Effect of dietary vitamin C supplement on reproductive performance of aviary pheasants

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ABSTRACT: The effects of three doses of vitamin C (100, 200 and 300 mg/kg) added to the feed of reproductive pheasants on egg production, egg fertility and parameters of hatchability were investigated. In experiments I (1999) and II (2000) birds were kept in outdoor aviaries. In 2000, air temperatures recorded on the farm during the experiment were high (25–30°C), differing considerably from those recorded in the preceding years. In experiment I no statistically significant differences were shown between the control pheasants and those supplemented with 100 and 200 mg/kg vitamin C in terms of egg production, egg fertility and parameters of hatchability. The poorest results were found in the group of birds receiving a feed supplemented with 300 mg/kg vitamin C. In experiment II, statistically higher egg production and egg fertility were noted, compared to the control group, in the groups supplemented with 100 and 200 mg/kg vitamin C. Compared to the control group, pheasants from these groups were also characterized by higher hatchability from set eggs (by approx. 15 percentage units) and fertilized eggs (by approx. 9 percentage units) and smaller number of unhatched chicks and dead embryos after day 10 of incubation. In experiment II, the beneficial effect of 100 and 200 mg supplements of vitamin C on the studied parameters could result from the soothing action of the vitamin on the effects of heat stress. The present results justify the prophylactic use of vitamin C supplement at 100 mg/kg feed in the nutrition of reproductive pheasants reared in aviaries. Under heat stress (high air temperatures) increasing the dose of this vitamin to 200 mg/kg feed seems beneficial.

Keywords: vitamin C; pheasant; reproduction; laying; hatchability; stress

In the aviary rearing of pheasants unsatisfactory results of their reproduction are still very common. This can be associated with the stress the birds are exposed to due to changing, frequently unfavourable, atmospheric conditions and to the observed growing intensification of rearing of this type (Krystianiak *et al.*, 1999). Since poultry, including pheasants, synthesise vitamin C endogenously, neither domestic nor foreign standards of poultry nutrition quote bird requirements for this vitamin (Larbier and Leclercq, 1995; Poultry Feeding Standards, 1996). However, numerous references can be found in literature (Pardue and Thaxton, 1986; Lechowski and Nagórna-Stasiak, 1995; Kontecka *et al.*, 1997; Zulkifli *et al.*, 2000a, b; Kolb and Seehawer, 2001) reporting a favourable influence of the addition of vitamin C either to drink or feed on poultry production results.

The role of vitamin C in the improvement of egg laying has not been sufficiently elucidated although various researchers indicate its involvement in the process of maturation of egg vesicles (Kolb and Seehawer, 2001). The beneficial effect on egg production of vitamin C added to feeds for laying hens was particularly evident when the birds were exposed to stress caused by high air temperature or increased stocking rate of birds per unit area (Njoku and Nwazota, 1989; Kontecka *et al.*, 1997). Peebles and Brake (1985) were among those researchers who reported the influence of vitamin C added to the feed on the improvement of hatchability in broiler chickens. In addition, vitamin C was also reported to have a positive impact on the hatchability of Pekin ducks (Kontecka *et al.*, 2001). However, no information in the available literature was found concerning the application of vitamin C in pheasant nutrition.

The objective of this study was to investigate if the inclusion of vitamin C in feeds has any influence on laying, egg fertilisation and hatchability results of pheasants.

MATERIAL AND METHODS

Two experiments were performed in 1999 and 2000. The 11-week studies were performed during the reproductive season of pheasants (April – June). Year-old pheasants from a farm of the Agricultural University in Poznań were kept in flocks (1 male and 8 females) in outdoor family aviaries. Birds were fed *ad libitum* with a complete diet containing 11.70 MJ/kg metabolizable energy, 19.10% crude protein and 2.62% crude calcium. In experiment I (1999) there were 4 groups of 2 flocks each: control (I) and experimental (II, III and IV), in which birds received dietary supplements of 0, 100, 200 and 300 mg/kg vitamin C, respectively. In experiment II (2000) there were 3 groups of 3 flocks each: control (I) and experimental (II and III), in which pheasants were given dietary supplements of 0, 100 and 200 mg/kg vitamin C, respectively.

