

Abanico Veterinario. January-December 2020; 10:1-10. <http://dx.doi.org/10.21929/abavet2020.28>
Original Article. Received: 18/05/2020. Accepted: 20/08/2020. Published: 26/10/2020. Code:2020-36.

Contribution to animal welfare of dairy calves: housing in pairs

Contribución al bienestar animal en la crianza de becerras de reemplazo: alojamiento en pareja

Alejos-de la Fuente Isidro¹ ID, Almaráz-Buendía Isaac² ID, Peralta-Ortiz Jesús² ID, Meza-Nieto Martín² ID, Torres-Cardona Guadalupe^{*2} ID

¹Universidad Autónoma Chapingo, Departamento de Zootecnia, km 38.5 carr. México - Texcoco, CP 56230, Chapingo, Texcoco, Estado de México, México. ²Universidad Autónoma del Estado de Hidalgo, Instituto de Ciencias Agropecuarias, Área Académica de Medicina Veterinaria y Zootecnia, Tulancingo, Hidalgo, CP 43600. *Author for correspondence: María Guadalupe Torres Cardona: maria_torres7599@uaeh.edu.mx, Rancho Universitario Ex-Hda. de Aquetzalpa, Av. Universidad km 1, Hidalgo, México A.P. 32 CP.43600. 017717172000 ext. 2455. jalejosd@chapingo.mx; isaac_almaraz9974@uaeh.edu.mx; peralta@uaeh.edu.mx; martin_meza3292@uaeh.edu.mx; maria_torres7599@uaeh.edu.mx

ABSTRACT

To evaluate the productive and behavioral response of pair-housed nursing Holstein calves, 30 calves from one week of age until weaning (8 weeks of age) were used and randomly distributed in two treatments: treatment 1 pair-housed calf (T1, n=10); treatment 2 single-housed calves (T2, n=10). No significant difference ($p>0.05$) was found between treatments in initial weight (IW, T1=38.18 vs. T2=39.58, evidencing homogeneous groups) and total dry matter consumption (TDMC, T1=56.84 vs. T2=56.85, kg). However, calves housed in pairs (T1) showed significantly better results in final weight (FW, T1=75.28 vs. T2=65.74, kg), total weight gain TWG, T1=37.10 vs. T2=26.16, kg), daily weight gain (DWG, T1=0.66 vs. T2=0.46, kg) and feed conversion (FC, T1=1.53 vs. T2=2.17), compared to individually housed calves. It concluded that paired calves showed greater productive response and lower frequency of stress-indicative behaviors compared with individually housed calves.

Keywords: animal welfare, housing, productivity, behavior, Holstein calves.

RESUMEN

Con el objetivo de evaluar la respuesta productiva y conductual de becerras Holstein lactantes alojadas en pareja, se utilizaron 30 becerras de una semana de edad hasta el destete (8 semanas de edad) y distribuidas aleatoriamente en dos tratamientos: tratamiento 1 becerras alojadas en parejas (T1, n=10); tratamiento 2 becerras alojadas individualmente (T2, n=10). No se encontró diferencia significativa ($p>0.05$) entre tratamientos en el peso inicial (PI, T1=38.18 vs T2=39.58, lo que evidencia grupos homogéneos) ni en el consumo total de materia seca (CTMS, T1=56.84 vs T2=56.85, kg). Sin embargo, las becerras alojadas en pareja (T1) mostraron significativamente mejores resultados en el peso final (PF, T1=75.28 vs T2=65.74, kg), en la ganancia total de peso GTP, T1=37.10 vs T2=26.16, kg), en la ganancia diaria de peso (GDP, T1=0.66 vs T2=0.46, kg) y en la conversión alimenticia (CA, T1=1.53 vs T2=2.17), respecto a las becerras que se alojaron de manera individual. Se concluye que las becerras que estuvieron alojadas en parejas mostraron mayor respuesta productiva y menor frecuencia de conductas indicadoras de estrés en comparación con las que estuvieron alojadas de manera individual.

Palabras clave: bienestar animal, alojamiento, productividad, comportamiento, becerras Holstein.

