Brazilian Journal of Agriculture **v.98, n.2, p. 132 – 140, 2023**
DOI: 10.37856/bja.v98i2.4335

FREEDOM FOR CHICKENS – THE INFLUENCE OF THE SILVOPASTORAL SYSTEM ON POULTRY BEHAVIOR

Nina Publio Camarero[1], Ciro Abbud Righi[1]; Eloá Ruffini Sabadin[2], Iran José Oliveira da Silva[1], José Fernando Machado Menten[1], Hilton Thadeu Zarate Couto[1].

[1] Escola Superior de Agricultura Luiz de Queiroz, Universidade de São Paulo, Piracicaba, São Paulo State, Brazil.
E-mail: ninapcagro@gmail.com; ciro@usp.br; iranoliveira@usp.br; jfmenten@usp.br
[2] UNESP, Universidade Estadual Paulista, Rio Claro, São Paulo State, Brazil. E-mail: eloa.sabadin@unesp.br

ABSTRACT

Egg is a worldwide appreciated cooking ingredient. To meet the consumption demand in a fast growing human population, the process of raising chickens developed over the years to an industrial scale in which birds are kept in stacked cages and unable to develop their behavior. The current demand for animal products raised in more ethical systems places conventional poultry farming as one of the main targets of criticism. On the other hand, it is possible to think about raising these birds in agroforestry systems bringing these birds closer to their habitat of origin. This would allow improvements in birds' life and produce food of greater quality and value. In this work, a Poultry Silvopastoral System (SSP) was developed. The systems of raising chickens in agroforestry environment or confined in barns (cage-free) were comparatively evaluated in terms of birds' behavior in response to the contrasting environment. In this initial trial we observed that birds in SSP spent about 30% of the time scratching, while those in confined space only 13% of the time. In addition, a higher occurrence of behaviors related to the limitations of the environment was observed for hens raised in confinement, such as "non-aggressive pecking", "exploring feathers" and "perching" indicating tedious. The similarities between the agroforestry environment and the chicken's original habitat stimulated a greater occurrence of natural behavior, favoring their well-being. More detailed and long-term researches are need in order to integrate this important animal into especially developed SSPs.

Keywords: Agroforestry, Animal Welfare, Free-range, Poultry, Silvopastoral Systems.

INTRODUCTION

The main theory about the origin of the domestic fowl (*Gallus gallus domesticus* - Linnaeus, 1758) is that these birds lived in the understory of the tropical forests of Southeast Asia

(APPLEBY et al., 2004). Some favorable characteristics to this process were their limited agility, relative independence of their mothers and favorable responses to the presence of humans, in addition to the flexibility in food requirements, as omnivorous foragers (GESSULI, 1999; APPLEBY et al., 2004). After the domestication, it was a leap for these birds to spread around the world and today, they are among the most consumed protein sources in all regions of the planet (OECD-FAO, 2022).

In the period known as the "green revolution" (1960s and 1970s), the industrialization process of poultry farming began, with the aim of increasing the scale of meat and egg production (HELLMEISTER FILHO, 2002; HAVENSTEIN, 2003; BARBOSA, 2004). However, this process generated some losses about the quality of life of the birds. According to Duncan (2004), of the farm animals, chickens and hens are probably the ones that live in the most intense and dense systems, spending their short lives in cramped cages and large confinement sheds.

Although the increase in productivity has enabled greater access to these protein sources for a large part of the population, the current consumer market has questioned the treatment given to animals raised on an industrial scale. There is a growing demand for high quality of poultry products that consider important issues, such as animal welfare and the need for more holistic breeding systems that generate better products, jobs, and income distribution (BERG, 2002; HENG, et al. 2012; RODRIGUEZ-AURREKOETXEA et al., 2016; RIGHI, 2016; TUFARELLI, et al. 2018; DIEP et al, 2018; CAMPBELL, et al. 2020).

The animal welfare can be accessed through environmental improvement and enrichment of breeding places that stimulates the expression of some important behaviors of the species repertoire. The approximation of production animals to environments more like which their ancestors inhabited is a way to favors the expression of natural behavior, and consequently, improve their welfare (WSPA, 2009; FAWC, 2009; BRACKE and HOPSTER, 2005; COSTA et al. al., 2012; DUNCAN, 1998).

