The Animal Welfare of Dairy Cows Housed in Free-Stall Barn According to the Welfare Quality® Protocol: Good Feeding and Good Housing Principles

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Abstract. *The objective of the present study was to evaluate the animal welfare of dairy cows according to good feeding and good housing principles of the Welfare Quality® protocol. The protocol was applied to animals kept confined in a free-stall barn during their lactation. The farm was located in São João Batista do Glória, Minas Gerais state - Brazil. One hundred and one animals were evaluated (47 primiparous and 54 multiparous). The welfare measures were collected mostly through observing the animals and they were processed according to the Welfare Quality® protocol, resulting on welfare criteria, which in turn were used to generate good feeding and good housing principles of animal welfare. Results were analyzed following a completely randomized design, in which animal category (primiparous or multiparous) was the treatment, adopting a 5% level of probability. Good feeding and good housing welfare principles were better for primiparous cows than for multiparous ($P < 0.05$). Therefore, the welfare of primiparous cows was better than the welfare of multiparous animals, indicating that greater care should be taken with animals on this category to ensure their welfare.*

Keywords. *Animal housing, dairy farms, tropical climate, welfare quality.*

Introduction

The release of the book Animal Machine: the new factory farming industry (Harrison 1964) has marked the beginning of animal welfare (AW) concerns. The book had a great impact on public for describing the conditions in which farm animals were kept at that time. As an ultimate result, the five freedoms were published in 1979 and they are still today relevant, since legislations and animal welfare assessment protocols have been created based on them. However, there is not a widely accepted definition of animal welfare (STOA 2009). The difficulty in establishing a precise definition lies in the multidisciplinary characteristics of the AW, which involves several aspects related to animals such as their feeling, mental health, harmony with the environment, and physical aspects (Duncan and Dawkins 1983).

Even though there is no consensually accepted definition of AW, interest about the topic has been increasing among consumers (EUROBAROMETER 2016). As a direct consequence, animal welfare could become a commercial barrier between countries as stated by (Bond et al. 2012). It is, therefore, highly necessary to develop and validate methodologies of AW evaluation. The Welfare Quality® (2009) protocol has been developed to fulfill this task. It evaluates a set of different indicators obtained mostly from animal-based measures, generating a final score-based evaluation of the AW level. This result could then be used by producers in order to make management decisions to improve AW of their animals as well as to inform consumers about AW level that animals were kept at the farm during the production cycle (STOA 2009).

The protocol applied to dairy cows has been created to evaluate the AW of animals kept on intensive housing systems, such as free-stall. The confinement of dairy cows in free-stall barns has been an option aimed at intensifying and increasing milk production in Brazil. However, little is known about the impact of confining animals on this type of barn on their AW under tropical conditions such as the one found in Brazil. Therefore, we aimed at evaluating the AW of dairy cows according the good feeding and good housing AW principles from the Welfare Quality® (2009) protocol.

Materials and methods

The Ethics Committee on the Use of Animals from the Federal University of Jequitinhonha and Mucuri Valleys – "*Universidade Federal dos Vales do Jequitinhonha e Mucuri*" (UFVJM) approved the experimental procedures under the protocol number 006/2013.

The study was carried out between 04/22/2013 and 04/26/2013 in a dairy farm located in São João Batista do Glória, Minas Gerais state, Brazil, at 20º 43' South latitude, 46º 36' West longitude, and 741 meters of altitude. According to Köppen classification, the weather of the region is Aw – Tropical Savanna with dry winter (Reboita et al. 2015).

The Holstein Friesian dairy cows evaluated were housed on a free-stall barn throughout their lactation. The barn was 27.50 meters wide by 70.00 meters long, 12.50 meters high, and with 1.00 eaves. There were 204 sand beds, 102 on each side of the barn. The manure was cleaned from beds and floors three times a day at 0100h, 0900h, and 1700h. It was done when the animals were conducted to the milking parlor. The manure was manually removed from the beds while the floor was washed with recycled water. In addition, hydrated calcium hydroxide was applied to the beds every day (average of 200 grams per bed) and fresh sand was weekly added.

The barn cooling system was composed with two rows of fans installed over the beds and one row over the feedline as well as one row of sprinklers over the feedline. The cooling system was automatically turned on if air temperature reached 19º C inside the barn, and was automatically turned off when the temperature was lower than 18º C. The sprinklers and fans over the feedline were on an interchangeable cycle: each 1 minute of sprinkling was followed by 5 minutes of

ventilation.

