Laying Productivity with Constant Renewal in Water Fountains During Heatwave

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Abstract

This study aimed to evaluate the effect of the water renewal system of drinking fountains in laying hens and its relationship with productivity. For this, 5,000 laying hens of the Dekalb White line were used in each shed, which received food and water ad libitum. The warehouses had a conventional typology, Californian type. For this, a digital water renewal system was installed in three nipple drinking fountains in one of the warehouses (treatment 2 - T2) and the other remained without the water renewal system (treatment 1 - T1). Using Thermo hygrometers, the average air temperature (° C) and the average relative humidity of the air (%) were measured. For the water temperature (° C), a water renewal system (Flushing Control® - Lubing model) was used, which carried out the renewal of the birds' drinking water six times a day. Feed consumption (g / bird / day), water consumption (ml), egg production (%) and mortality (%) were evaluated. During the study period, using data from the weather station, the occurrence or not of heatwaves was defined. A completely randomized design (DIC) was performed in a 2 × 2 factorial scheme (two sheds: conventional system and with water renewal; with and without heatwave) and the data were subjected to analysis of variance (5%). It concludes the efficiency of the use of the water renewal system for zootechnical performance, during the heatwave, but the use of air conditioning systems and measures to reduce the direct radiation in the birds and installation is still necessary. There was a positive influence (p <0.05) in the use of the water renewal system for water temperature (° C), water consumption (ml) and egg production (%). In the presence of a heatwave, the feed and water consumption variables were lower (p <0.05). There was no interaction between the systems and the presence of heatwaves. It is concluded *that the use of a water renewal system has benefits in zootechnical indexes, however, it does not interact with the presence of heatwaves.*

Keywords: ambience, equipment, water, extreme climate.

1. INTRODUCTION

Egg production is considered one of the most important economic activities for Brazil and for food production, where São Paulo is the state that produces the most eggs in Brazil, concentrating 30.9% of Brazilian production, capable of feeding more than 60 million of people per year, considering the per capita egg consumption in the country of 212 eggs per year [1]; [2].

The Secretariat of Agriculture and Supply of the State of São Paulo states that the Bastos region is the largest egg producer in the State, representing 36% of the São Paulo total. With a herd of 32 million heads, 25 million of which are in production and 6 million are young chickens [3].

However, the main limitation in poultry production is the high temperature recorded most of the year, in the Bastos region. Thus, the aim of this study is to verify the influence of the use of water renewal system in drinking troughs for laying hens and its influence on productivity, in the presence or absence of heatwaves.

2. LITERATURE REVIEW

The temperature above the upper limits of the thermal comfort zone, in birds, causes thermal stress, which can harm the animal organism and significantly increase mortality rates [4]; [5]. The thermal comfort ranges comprise the temperature range of 20 to 27 ° C for adult birds, and above 35 ° C the birds enter thermal stress [6].

To be able to maintain the body's homeotherm, water consumption is used as a tool to minimize the effect of thermal stress, therefore, all care and planning aimed at poultry practice is essential for there to be managed in the availability and quality of water, so that there are no limiting factors in this process [7].

The water temperature is directly related to the water consumption of the birds and consequently their productivity. However, there are few studies on the types of drinkers used for laying poultry in Brazil [8].

Studies have found that the drinking water temperature for birds is in the range of 20oC to 26oC, with positive effects on egg production. On the other hand, temperatures above 32 ° C, for example, cause intense stress and loss in shell resistance [9]; [10]; [11].

The increase in ambient temperature leads to a decrease in the bird's capacity to dissipate heat and the consequent and respiratory alkalosis, thus increasing productive losses, such as increased mortality in the final stages of creation [12].

Studies reveal that heatwaves will be more and more frequent and the estimate until the year 2100 is that the world temperature will increase by up to 5.8 ° C; for every 1 ° C increase in global temperature, mortality can increase by up to 1.4% [5].