Thus, silvopastoral systems (SSP) can be a tool to promote positive states in the physical and mental spheres, while providing greater food diversity to animals (RIGHI, 2016; BROOM, 2017). The presence of trees in the free-range system is advantageous because, in addition to the economic perspective (source of wood and non-wood products), it brings many gains in terms of animal welfare. The forest canopy cover serves as a protective barrier against extreme weather conditions and the vision of predators, and therefore, provides greater security for animals to

DOI: 10.37856/bja.v98i2.4335

frequent the paddocks and express their natural behavioral repertoire (SINGH & COWIESON, 2013; PANERU. & JACOBS, 2021, DAWKINS, et al., 2003; DAL BOSCO, et al., 2014.).

The implementation of silvopastoral systems also promotes the multiple use of land, intensifying the productive system through the association of its components. Thus, the presence of birds favors the fertilization of the system through excreta and the control of weeds and insect pests when they are foraging. At the same time, trees make the environment more pleasant and welcoming for the hens to express the intrinsic behaviors of the species. In this work, we comparatively evaluated the behavioral expressions of the hens raised in SSP and in confinement and present the initial results of our research.

MATERIAL AND METHODS

The silvopastoral system was installed in a conventional rubber plantation (8x2.5m) belonging to the Department of Vegetable Production of the Escola Superior de Agricultura "Luiz de Queiroz", located in the municipality of Piracicaba – Brazil. The hens' walking area was delimited by a 1.5 m high fence and totaled 210 m² (10 $m^2.bird^{-1}$). During the night, the SSP birds took shelter in the suspended chicken coop Model Esalq Nº1(Figure 1), where the hens also laid eggs.

Figure 1. The suspended chicken coop Model Esalq Nº1 with the laying hens in Silvipastoril System. Piracicaba, 2019. Personal collection.

The chicken house has an area of 3 m² with twelve nests and a perch. The number of birds used was based on the dimensions of the existing chicken coop and the recommended standards to guarantee the well-being of the birds inside the shelter (7 birds.m^{-2}), resulting in a batch with 21 birds of the Brown Lite strain (Lohmann). The birds were taken to the silvopastoral system at the 14th week of age where they remained until their 89th week of life. The control treatment birds were reared in a commercial shed with a density of 7 birds.m^{-2} in sawdust bedding.

Bird welfare was assessed according to behavior observations in both systems. For this, an ethogram was prepared based on some ethological studies with laying hens (SALGADO et. al., 2007; BARBOSA, 2004; FERNANDES, 2016). The activities recorded were sitting, eating, drinking, scratching, exploring feathers, comfort movement, dust bathing, non-aggressive pecking, aggressive pecking, object pecking, perching and using a nest. Observations of animal behavior were made over nine days in the morning and afternoon periods for four hours (9 am-10 am, 11 am-12 pm, 1 pm-2 pm and 3 pm-4 pm). The methodology used was scanning or SCAN, which involves photographing the batch of birds every five minutes and counting how many birds were performing a certain behavior (ALTMANN, 1974).

RESULTS AND DISCUSSION

The assessment of animal welfare assumes that the longer the bird performs activities of its natural behavior, there is a higher welfare index (FAWC, 2009; BRACKE and HOPSTER, 2005; COSTA et al., 2012; DUNCAN, 1998). The comparative results can be seen in Figure 2. The data represent the percentage of animals from different breeding systems that performed a certain behavior.

In the SSP, the frequency of the “scratch” behavior represented 30.2% of the total number of observations, while for the birds in the shed, only 12.9%. "Scratch" is one of the main ethological characteristics of the species, as well as rooting for pigs and grazing in the case of cattle (SALLES, 2005; COSTA, 2012; BRACKE and HOPSTER, 2005). According to Romano (2017), even without the presence of any substrate, hens raised in cages try to express such behavior, which indicates the importance of this activity for these animals. Studies indicate that the more time spent in the range area, the greater the stimulus for the expression of this and other important behaviors for these birds (CAMPELL et al. 2016; DIEP et al. ,2018). The greater the intensity, duration, and incidence of this behavior, higher the improvements in terms of animal

welfare (BRACKE and HOPSTER, 2005; COSTA, 2012.) With this, we emphasize that the birds of the SSP had a greater opportunity to express the activity intrinsic to the species, whose impediment generate stress (ROMANO, 2017; SILVA et al., 2006). According to Bracke and Hopster (2005), natural behavior is strengthened if the animal is in an environment with conditions close to its original habitat, resulting in pleasurable experiences and promoting the biological functionality of chickens. The structure of the rubber tree forest resembles the environment where these animals were found in nature. Therefore, the presence of trees in the silvopastoral system is a great attraction for hens to explore the paddocks, as the forest canopy serves as a protection against direct sunlight, rain, strong winds, in addition to making it difficult the vision for predators - such as the birds of prey (SINGH & COWIESON, 2013; PANERU. & JACOBS, 2021, DAWKINS, et al., 2003; DAL BOSCO, et al., 2014.).