The animal welfare was assessed using the Welfare Quality® (2009) developed for dairy cows. The protocol uses a bottom-up approach organized in animal welfare measures, criteria, principles, and overall assessment. The data were obtained through *in loco* observations and from the management system of the farm. In order to minimize subjective bias, the same person measured all of the observational data.

The number of animals evaluated was determined by the protocol based on the size of the herd. For sampling purposes, the total number of animals in each category was considered to represent a distinct herd. During the experiment, 90 primiparous cows and 120 multiparous cows were housed in the free-stall barn. Then, we daily evaluated 101 animals: 47 primiparous and 54 multiparous. As determined by the protocol, the animals were randomly selected on the feedline. The same animals could or could not be evaluated on different days.

Animal welfare measures collected during the experimental period are shown in Table 1. They were processed as proposed by the protocol in order to obtain good feeding and good housing animal welfare principles as well as all animal welfare criteria within them.

Table1. Principles, criteria, and measures of animal welfare evaluated from the Welfare Quality® protocol (2009).

Animal welfare principle	Animal welfare criteria	Animal welfare measure
Good feeding	Absence of prolonged hunger	Body condition score
	Absence of prolonged thirst	Water provision, cleanliness of water points, water flow, functioning of water points
Good housing	Comfort around resting	Time needed to lie down, animals colliding with housing equipment during lying down, animals lying partly or completely outside the lying area, cleanliness of udders, cleanliness of flank/upper legs, cleanliness of lower legs.
	Thermal comfort	Not yet developed
	Ease of movement	Presence of tethering, access to outdoor loafing area or pasture

Statistical analyzes were conducted following a completely randomized design with two treatments (animal category) and five repetitions (days of evaluation). Animal welfare measures and criteria were submitted to analysis of variance using the GLM procedure of SAS (SAS Inst. Inc., Cary, NC, USA, version 9.2, 2008) at 5% of significance or lower.

Results

The scores of animal welfare principles, criteria, and measures obtained during the experimental period are shown in Table 2 and 3. Animal welfare criteria absence of prolonged hunger and comfort around resting as well as good feeding and good housing principles differed ($P < 0.05$) between animal category and were higher in the primiparous group, indicating better animal welfare conditions of this animal category.

Table 2. Animal welfare principles, criteria, and measures scores of primiparous and multiparous dairy cows observed during the experimental period.

Animal welfare principles and criteria	Primiparous		Multiparous		*P*
	Mean	SD[1]	Mean	SD[1]	
I Principle: Good feeding	60.2[a]	17.52	22.8[b]	2.88	< 0.01
Criterion: Absence of prolonged hunger	45.6[a]	23.97	9.0[b]	3.93	< 0.01
Measure: Very lean cows (%)[3]	15.2[b]	11.62	59.4[a]	14.63	< 0.01
Criterion: Absence of prolonged thirst[2]	100.0	-	60.0	-	-
II Principle: Good housing	76.8[a]	6.39	68.7[b]	3.01	0.03
Criterion: Comfort around resting	63.1[a]	10.10	50.3[b]	4.76	0.03
Measure: Time needed to lie down (seconds)	4.6	0.63	4.7	0.55	0.78
Measure: Collisions with housing equipment during lying down (%)[3]	6.2	8.52	12.5	8.17	0.26
Measure: Cows with dirty lower legs (%)[3]	82.8	30.65	92.3	9.04	0.52
Measure: Cows with dirty udder (%)[3]	22.0	26.09	46.1	22.24	0.16
Measure: Cows with dirty hindquarters (%)[3]	36.7	28.07	47.9	19.06	0.48
Criterion: Ease of movement[2]	100.0	-	100.0	-	-
Criterion: Thermal comfort	100.0	-	100.0	-	-

[1] SD = standard deviation.
[2] Not statistically evaluated because the scores did not vary during the time evaluated.
[3] Percentage calculated from 47 primiparous and 54 multiparous dairy cows.
[a,b] Means followed by different letters in line are statistically different according to the F test at 5% probability.

Table 3. Animal welfare measures not statistically analyzed since they were equal between primiparous and multiparous dairy cows during the experimental period.

