The Influence of Vitamin C over the Production Performances of the Laying Hens in Conditions of Thermal Stress

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Abstract

The global warming is topical on a global level today. In a parallel line with it the number of scientific researches which demonstrate the negative effect of high temperature over production performances, health and well being of the animals is increasing. Although the hens are homeothermic and keep constant body temperature, in comparison to the other home animals, they are more sensitive towards the temperature changes of the environment and thus more liable to developing a thermal stress. Consecutively the global warming, represents a direct threat to the poultry production. Having in mind that annually in the world 1 trillion and 300 billion eggs are produced and that they are highly nutritive food which the human nutrition does not have analog replacement, the finding of methods for overcoming the thermal stress and keeping the production at a level that satisfies the public consumption is of vital importance. Our aim is to make a correlation between the vitamin C as a food supplement and the productivity of laying hens in conditions of thermal stress. The research is carried out in the poultry farm 'Beli Most' – Bitola, North Macedonia and 13200, thirteen-month-laying-hens of Isa Brown type took part. The research lasted for 40 days and was conducted in two parts. In the first part i.e. the first 20 days the daily laying at average daily temperature of 23.84 Celsius degrees was followed. In the following twenty days the daily laying was followed again, but this time at an average daily temperature of 25.54 Celsius degrees and vitamin C as a food supplement. The vitamin C was added in the amount of one kilogram to one ton. In the first part of the research the average number of daily laid eggs was 11847 or in total 236940 eggs for all 20 days. The maximum number of daily laid eggs was 12660, and the minimum was 11250. In the second part, the average number of daily laid eggs was 11800 or in totals 236000 eggs for all 20 days. The maximum number of daily laid eggs was 13200, and the minimum was 10140. From the received results it can concluded that the increase of ambience temperature for 1.7 Celsius degrees even with the additional vitamin C the production went down for 40 eggs daily. In any case that reduction is insignificant. The absence of significant difference between the productive performances in the first and the second part, the most probably is due to the protective influence of the vitamin C.

Key words: laying hens, thermal stress, production performance, vitamin C.

Introduction

During the last century, the global temperature on the surface of the Earth grew for 0.74 ± 0.18 °C, and climate projections model summed up in the IPCC reports indicates that during the XXI century the warming (process) will continue to grow reaching the values of 1.1 to 6.4 °C (IPCC, 2007). In the parallel line with the global warming the number of scientific researches which demonstrate the negative effect of high temperatures over the production, morbidity and mortality of the animals is increasing. The weak performances, immunosuppression and the high rate of mortality which are results from exposures to high temperatures are a direct threat for the poultry production (Bottje & Harrison, 1985; Young, 1990; Mujahid et al., 2005, 2009 b).

Although the hens are homeothermal animals which maintain permanent body temperature, in comparison to the other domestic animals, they are too sensitive to thermal changes in the environment. The thermo neutrality zone of the comfort ambience temperature for the hens is 18–24 °C and within its frames the excess of body temperature is lost by means of conduction (Wolfenson et al., 2001), convention (Mitchell, 1985; Tzschentke et al., 1996; Lott et al., 1998) and radiation. Therefore the amount of created heat is in balance with the amount of the heat given away. In cases of increased ambience temperatures and their approximation to the body temperature of the hen (41 °C), giving away of the heat through the above mentioned ways is impossible. The only way of giving away heat is through gasping as a respiratory evaporative mechanism (Richards et al., 1968, 1970, 1976; Seymour, 1972; Marder & Arad, 1989). Going out of the comfort zone is followed by a series of physiological changes which have adaptation as an aim i.e. keeping of the body temperature (Simon, 2003).

The reduced production of eggs in conditions of thermal stress owes to reduced circulation of blood through the womb (Wolfhenson et al., 1981), reduced intake of food disruption of the hormones responsible for the ovulation, reduced reactivity of the granulous cells towards louteinising hormones (Donoghue et al., 1989; Novero et al., 1991) and reduced capability of the cells of the gastrointestinal tract for transmission of calcium (Mashaly et al., 2004). In the process of thermal stress free radicals such as O_2 and -OH are created, which damages the cellular membrane through simulating of the lipid peroxidation of the polyunsaturated fat acids (Laudicina & Marnett, 1990). That process affects the metabolic activity of the cells, the hepatocytes above all, which is followed by reduced synthesis and releasing of precursors for formation of the egg yolk (Puthpongsiriporn, 2011). The loss of functional hepatal tissue is followed by difficult or disrupted ability for elimination of the toxins of the organism that indirectly affects the reduction of the productional performance. Additionally corticosterone stimulates converting of norepinephrine in epinephrine which induces degeneration of the ovarial pholiculas (Moudgal et al., 1985).