Currently, there are several tools that make it possible to improve poultry rearing systems, be they broilers or layers. Regardless of the degree of available technology, it will always be necessary to turn attention to these animals [13]. Among these tools, the renewal of drinking water for birds is a tool that proves to be efficient, because with the constant use of water installations and pipes, contamination can occur in the system, causing accumulation of organic material, with deposition of dirt, growth algae and biofilms in the water supply line [14].

3. MATERIAL AND METHODS

Experiment Location and Climate Conditions

The experiment was carried out in field conditions, from December 22, 2018, to February 20, 2019, in an egg-producing poultry farm located in Bastos - São Paulo, Brazil (21º55 '19' 'south latitude and 50º44 '02' 'west longitude, with an altitude of 445 m). According to the Köppen climate classification, the climate is Aw, characterized by a tropical climate with dry winter, the rainy season in summer and dry in winter.

The external climatological variables (air temperature and relative humidity) were obtained through the National Meteorological Institute of Brazil, Inmet [15].

Air temperature (° C) and relative humidity (%) data were collected daily, in a specific spreadsheet, the values of air temperature and relative humidity, at the minimum and maximum times of the day (6:00 am) and (2:00 pm) at three points in the aviary, at the height of the bird using a Digital Thermohygrometer Asko®, AK28.

Experimental Design, Poultry and Water Renewal System

A completely randomized design (CRD) was carried out in a 2 × 2 factorial scheme (two warehouses: one with a conventional system and the other with water renewal; and with and without heatwave), to evaluate the two proposed treatments, namely: T1 - Shed without the digital water renovation system and T2 - Shed with the digital water renovation system.

5000 laying birds were initially housed in each treatment, of the Dekalb White strain, aged 84 weeks at the beginning of the study. We worked with three cycles of 21 days for each cycle, during the summer period (December to February) with the presence or absence of a heatwave.

Two poultry houses in production, with east-west orientation, Californian type, were used for the study, with three floors of cages (dimensions of 50.0 × 48.0 × 45.0 cm) on each side, with automatic distribution feed and nipple drinkers with a flow rate of 180 ml/minute and ceramic type tiles, without liner and without ventilation system.

The digital water renewal system was installed in three lines of nipple drinking fountains in one of the warehouses and the other remained without the water renewal system. The equipment consists of a control panel, and it is distributed to each line of the warehouses, passing through a pressure regulator, and then proceeding to the water pipes inside the shed (Figure 1).

The water renewal system (Flushing Control® - Lubing model) carried out the renewal of drinking water for birds six times a day, at times pre-programmed for every four hours by the equipment. In both warehouses, water meters were installed to measure daily water consumption. The birds received water and feed ad libitum.

