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Effects of Mating Ratio, Cock Number in the Flock and Breeder Age on Fertility in Thai Native Chicken Flock

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ABSTRACT

Trials were conducted to determine general semen characteristics of the male native chicken and effects of mating ratio, cock number in the flock, and breeder age on fertility in the native chicken flock. The results revealed that the mature native male had the semen volume of about 0.4 ml/bird/ejaculation, spermatocrit value of about 13.86-15.60%, semen concentration of about 7031-8001 million cells/ml, and total sperm of about 2870-3200 million cells/ejaculation. The motility score and pH value were around 4-5 and 7.7-8.4, respectively. The effect of mating ratios on fertility of the flock was not significantly different ($P>0.05$). The mean fertility rates measured during 35-44 weeks of (hen) age of the mating ratios of 1:7, 1:10, 1:13, and 1:16 were 88.21, 91.20, 88.20 and 79.82% ; and during 34-44 weeks of age of the mating ratios of 1:8, 1:12, and 1:16 were 84.31, 90.84, and 81.76% , respectively.

The evidence which the lower trend of fertility rate occurring in the 1:16 flock disappeared after the exchange of cocks between the flocks indicated that sexual competency of the male played a major role in fertility of the breeding flock. Continuous surveillance on egg incubation results and immediate replacement of the ill with the healthy cocks wherever needed were suggested. Housing two cocks within a flock showed ambiguous influence. While it caused a decrease in fertility percentage on the 1:8 flock, it showed no ill effect at all on the 1:16 flock. Furthermore, the incidence of low fertility observed in the 1:12 flock when its sole male was ill confirmed that the high fertility of the flock depended heavily on sexual competency of the male and it could possibly have been secured if there were two cocks in the flock. The results revealed more of the benefit of housing two cocks within the same flock. The declining fertility rate of the old hens in their third year of age was greatly improved from the mean value of 58.32% for the flock with one cock to 81.20% for the flock with two cocks. For the effect of breeder age on fertility, the overall results of these experiments indicated that the native cocks aged from nine months to two years had similar fertilizing ability of about 80-90% whereas the native hens had their fertilizing ability decreased annually from about 80-90% in the first year, to about 70-80% in the second year, and 60-70% in the third year.

Key words: native chicken, mating ratio, fertility, semen characteristics, breeder age

INTRODUCTION

Being successful in poultry breeding depends not only on basic reproductive characteristics of breeders, testicular and reproductive tract growth in the male or ovary and oviduct performance in the female and their hormonal-controlling system, but also on efficient management of the breeder flock. Application of additional daylight has long been accepted as an important practice required for the

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most efficient reproductive performance of the chicken flock. The photoperiod of about 15-16 hours a day was reported appropriate for the breeder (North and Bell, 1990). Mating ratio of males to females within a flock was another factor to be considered. The mating ratios of 1:14-16 and 1:10-12 were recommended for layer and broiler breeders, respectively (Appleby *et al*., 1992). Moreover, the breeder age was also important to the fertility of flock. The evidence of decreasing in fertility with increasing in age of the breeders was reported. It was due more to the male than to the female (Brillard and McDaniel, 1986). Becoming less often in mating activity of the older male was suggested to be the cause of lower fertility of the flock (Duncan *et al*., 1990).

For Thai native chickens which are popular for their not-too-soft and good-flavoured meat, their typical characteristics of being wild, aggressive and possessive of their mates and occupying areas were relatively distinct comparing with their commercial meat-type counterpart. Handling of the native breeder flock may need an extra caution and the outcome could be different from those had been reported in the modern breeds. These experiments were, therefore, designed to study general characteristics of semen in the native male and also the effects of mating ratio, cock number in the flock and breeder age on fertility of the flock.

