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Animal welfare evaluation in Bovans White laying hens on floor housing

Evaluación del bienestar animal de gallinas ponedoras Bovans White alojadas en piso

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ABSTRACT

Laying hen welfare has been studied increasingly, some works concluded that the cage housing system provides poor welfare for laying hens. These have a great interest in Mexico because it is the world's leading egg consumer (22.8 kg per capita by year) and the fourth leading producer. The aim of this work was to evaluate laying hen welfare. Fifty 22-weeks-old Bovans White laying hens were housed in the floor, assigning 1200 cm^2 per hen. Behavior, health, production parameters, and egg physical quality were evaluated at 22, 30 and 62 weeks. There was a difference ($P<0.05$) throughout the study in frequency and time of the following behaviors: dust bath, lie down, exploring and foraging. On the other hand, egg physical quality was according to the national regulations. At the end of the study, hens had good physical health and a wide behavior repertory.

Keywords: welfare, behavior, health, egg, housing system.

RESUMEN

El interés por el bienestar de las gallinas ponedoras ha ido en aumento y algunos estudios consideran que el sistema de alojamiento en jaulas proporciona un bienestar deficiente en las gallinas. Este tipo de estudios son de gran interés en México debido a que es el principal consumidor mundial de huevos (22.8 Kg *per cápita* anual) y cuarto productor a nivel internacional. Por lo tanto, el objetivo de la investigación fue realizar un estudio sobre el bienestar de gallinas ponedoras en piso. Para este propósito, 50 gallinas Bovans White fueron alojadas en piso, con espacio de 1,200 cm^2 por ave. Fueron evaluadas a las 22, 30 y 62 semanas de edad su comportamiento, estado de salud, las variables de producción y la calidad física del huevo. Durante el estudio se observaron de manera general diferencias ($P<0.05$) en tiempo y frecuencia de las siguientes conductas: baño de tierra, echarse, explorar y forrajear. Por otra parte, la calidad física del huevo cumplió las normativas al respecto. Al final del estudio las gallinas mostraron un buen estado de salud y un amplio repertorio de conductas.

Palabras clave: bienestar, conducta, salud, huevo y sistema de alojamiento.

INTRODUCTION

In recent years, interest in the welfare of hens has been increasing. The public and activist groups than by scientific evidence have influenced much of current European legislation on the welfare of laying hens more. These groups proposed that the European Union abolish the cage housing system by the enriched cage system (750 cm^2 of surface per bird); where the hens also have perches and nesting material (Bulmer y Gil, 2008). In this regard, in the United States of America it is expected that by the year 2025 more than 90 % of the production of egg for plate will be carried out in cage-free systems (Regmi *et al*., 2018). However, conventional cages are still the main housing system for laying hens in the world, although this system has been for limiting the hens' ability criticized. to express certain behaviors (Khumput *et al*., 2018). On the other hand, poultry farmers believe that the productivity of hens housed on the floor has a higher productive performance (Itza-Otiz *et al*., 2016). In this regard, Camphell *et al*., 2017, reported that hens housed on the floor have a higher expression of behavior.

In Mexico, the world's first consumer per capita and fourth largest producer of egg for dishes (UNA, 2019), the main housing production system is conventional cages, but due to social and cultural situations, other systems also coexist, making it particularly interest to carry out studies in this regard.

Therefore, the objective of this study was to evaluate the variables of egg production, behavior, health status and physical quality; as indicators to determine animal welfare in Bovans White laying hens housed on the floor.

MATERIAL AND METHODS

Experiment location

The study was carried out at the Experimental Center for Poultry Research and Extension (CEIEPAv), of the Faculty of Veterinary Medicine of the National Autonomous University of Mexico, located in Mexico City, at an altitude of 2,250 meters above the level of the sea, and with an annual average temperature of 18 ºC (FMVZ, 2019). A batch of 50, 22-week-old Bovans White laying hens were housed on the floor; one hen for each 1,200 cm^2, and as an additional accessory in its housing nest boxes were placed; they had no hangers. They were provided with a diet that covered recommendations for laying hens of the National Research Council,1994. During the 40 weeks of the study, they were provided with food and water ad libitum, and they had a photoperiod program of 16: 8 hours (light: dark). The temperature and humidity of the house remained at 20 ± 3 ºC and 65 to 70 % relative humidity, respectively. The hens were evaluated at 22, 30 and 62 weeks of age. The Ethics Committee (number DC-2017/1-5) of the Faculty of Veterinary Medicine and Animal Husbandry of the National Autonomous University of Mexico (UNAM) approved this study protocol.