Vitamin C is hydrosolluble, extremely unstable and multifunctional vitamin. Several types of poultry among which the hens inherited the ability to synthesise Vitamin C on their own (Plimmer et al., 1923; Hart et al., 1925; Hauge & Carrick, 1926) so at normal ambience conditions its supplementation in the food is not necessary (Emmet & Peacock, 1923; Hart et al., 1925). Among the series of the stress factors from the outward environment including the exposure to high temperatures stimulate vitamin C disintegration in the tissue (Freeman, 1967; Kechik & Sykes, 1979; Cheng et al., 1990) in which case the need exceeds the rate of endogene biosynthesis, so endogene supplement is imperative.

Material and Methods

The research is carried out in a poultry farm for breeding commercial laying hens 'Beli Most' – Bitola, North Macedonia, a country with over 300 sunny days a year and with high temperatures during the summer (up to 40 °C). In the research 13200, thirteen-month-laying-hens of Isa Brown type took part. The research lasted for 40 days and was conducted in two parts. In the first part i.e. the first 20 days the daily laying at average daily temperature of 23.84 Celsius degrees was followed. In the following twenty days the daily laying was followed again, but this time at an average daily temperature of 25.54 Celsius degrees and vitamin C as a food supplement. The vitamin C was added in the amount of one kilogram per one ton food.

Results and Discussion

In the first part of the research the average number of daily laid eggs was 11847 or in total 236940 eggs for all 20 days. The maximum number of daily laid eggs was 12660, and the minimum was 11250 (the exact numbers of eggs laid per day are given in Table 1 & Figure 1; and the

Table 1. Number of eggs laid per day and the average daily temperature, during part 1 of the experiment

Date	Number of eggs laid per day	Average daily temperature °C)
01.07.2015	12600	16.1
02.07.2015	12660	21.2
03.07.2015	11940	22.4
04.07.2015	12390	23.4
05.07.2015	11280	22.7
06.07.2015	11610	24.0
07.07.2015	11640	24.3
08.07.2015	12000	26.0
09.07.2015	11700	25.8
10.07.2015	11610	19.6
11.07.2015	12000	21.9
12.07.2015	11610	23.3
13.07.2015	11970	25.8
14.07.2015	11550	25.0
15.07.2015	11910	24.2
16.07.2015	11640	25.5
17.07.2015	11670	25.9
18.07.2015	11250	26.5
19.07.2015	12300	25.7
20.07.2015	11610	27.5
Measures of variation		
Average	11847	23.84 ºC
Sx	87.88	0.60
Sd	392.83	2.69
Cv	3.31	11.28
Iv	11250–12660	16.1–27.5

Table 2. Number of eggs laid per day and the average daily temperature, during part 2 of the experiment

Date	Number of eggs laid per day	Average daily temperature °C)
21.07.2015	11600	28.3
22.07.2015	10890	27.4
23.07.2015	12300	26.6
24.07.2015	10950	25.2
25.07.2015	12360	21.8
26.07.2015	10530	26.1
27.07.2015	12300	27.5
28.07.2015	11180	27.8
29.07.2015	13200	28.4
30.07.2015	11140	28.3
31.07.2015	12300	27.4
01.08.2015	12000	25.0
02.08.2015	10950	26.8
03.08.2015	11580	22.5
04.08.2015	10140	21.6
05.08.2015	12300	25.0
06.08.2015	11580	24.5
07.08.2015	12300	22.9
08.08.2015	13200	23.6
09.08.2015	13200	24.1
Measures of variation		
Average	11800	25.54 °C
Sx	199.32	0.50
Sd	890.95	2.25
Cv	7.55	8.80
Iv	10140–13200	21.6–28.4