MATERIALS AND METHODS

Experiment 1

The first experiment was carried out to determine general semen quality of the native chicken at weekly intervals during 35-52 weeks of age. Fourty-four healthy Thai native cocks were randomly allocated into 4 groups of 11 each. The chickens were reared in cages with free access to feed and water and under the photoperiod of 15 hours a day. Pooled semen of each group was obtained twice a week, by means of the conventional abdominal massage technique. Mean volume of the two ejaculations within a week of each group was regarded as the average pooled semen volume of the group from which the average semen volume/bird/ejaculation at that age level was calculated. Spermatocrit value of each pooled semen sample was determined by the method of microcapillary such as that used for the blood haematocrit determination. For each determination, duplicate semen samples were centrifuged at 15,000 g, for 5 minutes. The average spermatocrit value was then substituted for x value in the regression equation of y (semen concentration) = -0.732+0.56x acquired earlier from the previous experiment (Chotesangasa and Gongrattananun, 1999). The total number of sperm/ejaculation was obtained by multiplying the semen concentration value by the average semen volume/bird/ejaculation.

Microscopic examination of motility of the fresh semen was performed immediately after completion of each round of semen collection. Determination of pH value of the seminal fluid was also conducted.

Experiment 2

The objective of this experiment was to study the effect of different mating ratios on fertility in the native breeder flock. Twelve healthy males and 138 females of the same age of 35 weeks were randomly arranged into 4 groups of mating ratios of 3 replications each. The 4 mating ratios of male : female were 1:7, 1:10, 1:13, and 1:16, respectively. Fertility was evaluated in term of percentage of fertilized eggs, at weekly intervals, during 35-44 weeks of age. For each batch of incubation, the hatching eggs were collected daily and accumulated for 7 days before placing them in the incubators. On the seventh day of incubation, all incubated eggs were candled to identify live or dead or infertile eggs. All eggs identified as infertile or dead embryo were then break-opened to examine the germinal disc areas to verify the result of egg candlings. Eggs with live and dead embryos were regarded as fertile eggs. The fertility rate was expressed as

percentage of the fertile eggs out of the total number of incubated eggs.

Experiment 3

This experiment was aimed to compare the effect of different mating ratios on fertility in the breeder flock similar to what had been done in the experiment 2. The male used in this experiment was, however, at more mature age of 74 weeks, whereas the female was about the same age of 34 weeks as previously used in the experiment 2. Twelve males and 144 females were allocated into 3 groups of mating ratios of 1:8, 1:12, and 1:16 of 4 replications each. Fertility rates of the groups measured at 7 days of incubation were recorded at two-week intervals during 34-68 weeks of the female age.

Experiment 4

The effects of two experimental factors, the mating ratios with 3 levels of 1:8, 1:12 and 1:16 and the cock number in the flock with 2 levels of 1 cock and 2 cocks, were simultaneously studied. Eighteen cocks aged 36 weeks and 216 hens aged 56 weeks were grouped into six treatment combinations with 2 replications each. The six treatment combinations were 1:8, 1:12, 1:16, 2:16, 2:24 and 2:32. Fertility rates of the flocks measured at 7 days of incubation were recorded at two-week intervals for the whole experimental period of 30 weeks.

Experiment 5

This experiment was to test whether the age of breeder hens and the cock number in the flock affected fertility of the breeder flocks of the same mating ratio of 1:12. The hens were in their second year (age 72 weeks), and third year (age 110 weeks) whereas the cocks were 72 weeks of age. A total of 18 cocks, 108 hens in their second year of laying and 108 hens in their third year of laying were randomly allocated into 4 treatment combinations of 3 replications each. The four treatment combinations were as follows : 12 second-year hens + 1 cock, 24 second-year hens + 2 cocks, 12 third-year hens + 1 cock, and 24 third-year hens + 2 cocks. Fertility rates were measured at two-week intervals for the period of 20 weeks.

Statistical methods

For experiments 1, 2, and 3, a completely randomized design (CRD) was used. Statistical designs used for experiments 4 and 5 were 3x2 factorial experiment in CRD and 2x2 factorial experiment in CRD, respectively. All of the data obtained were analysed by means of analysis of variance and the differences between means were compared by the method of Duncan's new multiple range test (Snedecor and Cochran, 1980).

