decrease in hatching weight for the experimental chicks almost approximated the quantity of albumen removed. The body weight was reduced by about 80 per cent of the control. However the organ weights, heart and liver of these chicks were not reduced so much as the body weight.
3. Per cent decreases in egg weight during incubation were significantly larger in the experimental than in the control for every period of incubation investigated (Experiment 2).
4. Hatched weights as a percentage of egg weight were 52.1 or 55.1 per cent for the experimentals, while 66.0 or 67.5 per cent for the controls in Experiments 1 and 2, respectively.
5. Water contents of chicks and water percentages to chick weight were significantly lesser in the experimentals chicks (Experiments 1 and 2) than those in the controls.

Direct removal of a large quantity of egg albumen during incubation would be advantageous for clarifying the physiological and nutritional roles of albumen and yolk on embryonic growth.

* The oral presentation of this reprot was given at the Spring Meetg. of the Japan Poultry Science Association, Japan Branch of W.P.S.A., Tokyo, April 1965.

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Mizuma and Hashima (1) in such experimental methods reported comprehensively the influence on hatchability, growth and egg-laying performance.

In the present experiment newly hatched chicks were obtained to re-investigate the general effects of albumen removal. In addition, water content of the chick was examined to take into consideration the metabolic aspects.

Experimental Procedure

Hatching eggs in Experiment 1 were layed by four White Leghorns which were reared at the Laboratory of Animal Breeding, Tohoku University. The chicks hatched in November 1964. White Leghorn eggs with Rhode Island Red semen were introduced from Miyagi Prefectural Animal Husbandry Experiment Station. Chicks from these eggs used in Experiment 2 hatched at our Laboratory in December 1964.

The method of albumen removal was referred to by Mizuma (2) and Mizuma and Hashima (1). But when drawn out, the egg albumen often bubbled in the syringe so that it was difficult for us to know the exact volume removed. Therefore, differing from the previous authors (1) (2), the albumen quantity is represented not in milliliters but in grams according to the difference in egg weight just before and after the operation. It was 7.69 and 7.05 g for Experiments 1 and 2, respectively, tracing back to eggs from which chicks had hatched successfully. In this case, whether the albumen drawn off was the dense or the thin one could not be clarified. After the appointed volume was removed, the holes at both ends of egg were sealed with gyps, then the egg was returned to the incubator. The period of operation was determined to obtain the highest hatchability as described by Mizuma and Hashima (1). In consequence, the operations were carried out at 72 hours and 73 to 88 hours of incubation for Experiments 1 and 2, respectively.

Hatching eggs and chicks were weighed to the nearest one twentieth of a gram, while the heart, liver and unassimilated yolk weighed to the nearest 0.1 milligram. These materials were weighed again to the nearest 0.1 milligram after dried at 65°C for 3 to 5 days.

The significances of difference between means were tested by analysis of variance.

Results and Discussion

Eggs from which chicks hatched weighed as follows. Experiment 1: 55.12 ± 4.89 g and 55.11 ± 3.07 g for the experimental and the control, respectively. Experiment 2: 55.09 ± 3.07 g and 54.86 ± 3.68 g for the experimental and the control, respectively.

The ratios of albumen to yolk for any mean egg weight in both experiments

were estimated to be about 1.98, calculated from regression equations reported by Arai *et al.* (3). And the quantities of 7.69 and 7.05 g of albumen removed for Experiments 1 and 2, respectively, were equivalent to 24.0 and 22.0 per cent of the whole albumen, and the ratios of albumen to yolk would come to 1.50 and 1.54. These ratios were slightly higher than 1.40 observed in Japanese White Bantam egg, whose mean weight was 28.7 g (3).

TABLE 1. *Hatchability of Partially Albumen-Removed Eggs*

	Experiment 1		Experiment 2	
	Removed	Control	Removed	Control
Number of eggs set	33	12	89	46
Number fertilized	—	—	78	41
Number hatched	10	5	27	29
Hatched/set (%)	30.3	41.7	30.3	63.0
Hatched/fertilized (%)	—	—	34.6	70.7

Experiment 1: White Leghorn, Experiment 2: White Leghorn with Rhode Island Red semen.

Hatchability: as shown in Table 1, hatchability for the experimental in Experiment 2 fell down to about a half of the control. This agrees with the results of Mizuma and Hashima (1) who removed 7.5 ml of albumen.