INTRODUCTION

Animal welfare refers to the internal state of an animal when it faces the environment that surrounds it, so it includes its state of health, its perception of the environment and its mental states ([Greiveldinger, 2007](#)). It has been defined as the state in which the animal has its basic physiological, health and behavioral needs satisfied, in the face of changes in its environment ([Broom, 1986](#)). For this reason, it is increasingly perceived as an integral element of the global quality of food, with important implications for animal health and food safety, among others.

However, the foregoing, intensive production systems have been designed to obtain increasingly higher productions at lower and lower costs, adopting in many occasions inappropriate management that causes acute or chronic stress, leaving aside the behavioral needs of the animals, with what compromises your well-being; calf raising does not escape this situation. Currently, in most dairy production units, the newborn calf is raised under a scheme that includes various situations that generate stress, one of the most common is to house them in pens or individual cages as a sanitary control measure, to avoid excessive sucking and feeding behaviors; although most of the time the cages are so small that they restrict and even suppress individual and social behavior patterns, not allowing the animal to turn around or preen the back of the body, among others ([Flower and Weary, 2003](#); Galindo and Orihuela , 2004). The isolation of calves has several adverse effects on their well-being: it increases the frequency of vocalization and the presentation of abnormal behaviors, also increasing the physiological response to stress (heart rate and plasma cortisol levels), thereby affecting the use of nutrients, and consequently, the productivity of the animals. It can also impede the learning of essential social skills necessary to cope with the group environment that all dairy cattle are subjected to later in their adult life ([Duve and Jansen, 2011](#); [Horvat and Miller-Cushon, 2019](#)).

In a previous study, housing in pairs in lactation stage, resulted in more relaxed animals, but the evidence of improvement in productive indicators was not conclusive ([Chua et al., 2002](#)). One of the main objectives of the science of animal welfare is to offer management strategies that reduce animal suffering, thus increasing their welfare state.

Therefore, the objective of this research was to evaluate the productive and behavioral response of lactating Holstein calves housed in pairs, compared to calves housed individually.

MATERIAL AND METHODS

Location

This research was carried out in the facilities of the University Ranch of the Institute of Agricultural Sciences (ICAP) of the Autonomous University of Hidalgo State, located in the municipality of Tulancingo de Bravo, Hidalgo, Mexico. The climate of Tulancingo de Bravo is temperate-cold, with an average annual temperature of 14 °C and a rainfall that ranges between 500 and 553 mm per year and is located at 2,580 m.a.s.l. (García, 2017). Tulancingo is a fertile valley whose dairy basin produces approximately 40,000 L of milk per day, contributing a significant amount to the total state production, thus contributing to Hidalgo state occupying 10th place in the national production of cow's milk (SIAP, 2018).

Experimental animals and management

30 one-week-old Holstein calves were used. Prior to the experiment from day 0 to 7 post-birth, all the calves received the same management, which consisted mainly of separating them from their mother and housing them in an individual pen where they were offered two 2 L colostrum intakes, each with a 6 h interval during the first day of birth; From day 2 after birth, they were fed 4 L of milk daily, two in the morning and two in the afternoon (without rejection), and from the first week of age they were offered commercial starter concentrate and free access water.

Treatments

The animals were housed for 8 weeks of the test in two treatments:

- a) *Treatment 1*: calves housed in pairs. At one week of age, 20 calves were housed in pairs, using 10 pens of 2.40 x 1.25 meters, designed with an outdoor area and another covered area, having ten experimental units.
- b) *Treatment 2*: calves housed individually. At one week of age, 10 calves were housed individually in pens of 1.20 meters x 1.25 meters, designed with an outdoor area and another covered area, having ten experimental units.

Los animales fueron alojados durante 8 semanas de duración de la prueba en dos tratamientos:

Variables of response

a) *Productives*:

- I) **Initial weight (IW), Final weight (FW), Daily weight gain (DWG) and Total weight gain (TWG)**. The calves were weighed at the beginning of the experiment and every 15 days thereafter. The IW of the calves was considered as a covariate to confirm the homogeneity between treatments in said variable and to obtain the FW, DWG and TWG.