RESULTS AND DISCUSSION

Semen characteristics of the native chicken

Semen characteristics of the native chickens measured at various age levels are shown in Table 1. It was found that the native cocks during 35-52 weeks of age had similar quality of semen, though the semen volume and total sperm/ejaculation tended to be lower in the younger ones. Generally, it could be concluded that the native cocks from the age of 38 weeks upwards were able to give high quality semen similar to the more mature chickens. The results of semen measurements were as follows : the semen volume was about 0.4 ml/bird/ejaculation, spermatocrit was in the range of 13.86-15.60%, semen concentration was about 7031-8001 million cells/ml, and the number of total sperm was in the range of 2870-3200 million cells/ejaculation. The rather low values observed at the 52 weeks of age were, however, not included into the calculations since they could by erred by the long pause period (8 weeks) prior to the last collection time. There was clear evidence that the semen collected at a rather low frequency usually had lower quality than that obtained at a higher frequency (Sexton, 1983). Apart from the characteristics mentioned above, sperm motility

Table 1 Semen characteristics of native cocks aged 35 to 52 weeks, (experiment 1).

Cock age (w)	Semen volume (ml./bird/ejac.)	Spermatocrit (%)	Semen concentration (million cells/ml.)	Total sperm (million cells/ejaculation)
35	0.35	13.93	7067.4	2473.59
36	0.37	13.39	6767.80	2504.09
37	0.40	13.66	6917.60	2717.04
38	0.41	14.54	7411.80	3038.84
39	0.41	13.86	7031.00	2882.71
40	0.40	14.12	7176.6	2870.64
41	0.37	15.52	7956.4	2943.87
42	0.40	15.11	7726.8	3090.72
43	0.40	15.55	7977.4	3190.96
44	0.40	15.60	8001.2	3200.48
⋮				
52	0.29	14.91	7617.6	2209.10

Apart from the Characteristics shown in the table, pH values and motility scores of the pooled semen were also evaluated. It was found that both qualities of the pooled semen did not change in accordance with age of the cock but rather scattered in nature. The pH values of seminal plasma obtained from this experiment were ranged from 7.7 - 8.4. The motility scores varied within the range of 4 - 5 of the 0 - 5 scale. Each figure was the mean of 4 replications of 11 cocks each.

scores and pH values of the semen were also similar among the various ages studied. The motility scores were mainly at the level 4 or 5 and occasionally at the level 3 of the 0-5 scale (Wishart and Wilson, 1997). The semen pH varied within the range of 7.7-8.4. The rather high alkalinity of semen in this experiment was possibly due to high amount of CO_2 loss during the long waiting period prior to the measuring time (more than an hour). Furthermore, these measurements were taken place at rather warm room temperatures, the changes of pH values were then even more rapid. Lake (1984) revealed that the pH value of chicken semen kept at room temperature under paraffin sheet was about 7.1, and after removing the paraffin sheet it turned rapidly into 7.8 because of CO_2 loss into the air. The evidence indicated the difficulty of acquiring a true pH value of the chicken semen. What could be concluded from the results of this experiment was that the pH value of the chicken fresh semen measured in an open-air condition, at room temperature, within 1-2 hours after the collection time, was about 7.7-8.4.

Mating ratio

The effects of different mating ratios on fertility of the breeder flock were studied separately in two different conditions. In one condition, both male and female breeders were started from the same age of 35 weeks (experiment 2) and in the other one, the male and female breeders were from 74 and 34 weeks of age, respectively (experiment 3).

Results obtained from the two experiments were in agreement and revealed that the different mating ratios did not affect ($P>0.05$) the fertility of flock. In experiment 2, the average fertility rates measured during 35-44 weeks of age of the 1:7,

