
# The Correlation between Criteria from Welfare Quality® Protocol Applied to Dairy Cows Housed in Free-Stall Barn

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***Abstract.*** *The objective of this study was to evaluate correlations between animal welfare criteria from the Welfare Quality® protocol applied to dairy cows. The protocol was applied on 47 primiparous and 54 multiparous dairy cows housed in a free-stall barn located in São João Batista do Glória, Minas Gerais - Brazil. Twelve welfare criteria were obtained from mostly animal-based welfare measures as proposed by the protocol. Pearson correlation coefficients (r) were calculated between criteria adopting 5% of probability as the significance level. Positive correlations (P < 0.05) were found between absence of prolonged hunger criterion and the criteria absence of prolonged thirst (r = 0.77), comfort around resting (r = 0.84), and absence of diseases (r = 0.70). Absence of prolonged thirst was also positively correlated (P < 0.05) with comfort around resting (r = 0.67) and absence of injuries (r = 0.64). Similarly, a positive correlation (P < 0.05) was found between comfort around resting and expression of social behaviors (r = 0.68). Lastly, a negative correlation (P < 0.05) was found between absence of disease and good human-animal relationship (r = 0.65). Therefore, we conclude that there is significant correlation between certain animal welfare criteria from the Welfare Quality® protocol.*

***Keywords.*** *Animal production, dairy farming, intensive systems, welfare quality protocol.*

## Introduction

The interest for animal welfare (AW) has been increased among consumers. In a recent survey, more than half of the European population has answered to be ready to pay more for animal products produced following AW regulation (EUROBAROMETER 2016), which indicates that AW could be economically relevant if consumers become aware about harmful practices in raising animals (Molento 2005). In addition, the same survey has found that people believe animal products imported from non-European countries must have been produced following the same AW regulation (EUROBAROMETER 2016). Therefore, AW might become a commercial barrier between countries in the near future (Bond et al. 2012; Molento 2005).

In light of popular pressure regarding AW, it is necessary to create methodologies to evaluate AW of farm animals. The Welfare Quality® (2009) protocol is a great tool for that end. It evaluates a set of different indicators obtained mostly from animal-based measures, generating at the end 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 as well as to inform consumers about AW level that animals were kept at the farm during the production cycle (STOA 2009).

The evaluation using the Welfare Quality® (2009) protocol can be seen as time-consuming, which is a major drawback. The protocol for dairy cow has been developed to evaluate AW of animals kept on free-stall or tie-stall barns. About 31 AW measures must be collected, taking approximately 6.6 hours to evaluate a herd with 100 cows (Welfare Quality® 2009). It would be of great importance if some measures and criteria could be removed from the evaluation if they were significant correlated with each other, potentially reducing time required for evaluation. Therefore, the objective of this study was to evaluate linear correlations between AW criteria from the Welfare Quality® (2009) protocol applied to dairy cows.

## 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-meter eaves. There were 204 sand beds, 102 on each side of the barn. Manure was cleaned from beds and floors three times a day at 0100h, 0900h, and 1700h while animals were conducted to the milking parlor. 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 AW was assessed using the Welfare Quality® (2009) developed for dairy cows. The protocol uses a bottom-up approach organized in 31 measures, 12 criteria, 4 principles, and 1 overall assessment of animal welfare. 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.

Once all AW measures had been collected, they were used to generate criterion-scores according to the Welfare Quality® (2009) protocol (Table 1). Data were analyzed in one out of the following three alternatives: decision tree for measures of available resources to animals; I-spline function in addition to warning and alarm thresholds for measures in different scales (e.g. seconds, percentage, or frequency); or I-spline function in addition to weighted sum for measures with different degrees of severity (e.g. moderate and severe lameness).

**Table 1. Criteria and measures of animal welfare evaluated from the Welfare Quality® protocol (2009).**

| Animal welfare criteria | Animal welfare measure |
|---|---|
| Absence of prolonged hunger | Body condition score |
| Absence of prolonged thirst | Water provision, cleanliness of water points, water flow, functioning of water points |
| 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 |
| Absence of injuries | Lameness, integument alterations |
| Absence if disease | Coughing, nasal discharge, ocular discharge, hampered respiration, diarrhoea, vulvar discharge, milk somatic cell count, mortality, dystocia, downer cows |
| Absence of pain induced by management procedures | Disbudding/dehorning, tail docking |
| Expression of social behaviors | Agonistic behaviors |
| Expression of other behaviors | Access to pasture |
| Good human-animal relationship | Avoidance distance |
| Positive emotional state | Qualitative behavior assessment |

Pearson coefficient of linear correlation was calculated between animal welfare criterion-scores using the CORR procedure of SAS (SAS Inst. Inc., Cary, NC, USA, version 9.2, 2008) at 5% of significance or lower.