- II) **Total dry matter consumption (TDMC).** The starter concentrate was offered free access, and consumption was obtained by difference between what was offered and what was rejected daily. To obtain the dry matter content of the starter concentrate and the milk, a forced air oven was used until the samples reached a constant weight.
- III) **Feed conversion (FC).** To calculate the amount of feed needed to increase one kg of live weight in each calf, the amount of kilograms of dry matter consumed (TDMC) was divided by the total weight gain (TWG).

b) Behavioral:

Two days a week the behavior catalog of each calf was recorded, observing them for three hours each day for eight weeks; A sweep sampling was used in combination with a recording at five-minute intervals for the states, and a behavioral sampling for the events (Martin, 2007); obtaining a total of 576 sweeps for each calf during the experiment.

The behavioral variables considered in the behavioral catalog were:

- States: standing, lying down, walking, running, eating, drinking and licking.
- Events: vocalizing, urinating and defecating.

The final percentage of sweeps recorded in each behavior was calculated for the states, and the frequency for the events.

Statistical analysis

A completely randomized experimental design was used; behavioral variables were analyzed using a completely randomized model in repeated measures; while the productive variables were analyzed using a completely random model; in both using the PROC GLM procedure of SAS (SAS, 2009).

RESULTS AND DISCUSSION

Table 1 shows the means of the productive variables by treatment, finding no significant difference ($p > 0.05$) in the IW (T1 = 38.18 vs T2 = 39.58, kg), thereby confirming the homogeneity of the experimental units between treatments with respect to this variable. The type of accommodation did not significantly modify ($p > 0.05$) the total dry matter consumption; this variable being statistically the same in both treatments (T1 = 56.84 vs T2 = 56.85, kg). However, the type of housing significantly modified ($p < 0.05$) the final weight, finding an increase of 14.52 % in calves that were housed in pairs, with respect to those housed individually (FW = T1: 75.288 vs T2: 65.747 kg). The variables total weight gain and daily weight gain were also modified by the effect of the type of housing, with increases of 41.81% and 43.04%, respectively, in calves housed in pairs (TWG = T1:

37.108 vs T2: 26.167, kg ; DWG = T1: 0.6683 vs T2: 0.4672, kg). Regarding feed conversion, significantly lower values ($p < 0.05$) were obtained in 41.83% in the calves housed in pairs (T1 = 1.53 vs T2 = 2.17), which means that this group of animals used significantly less feed to achieve a kilogram of body weight gain, compared to calves that were housed individually.

The results of this research agree with what was found in other studies, where it is reported that calves housed in the company of another or other individuals of the same age, establish strong social ties with their companions, which allows them to better face different situations of stress; which results in a lower biological cost when facing these stressful situations, showing a greater productive response and a wide range of behaviors (Christensen *et al.*, 2002; Chua *et al.*, 2002; Tapki, 2007; Duve and Jansen, 2011; Jansen and Larsen, 2014). It has also been found that calves housed in groups of 10 or less have better growth rates and lower morbidity rates associated with bovine respiratory disease, and with better levels of welfare (Nabais, 2011; Jansen and Larsen, 2014).

Table 1. Productive variables in lactating Holstein calves housed in pairs (T1) or individually (T2)

VARIABLE	Types of accommodation		Probability	C. V.
	In pairs T1	Individual T2		
Initial weight (IW, kg)	38.18	39.58	0.4946	8.79
Final weight (FW, kg)	75.288	65.747	0.0153	7.95
Total weight gain (TWG, kg)	37.108	26.167	0.0153	20.46
Daily weight gain (DWG, kg)	0.6683	0.4672	0.0417	24.03
Total dry matter consumption (TDMC, kg)	56.84	56.85	0.9987	11.87
Feed conversion (FC)	1.53	2.17	0.0483	18.31

T: treatment 1: housed in pairs; T2: treatment 2: housed individually, C. V.: coefficient of variation

Table 2 shows the means of the behavioral variables by treatment; It was found that the type of accommodation significantly modified ($p < 0.05$) the percentage of time that the calves devoted to expressing the behaviors "standing", "walking", "drinking" and "vocalizing", finding that the calves that stayed in couples spent 16.26% less time standing (T1 = 26.57 vs T2 = 31.73), 24.77% less time walking (T1 = 2.52 vs T2 = 3.35), 23.52%

less time drinking (T1 = 5.17 vs T2 = 6.76) and they vocalized 41.16% minus (T1 = 2.83 vs T2 = 4.81); compared to calves that were housed individually. During the experiment, the presence of diseases or abnormal behaviors was not observed in the animals of both treatments. The behavioral results of this research suggest that partner accommodation decreases the expression of stress-related behaviors, such as vocalizations. In this regard, [De-Paula et al., \(2012\)](#) indicate that under natural conditions, calves interact with other animals of the same age, so that individual housing limits or disappears this necessary interaction.