1:10, 1:13, and 1:16 groups were 88.21, 91.20, 88.20, and 79.82%, respectively (Table 2). The results of experiment 3 showed that the average fertility rates measured during 34-44 weeks of hen age of the 1:8, 1:12, and 1:16 groups were 84.31, 90.84, and 81.76%, respectively (Table 3). Though the two experiments did not show any significant difference between the mating ratios, both reflected the same trend of having relatively low fertility rate in the 1:16 group. The previous suggestion that the ratio of 1:16 was too large to give a satisfactory fertility rate should be reconsidered because it was found that the fertility of the very same female flock was considerably improved after the exchange of the males between groups. The average fertility rate of the 1:16 group measured after the male exchange, during 48-68 weeks of the (hen) age, was increased to 89.41% which tended to be higher than the 81.16% of the 1:8 group and the 75.80% of the 1:12 group. The difference was, however, not significant ($P>0.05$). The evidence of exchanging of the males resulted in altering in fertility of the flock indicated the importance of sexual competency of individual males on the flock fertility. Though the sexual competency was, in general, related to the age of the cock, it was probably not the case of those under 2 years of age since a significant difference in fertility rates between the cocks of different ages was not observed (Table 2, 3).

On the fertility basis, the evidence suggested that the mating ratio of 1:16 in the native breeder flock was not too large and could bring a satisfactory result as long as the male breeder was staying sexually competent. To maintain the satisfactory fertility, a close watch on egg incubation results of each breeder flock was suggested to be carried out at intervals so that the incompetent males could be replaced with the competent ones whenever considered necessary. In facts, the incidence of low fertility occurring within a rather short period of time after the onset of flock mating was not unusual and could happen even in the modern-commercial hybrid flock. Practically, the deteriorating situation could be improved by means of "**spiking the**

Table 2 Fertility percentage measured at 7 days of incubation in native chicken flocks of different mating ratios, (experiment 2).

Hen-Cock age (w)	Mating ratio			
	1 : 7	1 : 10	1 : 13	1 : 16
	%			
35 - 35	85.24	90.70	84.11	77.06
36 - 36	89.68	91.77	78.75	73.81
37 - 37	82.38	91.36	87.68	95.69
38 - 38	87.70	91.65	94.80	91.43
39 - 39	90.41	91.83	93.80	84.07
40 - 40	93.93	88.46	87.32	74.22
41 - 41	87.31	91.60	92.00	75.65
42 - 42	90.37	94.62	86.66	69.36
43 - 43	90.70	86.21	88.21	78.47
44 - 44	84.41	93.83	88.63	78.47
Average	88.21	91.20	88.20	79.82

Each figure, other than the average value, was the mean of 3 replications.

flock" which could be done either by the way of adding some supplementary males into the flock or replacing partially or entirely the males of low-fertility flock with the freshly new males. To clarify how the spiking technique worked to improve the flock fertility, Peterson *et al.* (2000) explained that the spiking technique caused a double action to occur simultaneously. That was while the supplementary or replacement males themselves were more active and had higher mating frequency than the original males, their frequent mating behavior also stimulated mating activity of the original males which still remained in the flock.

For the native cock which still had relatively high instinct of being ferocious, aggressive and possessive of their mates and occupying areas, the only spiking practice considered appropriate was the replacement of the whole set of cocks with a new one. It was also important to note that all replacement cocks to be housed in the same flock should have been together and be acquainted with each other from the beginning. The spiking practice by adding some supplementary cocks into the flock reared in a confined pen which its original cocks still existed, must be avoided. Fighting between unfamiliar native cocks would bring about not only

Table 3 Fertility percentage measured at 7 days of incubation in native chicken flocks of different mating ratios, (experiment 3).

Hen - cock age (w)	Mating ratio		
	1 : 8	1 : 12	1 : 16
	%		
34 - 74	71.40	81.45	77.06
36 - 76	84.39	93.86	76.81
38 - 78	80.30	87.74	71.54
40 - 80	83.51	94.84	86.34
42 - 82	93.45	94.22	89.75
44 - 84	92.78	92.90	89.06
Average	84.31	90.84	81.76
Cocks of the different mating ratios were exchanged			
48 - 88	90.16	88.18	92.98
50 - 90	80.57	84.87	96.63
52 - 92	83.93	65.95	91.86
54 - 94	75.11	87.69	92.41
56 - 96	91.01	76.47	92.40
58 - 98	81.98	83.44	87.80
60 - 100	77.32	80.61	80.53
62 - 102	68.18	60.70	96.43
64 - 104	77.26	62.39	92.92
66 - 106	94.87	79.30	88.75
68 - 108	72.38	64.23	70.84
Average	81.16	75.80	89.41

Each figure, other than the average value, was the mean of 4 replications.

emotional stress leading to the decreased fertility rate of the flock but also injury and/or death of the male breeders.