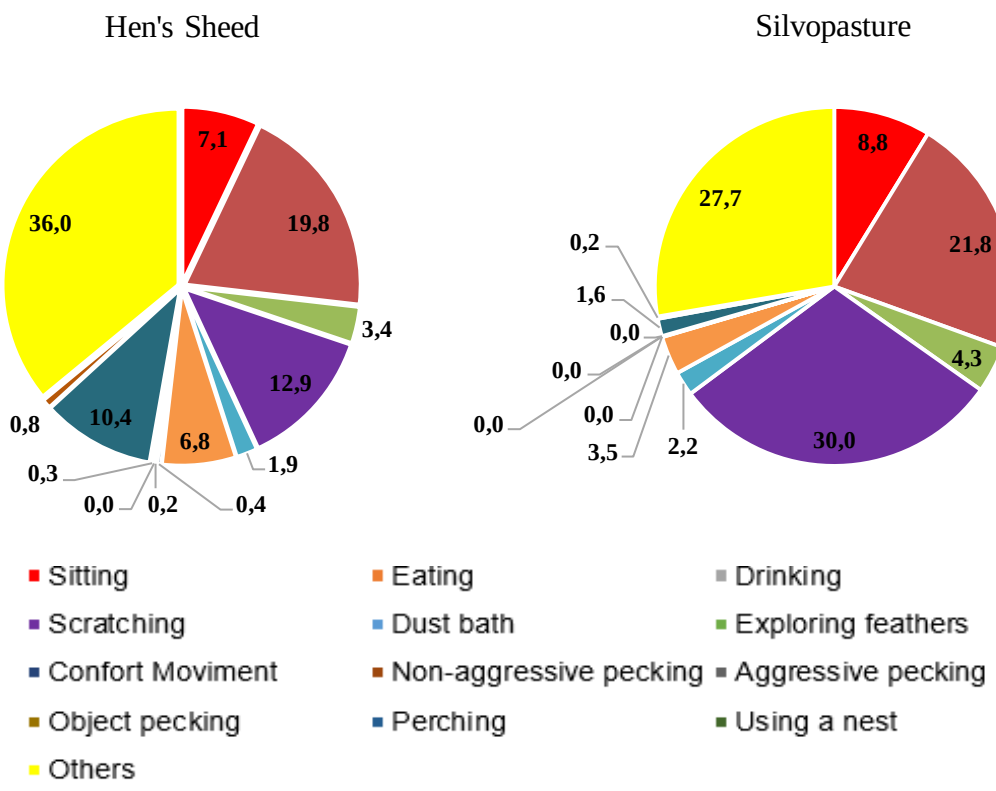

Figure 2. Average frequency of observations (%) of each behavior in the confinement system – Shed (on the left) and in the Silvopastoral System (on the right) using the "Scan" methodology.

In most free-range systems around the world, the absence of the tree component or other type of cover in the range area makes the environment unattractive to the hens. (DAWKINS, et al., 2003; DAL BOSCO, et al., 2014., TAYLOR, et al., 2017). Hegelund et al. (2006) estimates that in these systems with uncovered paddocks, only 7 to 38% (average of 18%) of the flock of layers usually frequent the outdoor area. For broilers, these values can drop to 15% (DAWKINS, 2003).

Among other behaviors we can highlight "Exploring feathers" (3.47% of the time in the SSP x 6.79% in the shed). Although this is a natural behavior for organizing feathers and spreading oil from the uropygial gland, the higher frequency observed in confinement may indicate a lack of opportunity for diversifying activities. Intense exploitation of feathers can also represent a negative symptom reflecting the limitation of "scratching" behavior (HAAS et al., 2010).