Daily group records of the number of laid eggs allowed calculating the total number of eggs laid by a group and mean egg production (%) in individual groups for each week of the experiment and for the whole period. Mean egg production was calculated in relation to the current number of pheasant hens, taking into account possible deaths. Five and 8 group artificial hatches were carried out in experiments I and II in the BIOS BA-134 incubator. Before setting in the incubator, eggs were stored for 7 days at 13°C and 70% relative humidity. In experiments I and II a total of 2 389 and 1 472 eggs were set. They were candled on day 10 of incubation. In the setting compartment the temperature was 37.5°C and relative humidity 75%. The respective values in the hatching compartment were 37.3°C and 90%. Chicks were hatched between days 24 and 26 of incubation. Daily inspection of air temperature on the farm gave a picture of thermal conditions which prevailed during the experiment (Figure 1).

Statistical calculations for egg production were performed by means of one-way variance analysis. The linear model of two-way variance analysis was employed for egg fertility and results of hatchability. For all the traits, significant differences between the means for the groups were analysed by Fisher test.

RESULTS

At the beginning of experiment I (Figure 2) egg production of pheasants in the groups was similar and ranged from 15 to 20%. From the 2nd to the 5th week, better egg production than in the control group was demonstrated in groups II and III. The highest number of eggs laid in these groups was found in the 5th week of the experiment. Compared to the other groups, pheasants from group IV were characterized by lower egg production throughout the experiment except week 7, in which all the groups showed similar egg production (approx. 85%). Mean laying rates of pheasants (Table 1) in groups I, II and III did not differ significantly. Birds from group IV compared to the other groups were characterized by significantly lower mean laying rate. In experiment II (Figure 3), the highest number of laid eggs was found from 1 to 6 weeks in group III. From 5 to 8 weeks of the study, pheasants from groups II and III showed similar egg production that was higher than in the control group. From 9 to 10 weeks of the experiment, egg production in group III increased from 59 to approx. 73%. Pheasants from groups II and III were characterized by significantly higher mean laying rate (by 5.5 and 11.6 percentage units) than in the control group (Table 2).

In experiment I (Table 1) egg fertility in groups II and III did not differ significantly from that obtained in the control group. In group IV egg fertility was shown to be statistically lower than in groups I and III by 4.5 and 5.7 percentage units, whereas hatchability of set eggs was lower by 5.5 and 5.7 percentage units, respectively. No significant differences were shown between the groups in percentages of dead chicks by 10th day of incubation, unhatched chicks, dead embryos after 10th day of incubation, crippled chicks and hatchability of fertilized eggs. In experiment II (Table 2) groups II and III were characterized by similar values of egg fertility, which were significantly higher (by 10.3 and 11.3 percentage units) than in group I. This group, compared to the other groups, was also characterized by a significantly higher percentage of unhatched chicks and

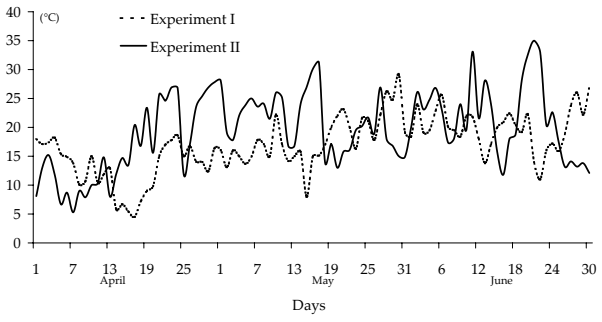

Figure 1. Means air temperatures (1:00 to 2:00 pm) recorded in both years of experiments

Table 1. The effect of dietary vitamin C level on laying rate (%), egg fertilization (%) and hatchability results in pheasants (Experiment I)