Mating ratio and cock number in the flock

The effects of two factors, mating ratio and cock number in the flock, on flock fertility were examined in experiment 4. Results of each factor and their interaction effects are shown in Table 4. Although there were exceptions at some age levels, the mating ratio and the cock number in the flock did not have any significant difference on the flock fertility. Furthermore, the result of the mating ratio in this experiment was also in agreement with those obtained from the experiments 2 and 3. The interaction of mating ratio by cock number (MR x CN) was found significant ($P<0.05$) at several age levels.

The significant effect of the MR x CN interaction implied that the effect of either factor depended on the condition of the other factor. For the flock of 1:8 mating ratio, it could be concluded

Table 4 Fertility percentage measured at 7 days of incubation in native chicken flocks of different mating ratios and with one or two cocks, (experiment 4).

Hen-cock age (w)	Mating ratio						Factor effect		
	1 : 8		1 : 12		1 : 16				
	One cock	Two cocks	One cock	Two cocks	One cock	Two cocks	MR	CN	MRxCN
	%								
56-36	95.00	59.02	75.00	64.04	75.42	85.65	NS	NS	NS
58-38	96.88	71.43	83.34	75.73	83.73	80.14	NS	NS	NS
60-40	94.12	65.00	93.93	77.84	98.57	93.84	NS	*	NS
62-42	93.75	62.16	81.20	71.91	97.92	97.22	*	*	*
64-44	97.06	75.42	87.21	89.48	88.10	89.98	NS	NS	NS
66-46	95.00	84.79	93.75	88.10	93.75	93.59	NS	NS	NS
68-48	81.25	77.17	82.26	78.24	100.00	89.66	NS	NS	NS
70-50	90.00	76.80	88.24	76.04	96.16	90.26	NS	NS	NS
Average	92.88	71.47	85.62	77.67	91.71	90.04	*	*	NS
Cocks of the different mating ratios were exchanged									
74-54	100.00	79.81	72.12	81.53	97.06	86.67	*	*	*
76-56	100.00	74.38	71.15	82.84	87.55	76.40	NS	NS	*
78-58	100.00	65.71	59.97	87.35	91.67	90.04	NS	NS	*
80-60	100.00	66.67	64.17	84.72	84.52	97.41	*	NS	*
82-62	99.00	68.75	60.72	78.82	75.95	86.26	NS	NS	NS
84-64	93.75	61.07	66.73	87.50	85.00	80.48	NS	NS	NS
86-66	86.50	61.58	53.69	86.21	82.94	84.93	NS	NS	NS
Average	97.04	68.28	64.08	84.14	86.38	86.03	*	*	*

Each figure, other than the average value, was the mean of 2 replications

MR = mating ratio, CN = cock number in the flock, MRxCN = interaction between the two factors

NS = nonsignificant difference ($P>0.05$)

* = significant difference ($P<0.05$)

that keeping two cocks in the flock would yield lower fertility than keeping only one cock. Fighting for hens between the two cocks was assumed to be the cause of lower fertility. A similar but with less degree of effect also occurred in the flock of 1:12 mating ratio. The experiment 4 revealed the good side of having more than one cock in a flock. It was found that when one of the two became weak or ill, the flock fertility could be sustained at a certain level by the remainder cock whereas there was no such compensation occurred in the flock with only one cock. For the flock of 1:16 mating ratio, no significant difference in fertility was observed between the flocks of one cock and two cocks. It was possible that the number of hens in the flock of 1:16 mating ratio was sufficient to maintain a peaceful mating activity without fighting between the two cocks and was also not too many for one cock to mate for the high fertility of the flock.

The results observed in this experiment indicated that the native chickens reared in a confined pen with two cocks would yield a negative effect on fertility if the mating ratio was rather low. The ill effect was decreased as the mating ratio was increased. At the mating ratio of 1:16, the negative effect of keeping two cocks in a flock was not observed. On the other hand, it helped securing the high fertility of the flock.