Sample size

The equation described by Dell *et al.,* 2002, was used to compare groups of continuous variables: $n = 1 + 2C\ (s/d)2$. Here C is a constant that depends on the value of selected α and β, where α = 0.05 and 1- β = 0.9; where s is the standard deviation of the variable to study, and d is the magnitude of the difference, which depend on the response variable; in our research, they were the behaviors to be evaluated. To determine the sample size with significant results, the number of subjects at the end of the study must be considered. For this purpose, the following calculation was performed: n (1/1-R), where: n represents the number of subjects without losses and R is the proportion of expected losses (García *et al.,* 2013).

Productive variables

The averages of the productive data of the flock of the following variables were obtained: feed per bird/day, conversion rate, percentage of laying or egg production, mortality, percentage of dirty egg and percentage of broken egg.

Behavior

Video cameras (Samsung HMX-F800 and Cannon VIXIA HF R70) were placed in front of the hens to accustom them to their presence and record their behavior (Martin y Bateson, 1993). A final focal observation range of 400 seconds per hen was selected between 10:00 a.m. and 11:00 a.m. as the designated time interval (Mishra *et al*., 2005). An ethogram was to assign the percentage, frequency and total time of observed behaviors developed, using the CowLog computer program (Haninnen y Pastell, 2009) with the Ubuntu Linux 8.04 operating system to create databases for the behaviors to be observed.

Health condition

To know the health status of the hens, their feathers, legs and combs were evaluated with a modified rating system (Welfare Quality, 2009).

Physical quality of the egg

Weighing of all the eggs obtained from a single day, at 22, 30 and 62 weeks of age of the hens (Ohaus Navigator Digital Scale Model N1D110, (capacity 4,100 g and precision of 0.1 g) was performed; the length and Egg width (digital Vernier), shell thickness, diameter and yolk height. Albumin height (Haugh units) and yolk color were measured (Eggware VI.06, Technical Services and Supplies Inc).

Statistical analysis

The physical quality of the egg was analyzed with the Student's t-test and the behavioral data with the Wilcoxon test (IBM. SPSS Versión 21, 2012). The P value <0.05 indicated the statistical significance. On the other hand, the accumulated percentage was used to

assess the state of health and the averages (tabulated data) of the productive variables of the flock were obtained.

RESULTS

Production variables

The following productive variables (table 1) in the flock were evaluated to detect any deficiency or sanitary problem during the study period. A greater increase in the conversion rate, feed consumption, and percentage of dirty egg was observed at week 62.

Table 1. Production variables of Bovans White laying hens housed on the floor

Productive variable	22 weeks	30 weeks	62 weeks
Accumulated Mortality %	0	0	4
Egg production %	90	100	90
Conversion rate	1.92	1.86	2.03
Food consumption g/bird/day	98	110	122
Dirty egg (%)	5.55	6	8
Cracked egg (%)	0	0	0

Hens' behavior

The most relevant differences between the behaviors were in the first instance in **Frequency** (Table 2). Differences ($P < 0.05$) were observed in the behaviors as Lie, Explore, Forage and Ground bath; the week with the most differences is 62 versus 22 and 30. On the other hand, Ground bath, lie down and stand is greater in week 62, with fewer frequencies in grooming, exploring and foraging behaviors. Likewise, in Time, in the Grooming behavior, differences were observed ($P < 0.05$), between week 30 versus 62. In addition, in the behaviors Feeding, ground bath, Lying, Exploring, Foraging, Standing and pecking the housing, the week that the most differences presented are 62 versus 22 and 30. Feeding and pecking the housing was greater in week 30. Ground bath, lying down and standing occupied a longer time in week 62, with less time in the grooming, exploring and Forage.