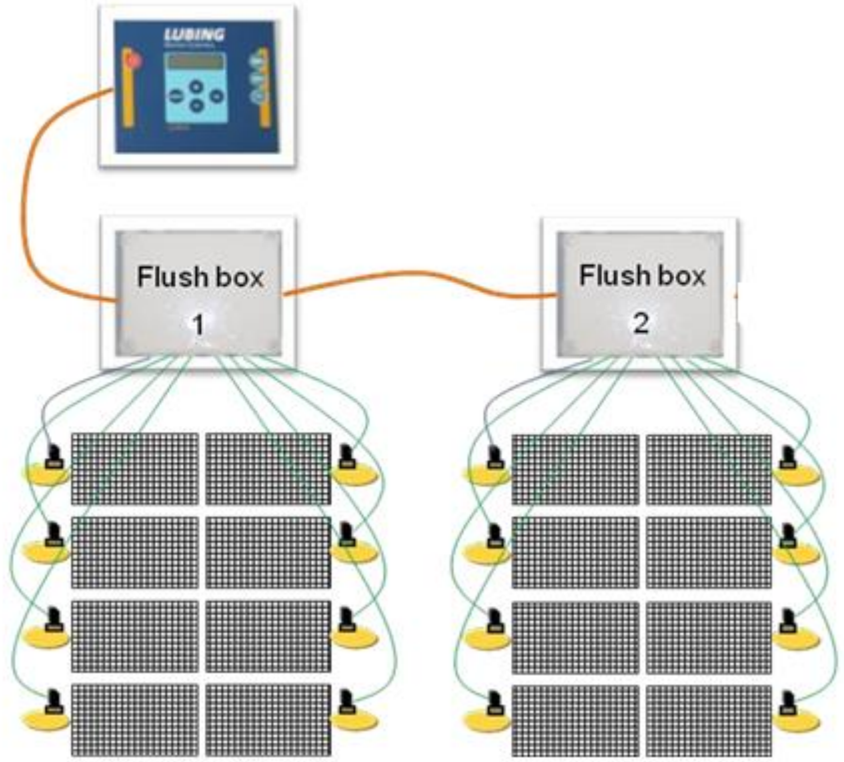

Figure 1. Scheme of distribution of water renewal system. Source: Lubing®

Animal Diet

The formulation used, was the basal feed off the farm, for the older birds, in the laying phase 3. For the nutritional requirements of layers, they were calculated according to the Brazilian Tables of Nutritional Requirements of Poultry and Swine [30]; according to Table 1.

The following zootechnical variables were collected per experimental unit: egg production (%), average daily feed consumption (g), average water consumption (ml) and mortality (%).

Table 1. Nutritional composition of the diet.

Ingredients	Posture 3
Macro Ingredients (kg)	
Grain Maize (7.5%)	652,800
Soybean Meal (46%)	197,000
Wheat bran	6,000
Meat and bone meal (42%)	31,000
Thick Limestone	64,000
Thin Limestone (38%)	38,000
Salt	2,050
Bicarbonate	2,400
Micro Ingredientes (kg)	
Dl Methionine	0,250
Lysine	1,350

Threonine	0,450
Choline chloride 60%	0,500
Premix Vitaminic / Mineral 4kg / ton	4,000
Carbohydrase	0,200
TOTAL	1.000
Níveis Nutricionais (%)	
Crude Protein	16,200
Ethereal Extract	2,880
Crude Fiber	2,520
Calcium	4,500
Phosphorus Available	0,400
Sodium	0,180
Chlorine	0,180
Energy Met Ap Poultry Kcal / Kg	2.800,000
Lysine dig Poultry	0,810
Methionine dig - Poultry	0,340
Met + Cist dig-Aves	0,560
Dig-Birds Tryptophan	0,160
Threonine dig-Poultry	0,570
Arginine dig-Poultry	0,910
Isoleucine dig-Ave	0,570
Valina dig-Ave	0,640

Mineral and vitamin premix (guarantee levels per kg of product): vitamin A 8000 MIU; vitamin D3 2500 MIU; vitamin E 15000 mg; vitamin K3 1500 mg; vitamin B1 500 mg; vitamin B2 3000 mg; vitamin B6 2000 mg; vitamin B12 10,000 mcg; niacin 18000 mg; calcium pantothenate 7000 mg; folic acid 500 mg; biotin 20 mg; iron 30000 mg; copper 8000 mg; manganese 70000 mg; zinc 70000 mg; iodine 1000 mg; selenium 250 mg; methionine 800 g; choline 400,000 g; phytase 60 g; halquinol 30000 mg

Characterization of the Heat Wave Incidence

For the characterization of the heatwave, a minimum temperature> 22 ºC and a maximum temperature ⩾32 ºC for at least 3 consecutive days was used as a reference [16].

Zootechnical Indexes

The main zootechnical indexes were calculated for the productivity analysis, of the 5000 birds of each house for all equations. (Equations 1 to 4).

$$Egg\ production = \frac{\text{daily number of eggs} * \text{number of birds in the house}}{100}\ (\%) \qquad \text{Eq. 1}$$

$$Feed\ consumption = \frac{total\ amount\ of\ feed\ provided\ per\ day}{total\ birds\ in\ the\ shed}\ (g) \quad \text{Eq. 2}$$

$$Water\ consumption = \frac{total\ consumption\ of\ water\ supplied\ per\ day}{total\ birds\ in\ the\ shed}\ (ml) \quad \text{Eq. 3}$$

$$Mortality = \frac{mortality\ number\ per\ day}{total\ birds\ in\ the\ shed}\ (\%) \quad \text{Eq. 4}$$

For the temperature of the drinking water of the birds, 5 different points were measured for each side (north and south) of the house and an arithmetic mean of these points was performed.