TABLE 2. *Effect of Partial Albumen Removal on Length of Incubation Time*

	No. of hatched chicks			
	Experiment 1		Experiment 2	
	Removed	Control	Removed	Control
To 21 days of incubation	7	2	16	25
21 days to 21 days and 12 hours	3	1	5	2
21 days and 12 hours to 22 days	0	2	2	2
Over 22 days			4	0

Length of Incubation Period was observed roughly (Table 2). In Experiment 2 the experimentals tended to be prolonged, while in Experiment 1 the controls were scattered. Thus, whether length of hatching time correlated with the treatment could not be clarified.

Mean Chick or Organ Weight at Hatching: differences in hatching weight between the experimental and the control were highly significant in both experiments (Table 3). Especially in Experiment 1 where both the experimental and the control chicks were obtained paired from four all dams, decrease in body weight almost approximated the quantity of removed albumen. Such an observation was

TABLE 3. *Mean Organ Weight of Newly Hatched Chicks from Partially Albumen-Removed Eggs at an Early Stage of Incubation*

		Mean			
		Removed	Control	Difference	$\frac{\text{Removed}}{\text{Control}}$ (%)
Experiment 1	n	9	5		
	Body weight (*g*)	28.82±4.05	36.43±2.91	7.61***	79.1
	Heart (*mg*)	226.2 ±26.6	261.4 ±22.3	35.2*	86.5
	Liver (*mg*)	869.2 ±96.2	866.8 ±64.1	2.4	100.3
Experiment 2	n	27	29		
	Body weight (*g*)	30.41±3.17	37.11±3.79	6.7***	81.9
	Heart (*mg*)	238.1 ±46.9	284.2 ±30.0	46.1***	83.8
	Liver (*mg*)	779.1 ±91.7	909.3 ±112.7	130.2***	85.7

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

impossible for Experiment 2, where the dam numbers were unknown.

Body weight in the experimental was reduced by about 80 per cent of the control.

On the other hand, as shown in Table 3, two kinds of organ were not reduced so small as the body weight in the two experiments. In Experimental 1, the liver did not reduce at all. However, bearing in mind that experimental chicks hatched apparently normal, 'under-size' would be the characteristic recognized in chicks of the albumen removal. As the difference in genotype exist in the two present experiments, further examination is necessary for elucidation of the problem on body conformation, in the light of the discussion in the previous paper (4).

Decrease in Egg Weight during Incubation: as shown in Table 4, differences in egg weight between the experimental and the control ones increased slightly as incubation went on.

The per cent losses based on egg weight at 3 days of incubation were almost straight as illustrated in Figure 1 and were significantly larger in the experimental for three periods, 7, 13 and 18 days of incubation. Egg weight in Experiment 1 was weighed in a mass. While no difference in the weight loss during 3 to 18 days of incubation was found between the controls in the two experiments (12.4 per cent in both), these in the experimentals as shown in Figure 1 amounted to 16.2 and 14.7 per cent for Experiments 1 and 2, respectively. This difference may indicate that, compared with Experiment 2, the experimental eggs in Experiment 1 evaporated larger quantities of water from the relatively larger egg surface, probably due to the more enlarged air cells, accompanied by the larger quantity of albumen removed.

TABLE 4. *Decrease in Egg Weight during Incubation (Grams)*

		Mean		Difference
		Removed	Control	
Experiment 1	n	10	5	
	3 days of incubation	46.00	53.98	7.98
	5 days	44.96	53.09	8.13
	7 days	—	—	—
	13 days	40.96	49.42	8.46
	18 days	38.57	47.31	8.74
Experiment 2	n	27	29	
	3 days of incubation	46.68±2.91	53.37±3.81	6.69
	5 days	—	—	—
	7 days	44.86±2.86	51.76±3.83	6.90
	13 days	42.20±2.87	49.15±4.01	6.95
	18 days	39.84±2.93	46.82±4.22	6.98

The difference between the experimental and the control was not tested statistically. Eggs in Experimental 1 were weighed in a mass.

TABLE 5. *Chick Weight as a Percentage of Egg Weight*

Experiment 1			Experiment 2		
Mean		Difference	Mean		Difference
Removed	Control		Removed	Control	
52.1±2.7	66.0±2.2	13.9***	55.1±3.8	67.5±3.6	12.4***

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

Differences in Chick Weight as a Percentage of Initial Egg Weight between the experimental and the control were highly significant for the two experiments (Table 5). Mizuma and Hashima (1) reported that the weight of chick was 65.5 per cent of the egg in the non-treatment, representing 51.8 per cent under the 7.5 ml albumen removal and only 48.3 per cent under the 10 ml removal. The present results reaffirm this description, by the fact that the per cent was lower with higher quantity of removal, i.e., in Experiment 1 (7.7 g) than in Experiment 2 (7.1 g).