## Results

Pearson correlation coefficients (r) calculated between animal welfare criteria from the Welfare Quality® (2009) protocol are presented on Table 2. Thermal comfort, ease of movement, absence of pain induce by management procedures, and expression of other behaviors criteria did not vary throughout the experimental period; therefore, no coefficient of correlation was calculated between these criteria and the others.

**Table 2. Pearson coefficients of linear correlation (r) found between animal welfare criteria from the Welfare Quality® (2009) protocol.**

| | APH[a] | APT[b] | CAR[c] | AI[d] | AD[e] | ESB[f] | GHAR[g] | PES[h] |
|---|---|---|---|---|---|---|---|---|
| APH | | 0,77* | 0,84* | 0,45 | 0,70* | 0,53 | -0,36 | 0,43 |
| APT | | | 0,67* | 0,64* | 0,40 | 0,33 | -0,08 | 0,55 |
| CAR | | | | 0,31 | 0,54 | 0,68* | -0,22 | 0,23 |
| AI | | | | | 0,19 | 0,19 | -0,11 | 0,58 |
| AD | | | | | | 0,47 | -0,65* | 0,33 |
| ESB | | | | | | | -0,18 | 0,21 |
| GHAR | | | | | | | | -0,09 |
| PES | | | | | | | | |

[a] Absence of prolonged hunger; [b] Absence of prolonged thirst; [c] Comfort around resting; [d] Absence of injuries; [e] Absence of disease; [f] Expression of social behaviors; [g] Good human-animal relationship; [h] Positive emotional state.
*Statistically significant correlations ($P < 0.05$).

The criteria that showed statistically significant correlations ($P < 0.05$) were strongly correlated ($r > 0.60$). Positive correlation ($P < 0.05$) was observed between the criterion absence of prolonged hunger with the criteria absence of prolonged thirst, comfort around resting, and absence of disease. Absence of prolonged thirsty was also positively correlated ($P < 0.05$) with comfort around resting and absence of injuries criteria. Similarly, a positive correlation ($P < 0.05$) was found between comfort around resting and expression of social behavior. Interestingly, a negative correlation ($P < 0.05$) was found between the criteria absence of disease and good human-animal relationship.

## Discussion

The positive correlation found between absence of prolonged hunger and absence of prolonged thirty ($P < 0.05$) indicates the direct relationship between feed and water intake. Water intake restriction is highly harmful for AW quality as well as animal performance. Reduced dry matter intake has been observed in dairy cows (Ali et al. 2015; Burgos et al. 2001) and heifers (Utley et al. 1970) with restricted water intake. Even though feed intake reduction occurs in an attempt to adapt to water shortage and keep osmotic balance of body fluids (Burgos et al. 2001), the final consequence is body weight loss (Little et al. 1980).

Water intake restriction reduces the total milk yield and reproduction performance. Little et al. (1980) reported 14% reduction on milk yield of British Friesian dairy cows under water intake restriction. Similar results have been found by Ali et al. (2015) and Burgos et al. (2001). In addition, blood urea nitrogen of primiparous and multiparous dairy cows under water intake restriction is high (Utley et al. 1970). Blood urea nitrogen is highly correlated to the concentration of urea in the fluid of reproductive organs (Hammon et al. 2005). In turn, high concentration of ammonium or uretic nitrogen on reproductive fluids could cause embryonic death (Hammon et al. 2005), reducing animal reproductive performance.

The positive correlation ($P < 0.05$) found between comfort around resting, absence of prolonged hunger, and absence of prolonged thirst implies the importance of the bed of a free-stall barn on the welfare of cows housed in it. Bed dimensions substantially affects the lying behavior of dairy cows as well as the length of time spent on this position (Haley et al. 2000). Dairy cows spent on average 12 to 13 hours a day laid down (Fregonesi et al. 2007; Jensen et al. 2005). They prefer to ensure resting time at the expense of feed intake and interaction with other animals (Munksgaard et al. 2005).

Surprisingly, we found a negative correlation ($P < 0.05$) between absence of disease and good human-animal relationship, which is contrary to what have been previously reported in literature. For instance, higher average daily gain in calves (Lürzel et al. 2015), higher milk yield (Peters et

al. 2010; Hemsworth et al. 2002), and lower avoidance distance (Lürzel et al. 2016) have been observed in animals handled gently compared to animals aversively handled. We, therefore, hypothesized that our findings reflect previous experiences of the animals, since most human-animal interactions are considered a negative stimulus such as veterinarian treatment, artificial insemination, and vaccination (Honorato et al. 2012), which may have biased the animals to become more aggressive towards human beings in general (Lewis and Hurnik 1998). The hypothesis of previous experiences have also been raised by Peters et al. (2010) since they observed reduction on milk yield of 60 months old dairy cows after being aversively treated while the same was not observed on 96 months old animals subjected to the same treatment.

## Conclusion or Summary

We concluded that there are significant linear correlations between certain animal welfare criteria from the Welfare Quality® protocol. Future work could focus on adapting the protocol removing highly correlated animal welfare criteria.


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