Data on feed consumption, water meter measurements to calculate water consumption and mortality were also collected daily.

Statistical analysis

For statistical analysis, data were subjected to analysis of variance (5%). The R Core Team software [17] was used.

4. RESULTS AND DISCUSSION

Climatological and Bioclimatic Variables

The climatological variables that occurred during the experiment (Figures 2 and 3) describe the behavior of air temperatures and relative humidity, on average between cycles.

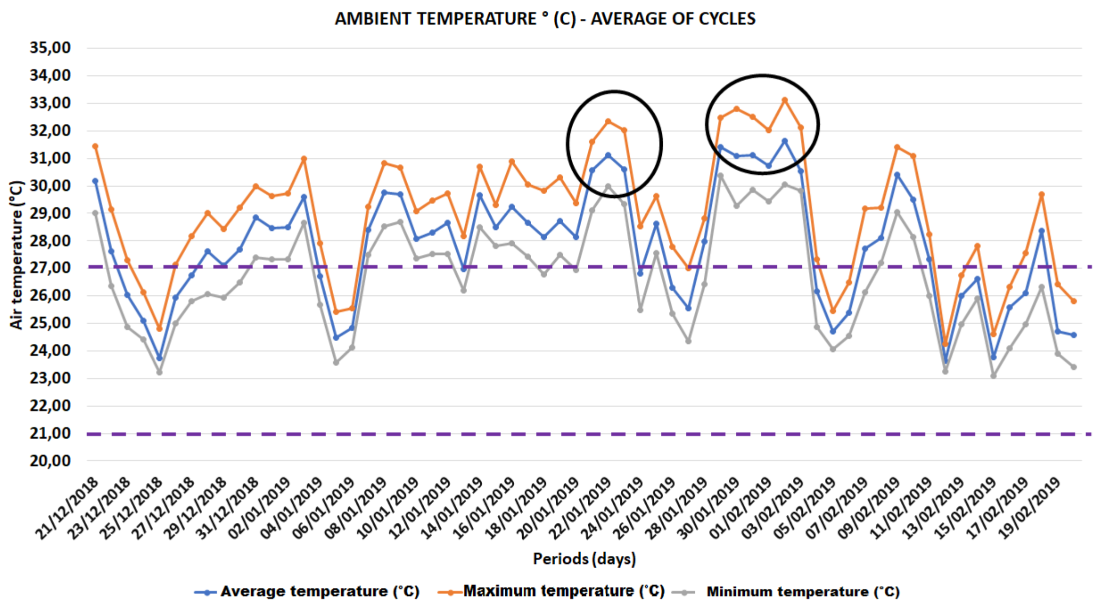

Figure 2. External Air Temperature (Average of cycles)