Unassimilated Yolk Weight: as shown in Table 6 tended to be smaller in the experimentals than in those of the controls.

On the per cent unassimilated yolk weight to chick weight at hatching, no significant difference was found between the experimental and the control in Experiment 1 and it reaffirmed the previous result (5). But the results of Experiment 2 should be reexamined with respect to the assumption of Mizuma and Hashima (1): if a certain ratio of the amount of the yolk corresponding to that of the albumen is utilized as its nutrients by the embryo, with the result that the yolk

TABLE 6. *Unassimilated Yolk Weight and Per Cent of Unassimilated Yolk Weight to Chick Weight at Hatching*

		Mean		Difference
		Removed	Control	
Exp. 1	Unassimilated yolk weight (*g*)	3.1430±1.1747	3.9952±0.9301	0.8522
	Per cent weight	11.0±4.0	10.9±2.2	0.1
Exp. 2	Unassimilated yolk weight (*g*)	4.9601±1.3394	5.1660±1.2331	0.2059
	Per cent weight	16.3±4.4	13.9±2.7	2.4*

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

TABLE 7. *Water Content*[a] *of Newly Hatched Chicks from Eggs with Albumen Partially Removed at an Early Stage of Incubation*

		Mean		Difference
		Removed	Control	
Exp. 1	Water weight (*g*)	19.0603±3.2050	25.4132±2.2352	6.3529***
	Per cent water wt.	74.1±1.6	78.3±1.4	4.2***
Exp. 2	Water weight (*g*)	19.3225±2.5447	25.0420±2.8428	5.7195***
	Per cent water wt.	75.8±1.9	78.3±1.7	2.5***

a) Unassimilated yolks were removed from the abdomen of the chicks.
* Significant at 5% level. ** Significant at 1% level. *** Significant at 0.5% level.

left unutilized remains within the abdomen of the chicken at birth, it should be expected that in the partial removal of albumen the quantity of the yolk utilized by the embryo for its development would be smaller and that a larger amount would remain with the abdomen of the chicken, compared with the result obtained in the nontreatment.

Further experiments are nesessary to clarify the percent unassimilated yolk weight to newly hatched chick weight from egg with albumen partially removed.

Water Content of the Chick at Hatching: notewrothy in both experiments would be the observation that the experimental chicks consisted of less water and a smaller per cent content than the control (Table 7). It is interesting, from the viewpoint of 'in take and out put' and of the production of water.

Eventually, the experimental embryos were subjected to less total water in the whole egg, larger per cent water loss during incubation (Fig. 1), and consequently compensated with yolk materials for the lack of albumen. The hatched chicks had a lower per cent of water content.

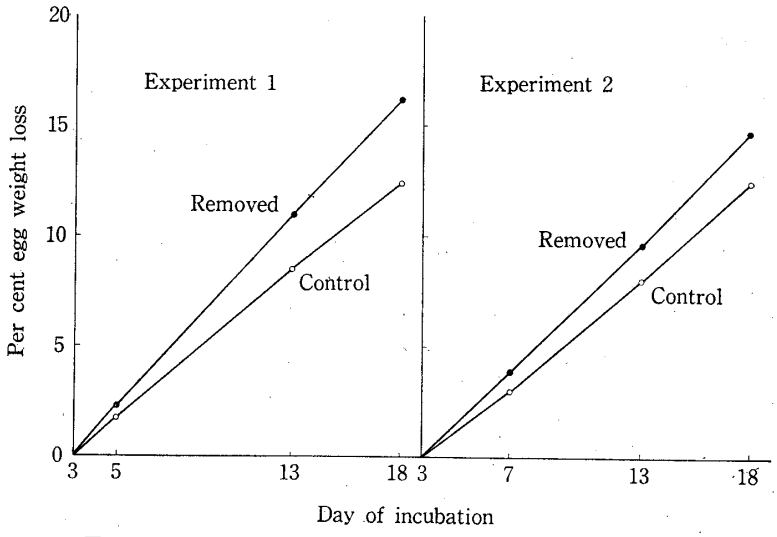

FIG. 1. Per cent egg weight loss during incubation.

In conclusion, though a study of the content of the unassimilated yolk is necessary, the experimental chicks subjected to deficient albumen could survive and hatch successfully by efficient utilization of nutrients in the egg and by limited utilization of water under closed environment.

The possibility of the low hatchability in the experimental being due to a physical phenomenon, i.e., limitation of space because of enlarged air cell (1) was not examined in the present experiments.

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