Another important aspect that reflects the environmental impoverishment of the treatment in the shed is the frequency of the "perching" behavior of 10.42% of the observations, while in the SSP this occurred only 1.58%. Perching is also a natural behavior that indicates well-being and improves the locomotor ability of hens (COSTA et al., 2012). However, we can infer that its greater occurrence in the shed is due to the sedentary lifestyle of the hens. With less room to move around, the birds spent a lot of time perched on top of the nests. According to Barbosa (2004), the high incidence of "perching" may be related to a worse adaptation to the environment. Campbell et al (2016) evaluated the behavior of hens when using indoor and outdoor spaces and found that most behaviors associated with "rest" of birds were observed in the inner area of the shed and more dynamic behaviors were more frequent in the foraging area. In this present research, while the hens in the shed were perched or exploring the feathers, in the rubber plantation the animals demonstrated a more active and varied repertoire of behaviors.

CONCLUSIONS

In this initial trial we observed that laying hens in the SSP spent more time scratching while those in the shed spent more time perching and exploring for feathers – which could represent a more tedious life and lack of stimulation in the confinement environment. On the other hand, the silvopastoral system proved to be a favorable environment for the expression of

the birds' natural behavior, which brought gains in quality of life and generated more opportunities for pleasurable experiences for the animals.

It is necessary to develop experiments increasing the number of chicken coops and the analysis time to assess the adequacy of the practice to provide greater support to poultry farmers.

There is a vast field of research yet to be explored.

ACKNOWLEDGEMENTS

The authors are grateful to the Higher Education Personnel Improvement Coordination (CAPES/PROEX) for the scholarship given to NPC. They also express their gratitude to the employees of the Forestry Science Department for their constant support, students and personal friends who supported this experiment carried out without direct financial support. A special thanks to all the people who contributed financially to our project through our "Agroforestry Hens" raffle. The authors also thank Leonardo Courtois Vidal and Flávio André Omena Baracho, who sponsored the construction of chicken coops and installation of fences, and technician Donizete Sabino, who was essential for the construction of the structure of the experiment. Sincere thanks to all students and professors who contributed directly and indirectly to the success of our research.

REFERENCES

ALTMANN, J. (1974). Observational study of behavior: sampling methods. **Behaviour**, v. 49, No. 3/4, pp. 227-267. Available at: <https://doi.org/10.1163/156853974X00534>. Accessed on May. 2020.

APPLEBY, M.C.; MENCH, J.A.; HUGHES, B.O. (2004). **Poultry behaviour and welfare**. London, Cabi. 1ª ed. 288p.

BARBOSA FILHO, J. A. D. (2004). **Avaliação do bem-estar de aves poedeiras em diferentes sistemas de produção e condições ambientais, utilizando análise de imagens.** Dissertation ESALQ-USP, Piracicaba. 140 p. Available at: <https://doi.org/10.11606/D.11.2005.tde-11052005-144156>. Accessed on Jun. 2020.

BRACKE, M.B.M.; HOPSTER, H. (2005). Assessing the importance of animal behavior for animal welfare. **Journal of Agricultural and Environmental Ethics.** Wageningen. v.19, p.77–89. Available at: <https://doi.org/10.1007/s10806-005-4493-7>. Accessed on: Apr. 2020.

BERG, C. (2002). Health and Welfare in Organic Poultry Production. **Acta Veterinaria Scandinavica.** v. 95, nº 37, P. 37-45. Skara, Sweden. Available at: <https://doi.org/10.1186/1751-0147-43-S1-S37>. Accessed on: Jan. 2021.

BROOM D.M. (2007). Components of sustainable animal production and the use of silvopastoral systems. **Revista Brasileira de Zootecnia.** Cambridge, U.K. v. 46, nº 8, 683-688 p. Availble at: <https://doi.org/10.1590/S1806-92902017000800009>. Accessed on: Jun. 2020.

CAMPBELL, D. L. M.; HINCH, G. N.; DOWNING, J. A.; LEE, C. (2016). Outdoor stocking density in free-range laying hens: effects on behaviour and welfare. **Animal**, NSW, Australia. v. 11, nº 6, 1036-1045 p. Available at: <https://doi.org/10.1017/S1751731116002342>. Accessed on: Mar. 2021.

CAMPBELL, D. L. M.; DYALL, T. R.; DOWNING, J. A.; COHEN-BARNHOUSE, A. M.; LEE, C. (2020). Rearing Enrichments Affected Ranging Behavior in Free-Range Laying Hens. **Frontiers in Veterinary Science.** NSW, Australia. v. 14. Nº 7. 446-456 p. Available at: <https://doi.org/10.3389/fvets.2020.00446>. Accessed on: Feb. 2021.