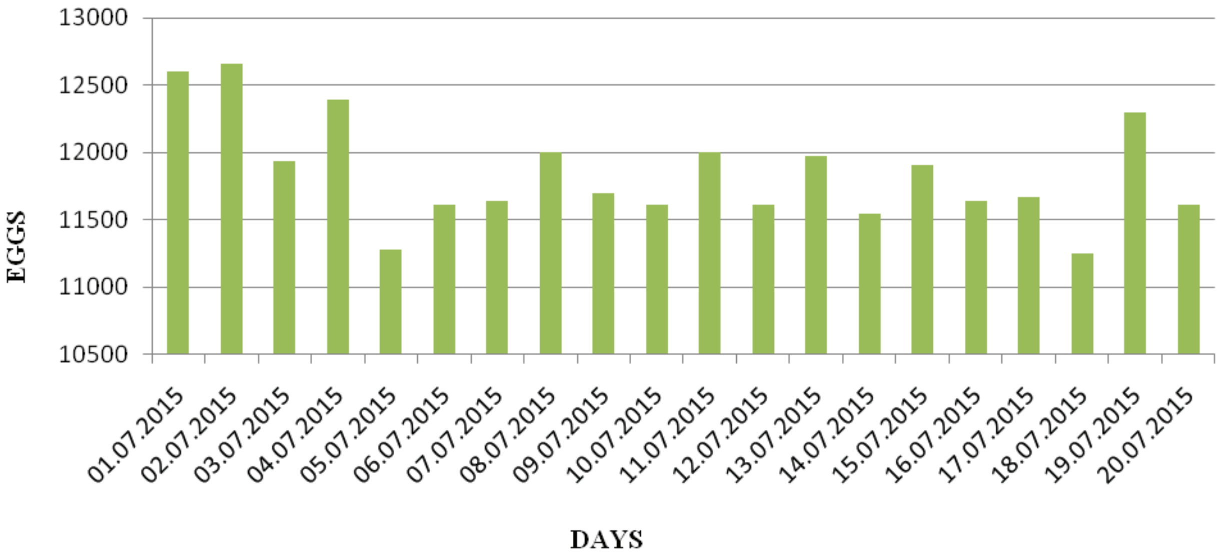

Fig. 1. Number of eggs laid per day (part 1)

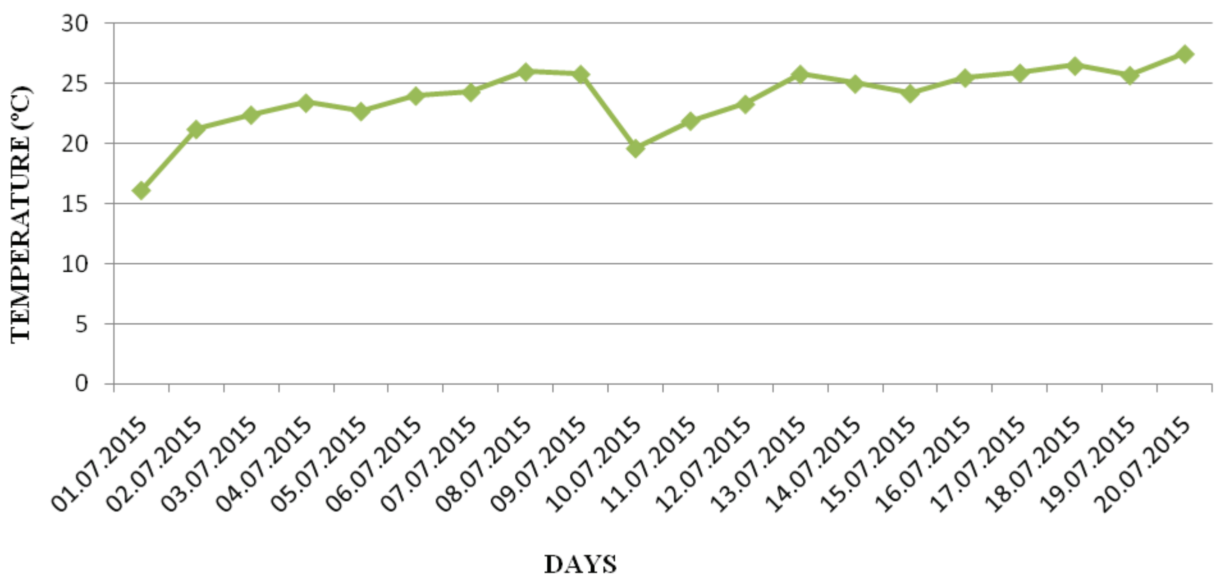

Fig. 2. Average daily temperature (part 1)

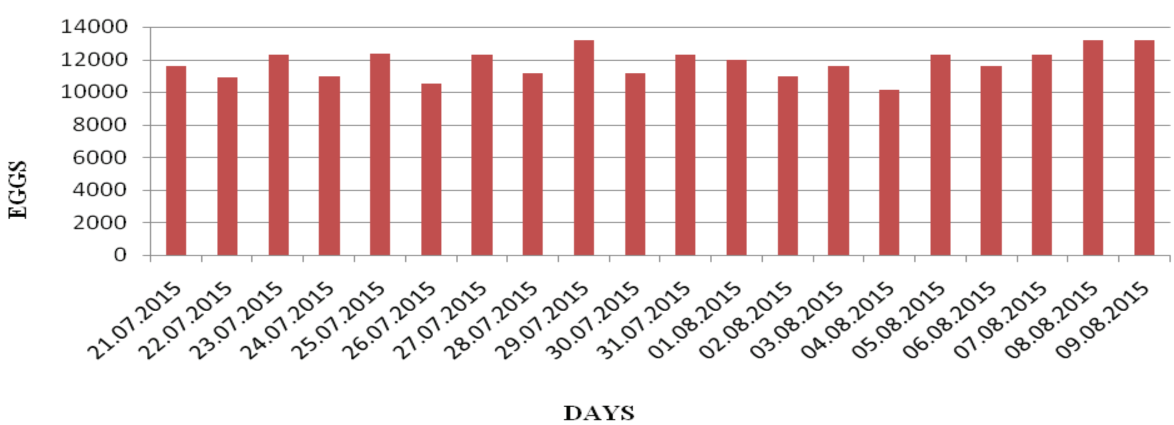

Fig. 3. Number of eggs laid per day (part 2)