Trait		Group I (control)	Group II (100 mg vit. C)	Group III (200 mg vit. C)	Group IV (300 mg vit. C)
Laying rate (%)	$\bar{x}$	80.7a	82.7a	82.5a	71.5b
	CV	18.1	17.9	18.9	25.6
Egg fertilisation (%)	$\bar{x}$	89.3a	87.5ab	90.5a	84.8b
	CV	7.2	5.1	3.4	5.8
Dead embryos by 10th day of incubation (%)	$\bar{x}$	2.9a	2.6a	3.0a	3.1a
	CV	143.1	130.8	158.3	117.4
Unhatched chicks and dead embryos after 10th day of incubation (%)	$\bar{x}$	20.3a	23.2a	20.0a	22.2a
	CV	9.1	17.1	24.3	51.0
Crippled chicks (%)	$\bar{x}$	1.7a	1.7a	2.5a	2.3a
	CV	50.0	48.2	42.4	53.9
Hatching of set eggs (%)	$\bar{x}$	69.8a	65.7ab	70.0a	64.3b
	CV	7.4	9.3	7.3	17.0
Hatching of fertilized eggs (%)	$\bar{x}$	78.0a	75.1a	77.5a	75.5a
	CV	2.7	6.1	6.7	13.6

Mean values in rows marked with different letters are significantly different at $P \leq 0.05$

dead embryos after 10th day of incubation. Higher hatchability of set eggs than in the control group (by approx. 15.3 percentage units) was shown in groups II and III. Similarly, the same groups exhibited higher results of hatchability of fertilized eggs (by 8.6 and 9.2 percentage units) than in group I. There were no significant differences between the groups in percentage of dead embryos by 10th day of incubation and in hatchability of crippled chicks.

DISCUSSION

The mean laying rate of pheasants in experiment I, in the control group and in the groups supplemented with 100 and 200 mg/kg vitamin C was similar and ranged from 80.7 to 82.7%. Pheasants receiving the 300 mg/kg vitamin C diet were characterized by the lowest laying rate. Data on air temperature during the experiment (Figure 1) are indicative that thermal conditions were close to optimal. Bell and Marion (1990), who examined laying hens under optimal conditions, also failed to show a significant effect of various doses of dietary vitamin C on the number of laid eggs. Similar findings were reported by Keshavarz (1996) and Kontecka *et al.* (1999). The mean laying rate of pheasants in experiment II was lower than in experiment I by approx. 31 percentage units in the control group and by approx. 20 percentage units in the experimental groups.

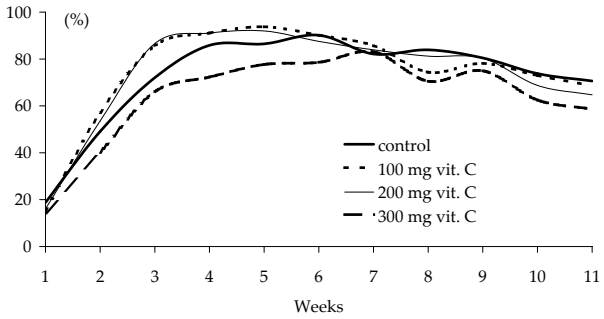

Figure 2. Pheasants' laying rate (Experiment I)

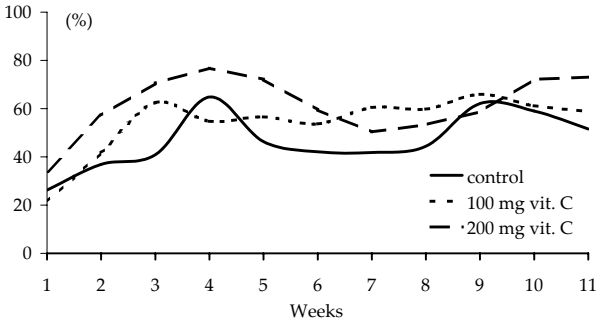

Figure 3. Pheasants' laying rate (Experiment II)

Table 2. The effect of dietary vitamin C level on laying rate (%), egg fertilization (%) and hatchability results in pheasants (Experiment II)