Table 2. Means of different behavioral expressions in lactating Holstein calves housed in pairs (T1) or individually (T2)

BEHAVIOR	Types of accommodation		Probability	C. V.
	In pairs T1	Individual T2		
States (time ratio, expressed as a percentage of scans)				
Standing	26.57	31.73	0.0280	5.2
Lying	43.33	45.18	0.5152	3.6
Walking	2.52	3.35	0.0464	8.7
Drinking	5.17	6.76	0.0020	4.2
Eating	5.48	4.07	0.1547	5.1
Licking	6.58	7.25	0.4438	2.2
Events (frequencies)				
Vocalizing	2.83	4.81	0.0291	3.6
Urinating	2.08	2.98	0.7515	3.1
Defecating	0.68	0.58	0.3958	2.2

T1: treatment 1: housed in pairs; T2: treatment 2: housed individually, C. V.: coefficient of variation

Calf housing methods have an important impact on the health and potential of the animal in its future production ([Quigley, 2001](#)). Individual housing is believed to help control disease, abnormal sucking behavior, and food consumption. While it has been proposed that individual housing simplifies disease detection and general management of calves, the practice has been highly criticized for the fact that it limits the degree to which the calf can behave naturally ([Nabais, 2011](#); [Jansen and Larsen, 2014](#)).

Social isolation is stressful for calves and can impede the learning of essential social skills necessary to cope with the group environment to which all dairy cows are subjected in their adult life ([Morisse et al., 2000](#); [Quigley, 2001](#); [Horvat and Miller-Cushon, 2019](#)). Individually housed calves show behavioral alterations, such as standing for long periods, walking more insecurely, are reluctant to change posture, and as they grow up they develop stereotypies motivated by lack of social activity.

Isolation at pre-weaning could also affect adaptation to group housing after weaning, especially with animals that had been in groups during the lactation period ([Morisse et al., 2000](#); [Quigley, 2001](#); [Mandel et al., 2016](#)). In contrast, group-housed calves are safer ([Nabais, 2011](#)), and show a greater repertoire of activities typical of the species, including the expression of social behaviors, such as play and learning from their peers ([Duve and Jansen, 2012](#); [Costa et al., 2016](#)). Social interactions can help them cope with stressful situations. Calves housed in groups or pairs are less stressed during handling and transfer and they are quicker to initiate solid feed consumption after weaning, compared to those housed individually; indicating that they are better able to cope with the elimination of liquid feeding ([Cobb et al., 2014](#)).

The small group or couples accommodation system can be considered viable and economical in terms of health, development and behavior ([Lakshman et al., 2009](#); [Krachun and De-Pasillé, 2010](#); [Faerevik et al., 2010](#); [Duve and Jansen, 2011](#)). Even though the quality of housing may not improve nutrition and management when they are poor, it can ruin the effectiveness of an excellent management and feeding program. Herein lies the importance of studying the behavior of calves in relation to housing systems ([Morisse et al., 2000](#); [Costa et al., 2016](#)). This was verified in the present study, where under the same feeding scheme and with similar consumptions of milk and concentrate, the animals housed in pairs showed a calmer behavior and a better repertoire of behaviors typical of the species. This better behavioral performance was reflected in a better feed conversion, probably due to a better use of nutrients. The difference in the best feed conversion represents a greater economic benefit with the use of this system.

A final point of importance for the future of animal production units is the “ethical cost” in production ([Capó, 2005](#)). If the ethical cost is high, it means that the animals are poorly treated and their welfare is low; those production units in which traditional management practices persist in causing unnecessary suffering to animals, will be less competitive in the market. The change has to do, not only with the fact that the animals must present absence of suffering, but also that they must experience pleasure, enjoyment (play behaviors, food of good nutritional/sensory quality, sex and social contact), which is essential to provide complete animal welfare ([Balcombe, 2009](#)).