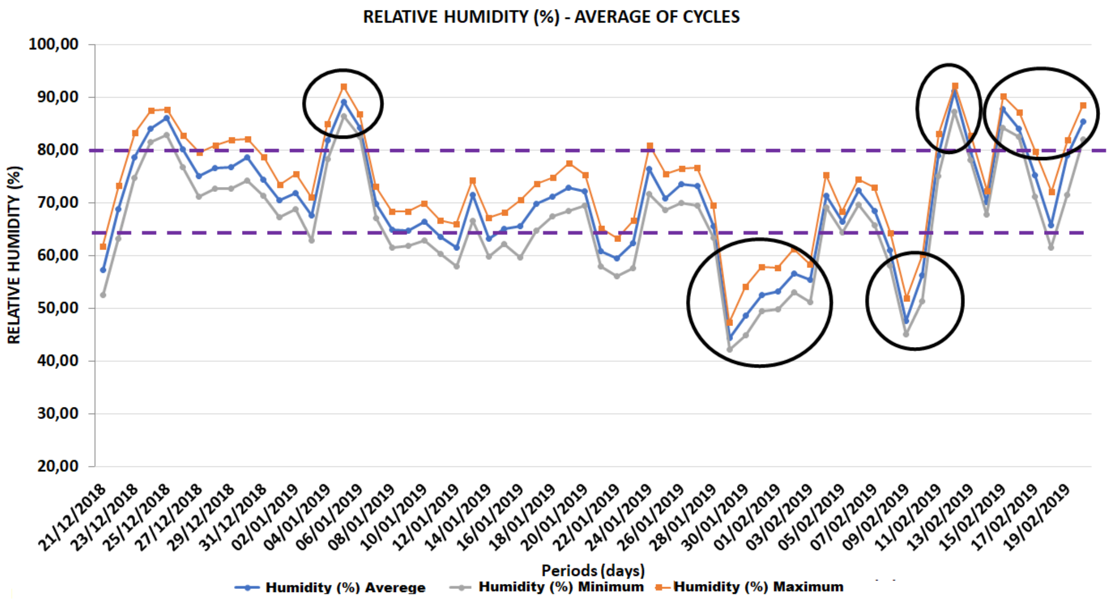

Figure 3. External Air Temperature (Average of cycles)

It was found that the air temperature (° C) and relative air humidity (%) were outside the thermal comfort limit for birds (Figures 2 and 3).

The accepted ranges are air temperature from 21 to 27 (° C) of recommended relative humidity is 65 to 80 (UBA, 2008).

With the thermal stress, consequently, changes in the performance of the birds occur, decreasing the food intake, losses in the performance and quality of eggs and even the death of the birds [18].

At two points (Figure 2) in the months of January and February, the presence of heatwaves is noted. At this stage, the layers are already acclimated, as they have already gone through this type of climatic extreme, which normally begins in September [4]; [19].

The temperatures to which the housed birds were subjected were largely highly thermally stressful. The average air temperature was around 29% above the recommended maximum.

The average relative humidity, on the other hand, was 13% above the maximum recommended range.

This shows that the birds went through thermal stress during most of the study period, which leads to productive losses [2]. Thus, the work of [20] reports that the birds are kept in suitable thermal environments so that an adequate thermal balance is carried out.

According to [21] thermal stress leads to an acid-base imbalance and plasma calcium concentration.

This has a direct influence on the production of commercial laying eggs.

Analysis of System Interactions and Heat Waves

The systems (T1 and T2) were analyzed in relation to the feasibility of the renovation in relation to productivity. The incidence of the heatwave was also adopted. The results are shown in Tables 2 and 3.

Table 2 - Water temperature in the different water supply systems, during the heatwave

VARIABLES	WATER SUPPLY SYSTEM	WATER TEMPERATURE (° C)
DRINKING SYSTEMS	Renovação	26,26 b
	Convencional	27,96 a
	P value*	**0,0033**
HEAT WAVES (°C)	Presence HW	26,89
	Absence HW	27,19
	P value**	**0,7709**
SYSTEMS x HW	**P value**	**0,6317**

* Averages followed by different letters, in lines, are significant at the 5% probability level.

Table 3 - Zootechnical indices in the different water supply systems, during the heatwave

VARIABLES	SYSTEM	EGG PRODUCTION (%)	FEED CONSUMPTION (GRAMS)	WATER CONSUMPTION (ML)	MORTALITY (%)
Systems	Renovation	78,42 A	98,00	244,94 A	0,05
	Conventional	73,10 B	103,00	192,02 B	0,06
	P value*	**<0,0001**	**0,8411**	**<0,0001**	**0,4435**
Heat Waves (HW)	Presence HW	76,45	79,61 b	189,55 B	0,06
	Absence HW	75,64	104,92 a	218,21 A	0,06
	P value**	**0,4075**	**0,0076**	**0,0207**	**0,7563**
Systems x HW	**P value**	**0,1338**	**0,6601**	**0,0787**	**0,3206**

* Means followed by different capital letters in the columns are significant at the 5% probability level (comparison between systems).

** Means followed by different lower case letters in the columns, are significant at the 5% probability level. (comparison between heat waves).