Trait		Group I (control)	Group II (100 mg vit. C)	Group III (200 mg vit. C)
Laying rate (%)	$\bar{x}$	50.1a	55.6b	61.7c
	CV	40.3	32.0	32.4
Egg fertilisation (%)	$\bar{x}$	78.1a	88.4b	89.4b
	CV	21.8	10.1	7.7
Dead embryos by 10th day of incubation (%)	$\bar{x}$	3.8a	3.1a	3.3a
	CV	145.0	137.4	114.8
Unhatched chicks and dead embryos after 10th day of incubation (%)	$\bar{x}$	18.5a	12.0b	11.9b
	CV	61.8	66.1	86.5
Crippled chicks (%)	$\bar{x}$	8.3a	6.2a	5.7a
	CV	98.3	97.9	69.3
Hatching of set eggs (%)	$\bar{x}$	55.4a	70.1b	71.2b
	CV	31.9	15.2	16.8
Hatching of fertilized eggs (%)	$\bar{x}$	73.2a	81.8b	82.4b
	CV	18.7	10.2	14.4

Mean values in rows marked with different letters are significantly different at $P \leq 0.05$

However, birds in experiment II were exposed to unfavourable environmental conditions resulting from high temperatures of air (25–30°C), which were considerably different from those recorded in the preceding years. The lower number of eggs laid by individual pheasant groups in experiment II could therefore be due to adverse climatic conditions. Similarly Klecker *et al.* (2002), who kept laying hens indoors at 28.5°C, found the laying rate to drop by about 24 percentage units. In experiment II, pheasants given the vitamin C supplemented feed were characterized by higher egg production compared to the control group. Njoku and Nwazota (1989) also ascertained that the vitamin C supplement of 200, 400 and 600 mg/kg given to laying hens in tropical conditions caused a proportional increase in the number of eggs laid. Sushil *et al.* (according to Whitehead and Keller, 2003) found that out of all hens kept at an elevated temperature (30°C) from 24 to 40 weeks of age, birds given a diet supplemented with 800 mg/kg vitamin C were characterized by a higher laying rate compared to the control group.

In experiment II, egg fertility and hatchability in the control group were lower than in experiment I. These parameters were similar in the experimental groups. Poorer reproductive results in experiment II in the control group could be due to stress (high air temperatures) to which the birds were particularly vulnerable from April to May. Mroczkowska (according to Mróz, 2003) also stated that unfavourable environmental conditions affecting adult pheasants adversely affected their reproductive traits. In 2000, however, significantly higher egg fertility (by approx. 11 percentage units) and hatchability of chicks from set eggs (by approx. 15 percentage units) and fertilized eggs (by approx. 9 percentage units) were obtained from pheasants given the vitamin C supplemented feed. Torgowski and Kontecka (1998) reported higher egg fertility (by approx. 2 percentage units) and lower hatchability of crippled chicks (on average by 1 percentage unit) in the group of pheasants supplemented with 500 mg/kg vitamin C and ferrous sulphate (500 mg/kg) compared to the control group.

This vitamin was also shown to exert a favourable influence when supplemented in feed on the parameters of hatchability in broiler breeders (Peebles and Brake, 1985) and ducks (Kontecka *et al.*, 2000). The better results of egg fertility in experiment II could be indirectly affected by higher sperm viability and concentration, resulting from the consumption of vitamin C supplemented feed by the males. In laying hens exposed to high air temperatures (hot

summer), Elansary *et al.* (1999) demonstrated larger ejaculate volume, higher sperm concentration and sperm motility in the group of roosters given feed supplemented with 100, 200 and 400 mg/kg vitamin C compared to the control group. Similar findings were reported by Monsi and Onitchi (according to Whitehead and Keller, 2003), who used a supplement of 500 mg/kg vitamin C in the feeding of roosters raised in a hot and humid climate.

Doses of 100 and 200 mg of vitamin C exerted a positive influence on laying as well as on egg fertilisation and hatchability indices. It appears advisable to use a prophylactic dose of 100 mg of vitamin C per 1 kg feed in the feeding of reproductive pheasants reared in aviaries. In conditions of thermal stress (high air temperatures), it is recommended to increase the applied vitamin C dose to 200 mg/kg feed.

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Received: 04–08–03
Accepted after corrections: 05–01–12

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