With respect to the correlations evaluated, only in the behavior Feeding was a positive correlation (0.91) of interest was observed between week 30 and 62.

Table 2. Frequency (%) and Time (%) of the behaviors expressed in Bovans White laying hens housed on the floor

Behavior	22 weeks	30 weeks	weeks	22-30	22-62	30-62
	Frequency					
Grooming	3.17	3.42	2.38			
Flap	1.29	1.00	1.25			
Feed	2.00	1.53	1.69			
Ground bath	1.00	1.33	7.43		*	
To drink	2.00	1.55	1.71			
Search for food	2.96	1.00	1.33			
Walk	4.78	5.16	3.80			
Aggressive behavior	1.00	0.12	1.00			
Lay down	1.91	1.42	4.45		*	*
Stretch	1.22	1.50	1.00			
To explore	4.03	4.35	2.17		*	*
Forage	2.26	4.74	1.50	*		*
Stop	1.31	1.13	1.69			
Pecking the housing	1.00	3.00				
Soft feather pecking	1.67	2.33				
Scratch	1.83	2.00	1.00			
Fly	2.38	3.60	1.25			
	Time					
Grooming	106.56	137.93	69.44			*
Flap	7.75	6.75	4.75			
Feed	234.97	408.07	364.62	*	*	
Ground bath	13.13	20.25	70.80		*	
To drink	35.17	28.67	63.17			
Search for food	29.79	26.00	18.14			
Walk	51.54	58.13	36.76			
Aggressive behavior		2.50	6.50			
To lean	119.96	215.93	241.69	*	*	
Stretch	10.33	3.33	6.00			
To explore	69.25	44.57	25.50	*	*	
Forage	29.93	60.68	20.83	*		*
Stop	7.07	3.47	9.21			*
Pecking the accommodation	21.75	108.00		*		
Soft feather pecking	12.43	13.00				
Scratch	5.67	4.00	3.50			
Fly	18.83	14.80	6.00			

Observation time: 10:00 a.m. to 11:00 a.m. 400 seconds of observation per hen. * Paired comparisons, differ significantly from each other ($P < 0.05$).

Health condition. In the housing system, the rating of 1 was maintained for both indicators in legs and feathers. On the other hand, in week 62 the comb indicator was with a rating of 2 in 100 % of the hens observed (Table 3).

Table 3. Health status (percentage accumulated) in Bovans White laying hens housed on the floor.

Health condition	22 weeks	30 weeks	62 weeks
Feather (1)	100	100	100
Feather (2)	0	0	0
Feather (3)	0	0	0
Legs (1)	100	100	100
Legs (2)	0	0	0
comb (1)	100	100	0
comb (2)	0	0	100

Physical quality of the egg. The differences between comparisons of the weeks (Table 4) show that only in Shell weight and Yolk height there are no differences between weeks. Week 22 was the one in which the most differences were found with the other weeks, having lower average values in Egg weight, Yolk color and Yolk diameter; this same week it has the highest values in the other variables.

Table 4. Physical quality of egg in Bovans White laying hens housed on the floor

Variables	22 weeks			30 weeks			62 weeks			22-30	22-62	30-62
Egg weight g	51.25	±	3.08	59.43	±	6.00	60.19	±	3.72	*	*	
Albumin Height cm	8.63	±	0.91	7.49	±	1.16	6.88	±	1.23	*	*	*
Haugh Units	94.90	±	5.20	86.27	±	7.38	81.72	±	9.39	*	*	*
Yolk Color DMS	8.34	±	0.94	10.64	±	0.90	10.08	±	0.92	*	*	*
Shell weight g	5.85	±	0.53	5.90	±	0.58	8.03	±	8.69			
Shell thickness mm	0.39	±	0.02	0.37	±	0.03	0.36	±	0.04	*	*	
Yolk diameter cm	3.39	±	0.15	3.93	±	0.16	4.01	±	0.11	*	*	*
Yolk height cm	1.64	±	0.15	1.60	±	0.06	1.64	±	0.08			
Yolk Index	0.48	±	0.04	0.40	±	0.06	0.41	±	0.03	*	*	
Egg length cm	6.05	±	0.18	5.63	±	0.22	5.72	±	0.20	*	*	*
Egg width cm	4.78	±	0.14	4.34	±	0.13	4.41	±	0.12	*	*	*
Shape Index %	79.10	±	2.76	77.12	±	1.98	77.17	±	3.22	*	*	