Animal welfare measure	Result
Number of functioning drinkers	8
Drinker length (cm)	132
Are drinkers clean?	Yes
Is water flow sufficient?[1]	Insufficient
Cows lying partly or completely outside the bed (%)	0.00
Are cows tethered?	No

Discussion

The score for absence of prolonged thirst AW criterion was lower for multiparous than primiparous cows and this result could explain the also lower absence of prolonged hunger AW criterion for multiparous than primiparous dairy cows, which in turn resulted on lower good feeding AW principle for multiparous than primiparous (Table 2). These results indicated that multiparous cows were restricted from *ad libitum* water intake during the experimental period. Water intake restriction has a negative consequence on AW and productivity performance of dairy cows. The restriction of water intake is followed by reduction in dry matter intake in lactating cows (Burgos et al. 2001; Ali et al. 2015) and heifers (Utley et al. 1970). Although animals reduce their feed intake in an attempt to adapt to the lack of water and to maintain the osmotic balance of their body fluids (Burgos et al. 2001), the nutritional restriction results in body weight loss (Burgos et al. 2001; Little et al. 1980). Hence, explaining the lower score of absence of prolonged hunger criterion (i.e. the greater percentage of very lean cows) for multiparous than primiparous dairy cows.

Comfort around resting was the only AW criterion used to calculate the good housing AW principle

that differed ($P < 0.05$) between primiparous and multiparous dairy cows (Table 2). Comfort of the beds in a free-stall barn is of great importance to ensure the AW of dairy cows since they expend most of their time laid down. Cows have little to any ability to adapt their lying down movement to the physical conditions of the environment where they are housed, mainly because it is determined by their muscular and skeletal structure, which are limited by their genetics (Österman and Redbo 2001). Consequently, bed dimensions substantially affect the resting time of dairy cows (Haley et al. 2000). Cows expend about 12 to 13 hours per day laid down (Fregonesi et al. 2007a; Jensen et al. 2005) and they prefer to assure the length of their resting period in detriment of the time spend on feed intake and interaction with other cows (Metz 1985; Munksgaard et al. 2005). In addition, dairy cows highly prefer dry beds than wet ones (Fregonesi et al. 2007b) as well as hay and sand bedding material rather than rubber, since they are soft materials (Tucker et al. 2003).

Rail of the beds directly influence the laying down movement of the animals (Cook and Nordlund 2004). Collision with bed rails and other parts of the bed was evaluated in our study through the AW measure of collisions with housing equipment during lying down. However, we did not find statistical difference between groups ($P > 0.05$) on this measure indicating that the beds were appropriate for both animal categories.

Even though we have not found statistical difference between animal categories for body cleanness AW measures ($P > 0.05$), other studies have reported that multiparous dairy cows tend to have legs and udder dirtier than primiparous (DeVries et al. 2012; Reneau et al. 2005). According to Reneau et al. (2005), multiparous cows have deeper and wider udder, increasing its proximity to the floor of the barn, thereby increasing the chance for it to get dirty. In addition, a positive correlation was found between the degree of dirtiness and milk yield, indicating that high and medium yield animals tend to be dirtier than low yield cows (Ellis et al. 2007; DeVries et al. 2012). High-yield dairy cows have high nutritional requirements, leading to a high feed intake and, consequently, a high volume of feces is produced (Ellis et al. 2007; Reneau et al. 2005), which in turn increases the likelihood of these animals to get dirty if the barn is not adequately and frequently cleaned (Magnusson et al. 2008).

Climatic conditions directly affect dairy cows. Under mild temperatures, cows reduce their feed intake and milk production, while increase their water intake (Gorniak et al. 2014). In addition, high temperatures affect the reproductive performance of cows, since animals under heat stress have reduced conception rate (Badinga et al. 1985). Thus, the evaluation of the thermal environment in countries with tropical conditions such as Brazil is of great importance. However, the Welfare Quality® (2009) protocol had not yet established a methodology to evaluate the thermic comfort of dairy cows by the time this study was conducted.

Garcia (2013) has proposed to measure shade provision as a means of evaluating thermal comfort of animals kept on pasture. Since cows were kept in a free-stall barn in our study, we have decided to follow the recommendation proposed by the protocol, which was to attribute to the thermal comfort AW criterion the same score as the highest score between ease of movement and comfort around resting AW criteria (Table 2).

Conclusion

As a conclusion, the animal welfare of primiparous dairy cows is better than multiparous according to good feeding and good housing animal welfare principles from the *Welfare Quality*® protocol.

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