COELHO, A.A.; SAVINO, V.J.; ROSÁRIO, M.F. (2008). **Frango Feliz.** Piracicaba: FEALQ, p. 88.

COSTA, L. S.; PEREIRA, D.F., BUENO, L.G.F. (2012). Some aspects of chicken behaviour and welfare. **Brazilian Journal of Poultry Science.** UNESP, Campus de Tupã-SP. v.14, n.3, p. 159-232. Availble at: <https://doi.org/10.1590/S1516-635X2012000300001>. Accessed on: Aug. 2021.

DAL BOSCO, A., MUGNAI, C. ROSATI, A., PAOLETTI, A., CAPORALI, S., CASTELLINI, C. (2014). Effect of range enrichment on performance, behavior, and forage intake of free-range chickens. **Journal of Applied Poultry Research.** Perugia, Italia. V. 23, nº. 2, p. 137 – 145. Available at: <https://doi.org/10.3382/japr.2013-00814>. Accessed on: Jul. 2020.

DAWKINS, M. S., COOK, P., WHITHINGHAN, M. J., MANSELL, K. A. & HARPER, A. (2003). What makes free-range broiler chickens range? In situ measurement of habitat preference. **Animal Behaviour.** Oxford, U.K. V. 66, nº 1. p. 151 – 160. Available at: < https://doi.org/10.1006/anbe.2003.2172>. Accessed on: Jun. 2020.

DAWKINS, M.S. (2003). Behaviour as a tool in the assessment of animal welfare. **Zoology**, Oxford, U.K. V.106, n. 4, p. 383-387. Available at: < https://doi.org/10.1078/0944-2006-00122>. Accessed on: May. 2020.

DIEP, A. T.; LARSEN, H.; RAULT, J. L. (2018). Behavioural repertoire of free-range laying hens indoorsand outdoors, and in relation to distance from the shed. **Australian Veterinary Journal**. Victoria, Australia. v. 96, n. 4, p. 127-131. Available at: <https://doi.org/10.1111/avj.12684>. Accessed on: Jun. 2021.

DUNCAN, I.J. (1998). Behaviour and behavioral needs. **Poultry Science.** Ontario, Canada. V. 77, n. 12, p. 1766-1772. Available at: <https://doi.org/10.1093/ps/77.12.1766>. Accessed on: Jul. 2021.

DUNCAN, I. J. (2004). Welfare problems of Poultry. In: BERSON, J. e ROLLING, B. E. **The Well-Being of Farm Animals: Challenges and Solutions.** Illinois, Urbana. Blackwell Publishing. 378 p.

FAWC (2009). **Farm animal welfare in Great Britain: Past, present and future.** London. Available<https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/319292/Farm_Animal_Welfare_in_Great_Britain__Past__Present_and_Future.pdf>. Accessed Jun. 10, 2019.

FERNANDES, D.P.B. (2016). **Enriquecimento ambiental para gaiolas convencionais de poedeiras em função de diferentes densidades de alojamento.** p.142. Dissertation - ESALQ/USP, Piracicaba. Available at:

<http://www.teses.usp.br/teses/disponiveis/11/11152/tde-15082016-095653/>. Accessed at Set. 2021.

GESSULLI, O.P. (1999). **Avicultura Alternativa "Caipira"**. Porto Feliz-SP. OPG ed. 217 p.

HAAS, E.N.; NIELSEN, B. L.; RODENBURG, B. (2010). Selection on feather pecking affects response to novelty and foraging behaviour in laying hens. **Applied Animal Behaviour Science**. Wageningen, The Netherland. v.124. n. 3–4, p. 90-96. Available at: < https://doi.org/10.1016/j.applanim.2010.02.009>. Accessed on: Nov. 2021.

HAVENSTEIN, G.B., FERKET, P.R.; QURESHI, M.A. (2003). Growth, Livability, and Feed Conversion of 1957 Versus 2001 Broilers When Fed Representative 1957 and 2001 Broiler Diets. **Poultry Science**. North Carolina. V. 82, n. 10, p. 1500 – 1508. Available at: < https://doi.org/10.1093/ps/82.10.1500>. Accessed on: Dec. 2021.

HEGELUND, L..; SøRENSEN, J. T.; HERMANSEN, J.E. (2006). Welfare and productivity of laying hens in commercial organic egg production systems in Denmark. **NJAS: Wageningen Journal of Life Sciences**. Tjele, Denmark. V. 54, n. 2, p. 147-155. Denmark. Available at: https://doi.org/10.1016/S1573-5214(06)80018-7>. Accessed on: Jan. 2020.