*Paired comparisons differ significantly from each other (P <0.05). n = 50.
All data are presented by mean ± SD.

DISCUSSION

Productive variables. The results generally complied with the provisions of the Bovans White line product guide by parent company Hendrix Isa, 2019; however, at week 62 feed consumption, conversion rate, and percentage of dirty eggs increased, which coincides with that reported by other authors (Ahammed *et al.,* 2014; Golden y Anderson, 2012; Holt *et al.,* 2011). It is important to highlight the concept of food safety, since the percentage of dirty eggs is a much-punished characteristic for the commercialization of eggs, added to the possible alteration in food safety (FAO, 2007).

Hens' behavior. Defining, prioritizing, and measuring the needs for behavioral expression are crucial in a study with hens. Animals have behavioral needs that are evident for individual maintenance, such as feeding and drinking behaviors (Downing, 2012). During the present work, a large repertoire of behaviors was observed, where they highlighted Searching for Food, which is suggested to be a redirected behavior of Foraging, such as Pecking feather described by Johannson *et al*., 2015; both behaviors and foraging decreased in time towards the end of the study. On the other hand, at the end of the study, the frequency and duration of the ground bath behavior increased significantly in hens; this behavior is very important to keep the hen's plumage in good condition (Campbell *et al.*, 2017).

In relation to the behavior Lying down, this increased remarkably until week 30, which is in accordance with what was reported (Singh *et al*., 2009), since in this week the hens required more food and rest, due to their high egg production rate. Furthermore, it was observed that the behaviors apparently linked at the time, such as Walking and Exploring, declined during the study from week 30. In this regard, the hens probably walk a short distance to reach another space inside the accommodation they change sides to another to escape other hens, or they have a longer walk for comfort as described by Mishra *et al.,* 2005. In the present study, the hens did not have perches in the facilities; however, the motivation to fly did exist.

Health condition. The hens remained in very good physical condition until the end of the study, with a relative deterioration in the comb, and which is in accordance with what was reported by other authors (Weitzenbuger *et al.*, 2006). On the other hand, the good health condition of the legs in the chickens was evident, which is confirmed by what has been described by some authors in relation to the low levels of hyperkeratosis in chickens that do not have access to perches (Navarra y Pinson, 2010).

Physical quality of the egg. The Haugh units that are indicators of the freshness of the egg varied during the study; however, they were found within the established parameters (NMX-FF-127-SCFI-2016), which also agrees with what was described by Farhad y Fariba, 2011 for hens on the floor. On the other hand, the color of the yolk was different between the weeks, which was undoubtedly influenced by the variation of the inclusion levels of pigment, carotenoids or xanthophylls in the diet. In general, the differences observed in the other variables are in accordance with that reported by Roberts *et al*., 2013, which attributes this to the age of the hen. In addition to the discussion, undoubtedly one of the most important factors in the production of egg for plate are the changes in population density, which can affect the patterns of various behaviors in the hen (Botreau *et al.,* 2007).

The population density described in this work was similar to that reported for the barn or shed system (AVMA, 2012), with nest boxes and no hangers.

CONCLUSIONS

The evaluation of the animal welfare of hens on the floor showed a good physical quality of the egg, an expression of a wide repertoire of behaviors and a good state of health. However, it must be considered that at the end of the study, feed consumption, conversion rate and percentage of dirty eggs increased. The results found provide a benchmark for animal welfare in the Bovans White hen housed on the floor

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