Hen age and cock number in the flock

The results of experiment 5 studying the effects of two factors, hen age and cock number in the flock, on the flock fertility are shown in Table 5. In general, the third-year hen showed a tendency of

Table 5 Fertility percentage measured at 7 days of incubation in native chicken flocks of old hens in their second or third year of age and with one or two cocks in the flock, (experiment 5).

Cock age (w)	Hen age				Factor effect		
	Second year (72-92 w.)		Third year (110-130 w.)				
	One cock	Two cocks	One cock	Two cocks	HA	CN	HAxCN
	%						
72	79.47	81.33	69.10	93.01	NS	NS	NS
74	81.57	82.09	66.67	92.83	*	*	*
76	86.76	79.35	65.37	92.15	NS	NS	*
78	84.16	71.51	43.27	84.17	NS	NS	*
80	84.62	77.14	54.91	82.80	NS	NS	NS
82	83.05	65.73	56.56	80.70	NS	NS	NS
84	59.21	75.16	68.18	55.56	NS	NS	NS
86	74.19	76.47	57.88	50.00	NS	NS	NS
88	94.45	84.13	63.40	86.91	NS	NS	*
90	81.49	82.84	42.86	86.97	*	*	*
92	67.86	87.10	53.33	88.09	NS	NS	NS
Average	79.71	78.44	58.32	81.20	*	*	*

Each figure, other than the average value, was the mean of 3 replications

Each flock (treatment combination) had the same mating ratio of 1 : 12

HA = hen age, CN = cock number in the flock, HAxCN = interaction between the two factors

NS = nonsignificant difference ($P>0.05$)

* = significant difference ($P<0.05$)

having lower fertility than the second-year hen with significant differences were observed only at some age levels. Regardless of hen age, housing one cock or two cocks in the flock virtually gave similar results. Only at some age levels that the difference was significant. However, when one confined only to the third-year hen, the positive effect of housing two cocks in the flock was more distinct. The average fertility rates during the 20 weeks of the experimental period, of the flocks of third-year hens with one and two cocks were 58.32% and 81.20%, respectively. Therefore, if could be concluded that housing two cocks could improve fertility of the flock of the older hens. The reason why the older hens usually had lower fertility rate was explained in such a way that the older hens had higher releasing rate of sperm from the sperm storage tubules (SST) located in the uterovaginal junction area into the fertilization site in the infundibulum of the ovidict. The higher sperm releasing rate brought about a rapid emptying of the SST and then a shorter period of rendering the fertilized eggs (Brillard, 1993). Another evidence indicated that eggs obtained from the older hens had less binding ability to spermatozoa than those obtained from the younger hens (Fairchild *et al*., 2000). The binding ability to spermatozoa of eggs was highly related to fertilizing ability of the eggs (Wishart, 1995). The evidence mentioned above suggested that the deterioration in fertility of the older hens was due mainly to the hens themselves. The higher benefit of housing two cocks over one cock could be clarified in such a way that the mating activity of either cock would psychologically stimulate the mating activity of the other cock which then help elevating mating frequency within the flock. The deterioration in fertility occurring in the old hens due to the rapid release of sperm from the SST would then be compensated. Therefore, when the cocks used in this experiment were still in their prime time which the frequent mating activity was likely, the improvement in fertility of the third-year hens with two cocks in the flock was understandable.

In conclusion, the native cocks aged from 9 months to 2 years had similar quality of semen. Mating capability of the cocks was proved important to determine the fertility of the breeder flock since the mating ratios of 1:8, 1:12, and 1:16 gave similar results in fertility as long as the cocks of the flocks were healthy and competent. Assuring high fertility by housing two cocks with hens reared in a confined pen would give a satisfactory result only when the number of hens was large enough to provide peaceful mating without fighting between the two cocks for the hens. The reverse was true if the number of hens was too small. Additionally, housing more than one cock in the breeder flock could help elevating fertility of the old hens.

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