CONCLUSIONS

Under the conditions in which this research was carried out, in order to compare the housing systems in Holstein calves, the results found suggest that housing in pairs is more appropriate, compared to individual housing, since it increases the productive response and decreases the expression of behavioral patterns, indicators of stress such as vocalizations. Therefore, it is possible to conclude that housing with a partner improves the well-being of the calves.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the support provided to the Teaching Staff Improvement Program (PROMEP / 103.5 / 08/5165) for the realization of this project.

CITED LITERATURE

BALCOMBE J. 2009. Animal pleasure and its moral significance. *Appl Anim Behav Sci*; 118(3-4):208–216. ISSN:0168-1591. <https://doi.org/10.1016/j.applanim.2009.02.012>

BROOM DM. 1986. Effects of group-rearing or partial isolation on later social behavior of calves. *Anim Behav*; 26:1255-1263. ISSN: 0003-3472. [https://doi:10.1016/0003-3472\(78\)90116-1](https://doi:10.1016/0003-3472(78)90116-1)

CAPÓ MM. 2005. Aplicación de la bioética al bienestar y al derecho de los animales. 1ª Edición. Ed. Complutense. España. ISBN: 84-7491-771-9.

CHRISTENSEN JW, Ladewing J, Sondergaard E, Malmkvist J. 2002. Effects of individual versus group stabling on social behavior in domestic stallion. *Appl Anim Behav Sci*; 75(3):233-248. ISSN:0168-1591. [https://doi.org/10.1016/S0168-1591\(01\)00196-4](https://doi.org/10.1016/S0168-1591(01)00196-4)

CHUA B, Coenen JE, Denle V, Weary DM. 2002. Effects of pair versus individual housing on the behavior and performance of dairy calves. *J. Dairy Sci*; 85(2):360-364. ISSN: 0022-0302. [https://doi:10.3168/jds.s0022-0302\(02\)74082-4](https://doi:10.3168/jds.s0022-0302(02)74082-4)

COBB CJ, Obeidat BS, Sellers MD, Pepper-Yowell AR, Hanson DL, Ballou MA. 2014. Improved performance and heightened neutrophil responses during the neonatal and weaning periods among outdoor group-housed Holstein calves. *J. Dairy Sci*; 97(2):930–939. ISSN: 0022-0302. <https://doi:10.3168/jds.2013-6905>

COSTA JHC, Von Keyserlingk MAG, Weary DM. 2016. Invited review: Effects of group housing of dairy calves on behavior, cognition, performance, and health. *J. Dairy Sci*; 99(4):2453-2467. ISSN: 0022-0302. <https://doi.org/10.3168/jds.2015-10144>

DE-PAULA V, De-Passillé AM, Weary DM. 2012. Effects of the early social environment on behavioral responses of dairy calves to novel events. *J. Dairy Sci*; 95:5149–5155. ISSN: 0022-0302. <https://doi.org/10.3168/jds.2011-5073>

DUVE OR, Jansen MB. 2011. The level of social contact affects social behavior in pre-weaned dairy calves. *Appl Anim Behav Sci*; 135:34-43. ISSN:0168-1591. <https://doi.org/10.1016/j.applanim.2011.08.014>

DUVE LR, Jensen MB. 2012. Social behavior of young dairy calves housed with limited or full social contact with a peer. *J. Dairy Sci*; 95:5936–5945. ISSN: 0022-0302. <https://doi.org/10.3168/jds.2012-5428>

FAEREVERIK G, Jensen MB, Boe KE. 2010. The effect of group composition and age on social behavior and competition in groups of weaned dairy calves. *J. Dairy Sci*; 93:4274–4279. ISSN: 0022-0302. <https://doi.org/10.3168/jds.2010-3147>

FLOWER FC, Weary DM. 2003. The effects of early separation on the dairy cow and calf. *Anim. Welfare*;12:339–348. ISSN:0962-7286. <https://www.ingentaconnect.com/content/ufaw/aw/2003/00000012/00000003/art00004>