HELLMEISTER FILHO, P. (2002). **Efeitos de fatores genéticos e do sistema de criação sobre o desempenho e o rendimento de carcaça de frangos tipo caipira.** 2002. 77f. Doctoral thesis – E.S.A. "Luiz de Queiroz", Piracicaba. Available at: < https://doi.org/10.11606/T.11.2003.tde-12022003-142456. > Accessed on: May. 2020.

HENG, Y.; PETERSON, H. H.; LI, X. (2012). Consumers Preferences for Shell Eggs Regarding Laying Hen Welfare 2012 Annual Meeting, **Agricultural and Applied Economics Association.** Seattle, Washington V. 38, n. 124592, 418-434 p. Available at: < 10.22004/ag.econ.124592>. Accessed on: Mar. 2020.

OECD/FAO (2022), OECD-FAO Agricultural Outlook 2022-2031, **OECD Publishing**, Paris. Available at: < https://doi.org/10.1787/f1b0b29c-en. >. Accessed on: July 2022.

PANERU, B. & JACOBS, L. (2021). Silvopasture-based poultry production. **Poultry Extension Collaborative Newsletter.** Virginia and Georgia. v. 13. P. 1-5. Available at: < https://en.engormix.com/poultry-industry/poultry-nutrition-other-additives/silvopasture-based-poultry-production_a48987/>. Accessed on: May. 2022.

RIGHI, C.A. (2016). **Galinhas agroflorestais: mudando o modo de se fazer.** X. Congresso Brasileiro de Sistemas Agroflorestais: aprendizados, desafios, perspectivas. Cuiabá-MT. 1p.

RODRIGUEZ-AURREOETXEA, A.; ESTEVEZ, I. (2016). Use of space and its Impact on the welfare of laying hens in a commercial free-range system. **Poultry Science.** Vitoria-Gasteiz, Spain. v. 95, n. 11, p. 2503-2513. Available at: <https://doi.org/10.3382/ps/pew238.> Accessed on: Apr. 2022.

ROMANO, G.G. (2011). **Ambiência, bem-estar e microbiota intestinal de aves poedeiras no sistema free-range livre de antibióticos.** 163 f. Doctoral thesis – E.S.A. "Luiz de Queiroz", Piracicaba. Available at: < https://doi.org/10.11606/T.11.2017.tde-25082017-093435 >. Accessed on: May. 2021.

SALGADO, D.D.; NAAS, I. A.; PEREIRA, D. F.; MOURA, D. J. (2006) Modelos estatísticos indicadores de comportamentos associados ao bem-estar térmico para matrizes pesadas. **Engenharia Agrícola** Jaboticabal, SP. V. 27 n. 3. p.619-629. Available at: < https://doi.org/10.1590/S0100-69162007000400004>. Accessed on: Mar. 2021.

SILVA, I.J.O.; SILVA, K.O. (2008) Impactos do Bem-Estar na produção de ovos**. VI Congresso de Produção e Comercialização e Consumo de Ovos**. Indaiatuba-SP. Available at: <

https://www.nupea.esalq.usp.br/admin/modSite/arquivos/imagens/b05d4e889b262efdc020182a8ee65f32.pdf>. Accessed on: Jun. 2020.

SINGH, M. & COWIESON, A. J. (2013). Range use and pasture consumption in free-range poultry production. **Animal Production Science.** NSW, Australia. V. 53, n. 11. p. 1202-1208. Available at: <https://doi.org/10.1071/AN13199. > Accessed on: May. 2021.

TAYLOR, P. S.; HEMSWORTH, P. H., GROVES, P. J. (2017). Ranging Behaviour of Commercial Free-Range Broiler Chickens 1: Factors Related to Flock Variability. **Animals**, Melbourne, Australia. V. 54, n. 7, p. 53-63. Available at: < https://doi.org/10.3390/ani7070054>. Accessed on: Jan. 2021.

TUFARELLI, V.; RAGNI, M. & LAUDADIO, V. (2018). Feeding Forage in Poultry: A Promising Alternative for the Future of Production Systems. **Agriculture.** Bari, Italy. v. 81. N. 8, p. 1-8. Available at: <https://doi.org/10.3390/agriculture8060081.> . Accessed on: Jun. 2020.

Received in: Aug, 28, 2023.
Accepted in: Sep, 27, 2023.