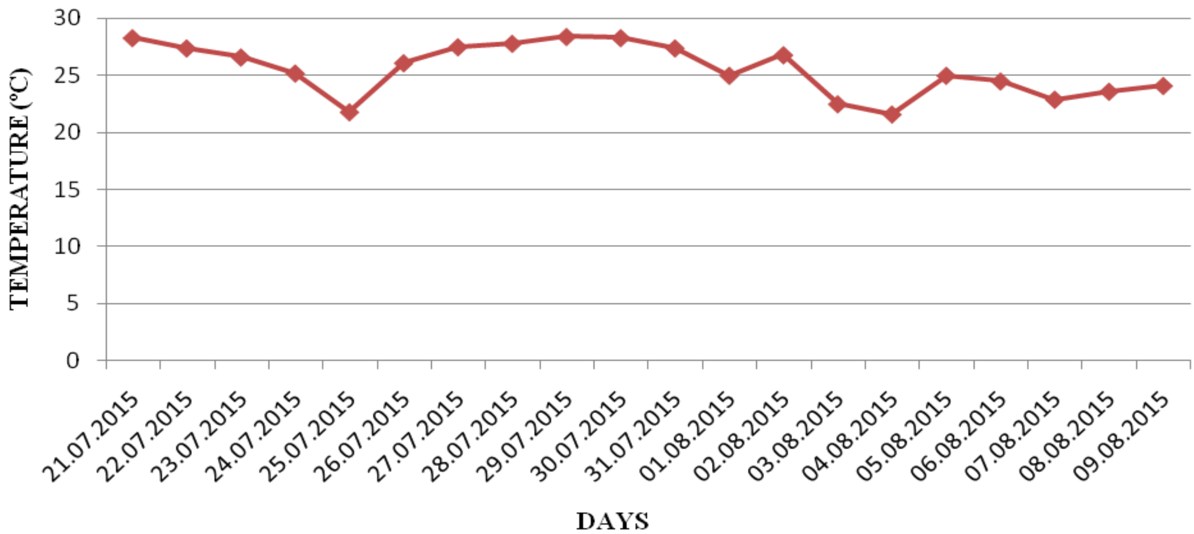

Fig. 4. Average daily temperature (part 2)

average daily temperatures are given in Table 1 & Figure 2).

In the second part the average number of daily laid eggs was 11800 or in total 236000 eggs for all 20 days. The maximum number of daily laid eggs was 13200, and the minimum was 10140 (the exact numbers of eggs laid per day are given in Table 2 & Figure 3 and the average daily temperatures are given in Table 2 & Figure 4).

In its extensive search of literature devoted to implementation of vitamin C in the nutritional poultry, Pardue and Thaxton in 1986 reported that because of domestic hens ability for endogene synthesis of this Vitamin, traditionally in the past its use in the food mixtures was excluded. But they quote a number of references which date from 1933 and which point out the need of egsogene nutritive source of vitamin C in conditions of stressful conditions which either increase the metabolic need for vitamin C or reduce the ability of the body for its synthesis. Whatever the case in our research addition of vitamin C did not brought us to growth of the production which is in accordance with the research of some authors (Nestor et al., 1972; Bell & Marion, 1989; El-Gendi et al., 1999; Souza, 2001; Salvador et al., 2009; Wang et al., 2011). On the other side our results do not correspond to the results of the authors in whose attempts vitamin C increased the productional performances (Hunt & Aitken, 1962; Perek & Kendler, 1962, 1963; McDowell, 1989; Kechik & Sykes, 1974; Njoki & Nwazota, 1989; Haazele, 1991; Behl et al., 1995; Salata et al., 1995; Baius, 1996; Ajakaiye et al., 2010; Fayeye, 2013; Surivan et al., 2013).

Conclusion

From the received results it can be concluded that by the increase of ambience temperature for 1.7 Celsius degrees even with the additional vitamin C the production went down for 40 eggs daily. In any case that reduction is insignificant. The absence of significant difference between the production performances in the first and the second part, the most probably is due to the protective influence of the vitamin C.

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