GALINDO MFA, Orihuela TA. 2004. Etología Aplicada. 1ª. Edición. México. Universidad Nacional Autónoma de México. México. ISBN: 970-32-1471-1

GARCÍA Enriqueta. 2017. Modificaciones al Sistema de Clasificación Climática de Köppen. 5ª Edición. Serie Libros UNAM. México. ISBN-10 (02): 970-32-1010-4

GREIVELDINGER I. 2007. Emotional experience in sheep: Predictability of a sudden event lowers subsequent emotional responses. *J of Physiology and Behaviour*; 92:675-683. ISSN 0031-9384. <https://doi.org/10.1016/j.physbeh.2007.05.012>

HORVATH, K. C., & Miller-Cushon, E. K. (2019). Evaluating effects of providing hay on behavioral development and performance of group-housed dairy calves. *J. Dairy Sci*; 102(11): 10411-10422 ISSN: 0022-0302. <https://doi.org/10.3168/jds.2019-16533>

JENSEN MB, Larsen LE. 2014. Effects of level of social contact on dairy calf behavior and health. *J. Dairy Sci*; 97(8):5035-44. ISSN: 0022-0302. <https://doi.org/10.3168/jds.2013-7311>

KRACHUN CR, De-Passillé AM. 2010. Play behaviour in dairy calves is reduced by weaning and by a low energy intake. *Appl Anim Behav Sci*; 122(2-4):71-76. ISSN:0168-1591. <https://doi.org/10.1016/j.applanim.2009.12.002>

LAKSHMAN KB, Harnarain P, Ramesh CP, Artabandhu S. 2009. Hemato-biochemical changes, disease incidence and live weight gain in individual versus group reared calves fed on different levels of milk and skim milk. *Anim Sci J*; 80:149–156. ISSN:1740-0929. <https://doi.org/10.1111/j.1740-0929.2008.00620.x>

MANDEL R, Whay HR, Klement E, Nicol CJ. 2016. Invited review: Environmental enrichment of dairy cows and calves in indoor housing. *J. Dairy Sci*; 99 (3):1695-1715. ISSN: 0022-0302. <https://doi.org/10.3168/jds.2015-9875>

MARTIN PMB. 2007. *Measuring behavior: An introductory guide*. 3rd. Edition. Cambridge. Cambridge University Press. ISBN-13: 978-0521535632. ISBN-10: 0521535638.

MORISSE JPD, Huonnic D, Cotte JP, Martrenchar A. 2000. The Effect of Four Brous Feed Supplementations On Different Welfare Traits In Veal Calves. *Anim Feed Sci Tech*; 84:129-136. ISSN: 0377-8401. [https://doi.org/10.1016/S0377-8401\(00\)00112-7](https://doi.org/10.1016/S0377-8401(00)00112-7)

NABAIS UAR. 2011. Medição de proteínas séricas e imunoglobulinas como indicador da transferencia de imunidade passiva em vitelos. Teses de Mestrado. Universidade Técnica de Lisboa, Lisboa.

<https://www.repository.utl.pt/bitstream/10400.5/3569/1/Medi%C3%A7ao%20de%20prote%C3%ADnas%20s%C3%A9ricas%20e%20imunoglobulinas%20como%20indicador%20da%20transferencia%20de%20imunidade%20passiva%20em%20vitelos.pdf>

QUIGLEY J. 2001. Calf Note # 64 –Métodos de alojamiento: influyen en el comportamiento del ternero? Ficha técnica. Recuperado el 29 de enero 2019: <http://www.calfnotes.com>

SAS (Statistical Analysis System). 2009. *User's Guide: Statistics, Version 9.02*. Edition SAS Inst., Inc. Cary. N. C.

SIAP. Servicio de información agroalimentaria y pesquera. 2018. Secretaría de agricultura, ganadería, desarrollo rural, pesca y alimentación. México. <https://www.gob.mx/siap>

TAPKI I. 2007. Effects of individual or combined housing systems on behavioural and growth responses of dairy calves. *Acta Agr Scand A-AN*; 57:55-60. ISSN:0906-4702; E-ISSN:1651-1972. <https://doi.org/10.1080/09064700701464405>