Checking the influence of the water renewal system, it was noted that it provides a more suitable temperature to the variable water temperature (P value 0.033) when compared to the conventional water supply system in drinking fountains for laying hens. However, in the presence of a heatwave, it had no influence (P value 0.7709). The same behavior is noticed when the interaction of the system with the heatwave is evaluated (P value 0.6317).

The water temperature for the constant renewal system showed significant results.

Note that even with the water renewal system, the water temperature was below the recommended, from 20 to 24 (° C) by [22] and [23].

This demonstrates that the renovation system minimizes the effects of stress, but must be associated with other means of promoting zones of thermoneutrality, such as the use of materials with low inertia and air conditioning systems.

As a consequence of the increase in air temperature, laying hens tend to consume more water, as it is an effective metabolic heat loss mechanism [24]; [20].

In the work of [25], the authors noted that the supply of colder water (20 ° C) results in a decrease in body temperature in turkeys, in addition to providing greater body weight, better daily weight gain, and less feed conversion.

Likewise, [26] stated that with the supply of colder water, it was possible to maintain the body temperature of broilers in homeothermia, even under conditions of thermal stress, and thus obtain better zootechnical performance.

There are several factors that can regulate the water intake of the birds, including room and water temperature, food intake, diet composition, age of the bird [27].

There is a chain of events (Table 3), in the system with water renewal.

First, birds consume more water (P value 0.0001) and have a higher egg production (P value 0.0001), even with similar feed consumption (P value 0.8411).

According to the manual of the Debalk White line, for birds over 80 weeks, production should be 72%, and feed consumption should be 106 grams/bird/day.

It can be seen how the presence of a heatwave (Table 3) alters the behavior of the zootechnical variables. In this case, in the presence of this climatic extreme, there was less water intake (P value 0.0207) and feed consumption (0.0076).

However, when the renovation system was evaluated with the heatwave, there was no interaction. This aspect still needs more studies on the occurrence.

Similar behavior regarding the ingestion of food under thermal stress was observed by [11]. They noticed that when the room temperature is above 26 ° C there is a decrease in food consumption.

The same authors still report that lower feed consumption can negatively influence the percentage of poultry production. In this study, the percentage of laying at room temperature was 20 ° C with 97% of production, while at room temperature of 32 ° C the production dropped to 85%.

In their work, the authors of [28] observed that quails subjected to 36 ° C showed egg production of 73% and feed consumption of 22 grams/bird/day in the stress period, while in the thermal comfort temperature (21 ° C) egg production was 79% and feed consumption was 28 grams/bird/day.

With the increase in the ambient temperature, there is consequently an increase in the water temperature of the drinking fountains, with this an increase in water consumption and a decrease in the feed consumption of birds [29].

According to [27], several studies have examined the effects of water cooling during the hot seasons, in layers, there is an improvement in the quality, of the shell and the internal, of the eggs. These effects appear, probably, due to the increase in water consumption, to maintain body homeothermia [30].

When assessing the mortality variable (Table 3), there is a similarity between the systems (P value 0.4435) and also during hot flashes (P value 0.7563).

This factor possibly has an influence on the age of the birds and when it was the first experience with hot flashes. Normally, there is acclimatization of the layers to prolonged stress, which reduces mortality, however, even with acclimatization, there is a decrease in the quality of eggs [5].

5. CONCLUSION

It is concluded that the water renewal system causes benefits in the zootechnical indexes, however, it did not present interaction with the presence of heatwaves.

The environment directly affects the zootechnical indexes of birds. The current way of providing drinking water makes it very difficult for birds to maintain homeothermia, generating significant production losses, leading to high mortality rates.

New water renewal tools can be studied as alternatives to minimize the impacts of heatwaves, thus providing animal welfare.

During the evaluated period, heatwaves occurred, with temperatures reaching peaks of up to 40 ° C, as evidenced by the data collected.

It is expected that, with the next analyzes carried out, the influence of water renewal and its interactions with productivity and egg quality under thermal stress will be checked in greater depth, as well as water quality, with bacteriological analyses that were carried out.

6. ACKNOWLEDGMENT

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