Welfare Impact of Heel Height on Claws Overgrowing of Mediterranean Italian Buffalo

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Abstract

The objectives of this study were to detect the impact of heel height (HH) on: 1) claws overgrowing (CO), and 2) milk yield (MY) in Mediterranean Italian Buffalo, to improve animal welfare. Data of HH and MY where collected from 740 Mediterranean Italian Buffalo, in five herds, by two evaluators, in the year 2016. CO was reported for each animal. To detect the impact of HH on claws overgrowing, adjusted means of HH for buffalo that showed CO, and for animals that did not show CO, were contrasted using PROC GLM procedure of SAS (SAS, 2005). Whereas, for investigating the effect of HH on MY, estimates of MY for HH classes were estimated using MTDFREML sets of programs. The fixed model for the analysis includes age-parity, days in milk, and lactation year, as fixed effects; and random effect of residual. Solutions of MY for HH classes were fitted using non-linear regression model, where HH was the explanatory variable. Unadjusted mean for HH was 4.05±1.20 cm; whereas, unadjusted mean for MY was 2,466.9±426.4 kg. Buffalo with CO showed smaller ($P<0.0001$) HH value (3.80 cm) compared to that of buffalo without CO (4.34 cm). Therefore, buffalo with HH ≤ 4.34 cm tend to be more subject to claws overgrowing, compared to animals with higher HH. Non-linear prediction of HH solutions for MY, showed an increasing of MY up to HH of 4 cm. Then, MY decreased to 2,282.1 kg for HH of 8.5 cm. Since HH is an heritable trait, selection for buffalo with HH of 4-4.5 cm will reduce in the population the number of buffalo that suffer from CO. Selecting for HH of 4-4.5 cm will also improve milk yield in the population. In conclusion, HH trait will be considered in setting up the Buffalo Welfare index.

Introduction

Over the last few decades buffalo milk production, including dairy farming, has increased considerably, leading to its intensification. In Italy, average milk production at 270d has increased in the past 10 years of almost 200 kg. In the same period, the number of Italian farms, has also increased from 282 (2005) up to 311 (2015) (ANASB, 2015).

A labor and cost-effective housing system for such herds are tie-stall housing system, where animals can lie, rest and walk on floors mostly slatted. In these housing systems most of the buffalo have overgrowth claws, and many of them tend to became lame. Overgrowth claws is the most common foot disorder in buffalo. Due to the incidence, duration and severity of this foot disorder, this problem is considered the main welfare issue for dairy buffalo kept in intensive housing systems. Claws overgrowing may cause long-lasting and intense pain. Consequently, the animal will experience difficulties in walking, lying down, and standing up, affecting the ability of dairy buffalo to perform their natural behavior and fulfill species needs. Furthermore, this foot disorder affect also milk production (Warnick et al. 2001) and decrease reproductive performance. As it happens in dairy cows (Machado et al. 2010), buffalo suffering from foot disorders have a higher probability of being culled.

Buffalo with overgrown claws have an impaired gait compared to buffalo with well-shaped claws. The long shallow toe acts as a lever when the animal is walking. Under natural conditions, wear balances horn growth, whereas under intensive production conditions wear may be reduced in tie-stall housing. A slight claw overgrowing primarily occurs in housing systems with little or no abrasion from the flooring, or on soft pastures. Functional claw trimming contributes to a maintained or restore correct weight bearing within and between the claws and protects the solar corium from contusion, thus, preventing hoof lesions. The growth rate is greater in young than in mature cows (Tranter & Morris, 1992). Therefore, heifers are at an increased risk of developing overgrown claws (Vermunt and Greenough, 1995). Thus, heifers should be trimmed before first calving (Scharko and Davidson, 1998). A genetic predisposition has also been suggested (Glicken and Kendrick, 1977).

The objective of this study was to detect the impact of heel height on claws overgrowing in Mediterranean Italian Buffalo to improve buffalo welfare. Moreover, the effect of heel height on milk yield was also investigate.

Materials and Methods

Data

Data of heel height (HH), and 270d milk yield (MY) where collected from 740 Mediterranean Italian Buffalo females, belonging to five herds in the Campania region, by two linear type trait evaluators, in the year 2016. Presence or absence of overgrowing claws (CO) was reported in the file. Buffalo were kept in paddocks close to the milking room, where buffalo were submitted to udder control and mechanically milked twice a day. Buffalo were fed a diets with a high content of energy and protein, based on maize and other silages, cereal grains, soya, and alfalfa.

Heel Height (HH) was measured by the evaluators directly from the animal during the milking practice. 270d MY data were collected for all the animals in the analysis from the farms.

Statistical Model

To detect the impact of HH on claws overgrowing in buffalo, adjusted means of HH for animals that showed CO, and for animals that did not show CO, were contrasted using PROC GLM procedure of SAS (SAS, 2005).

Whereas, for investigating the effect of HH on MY at 270d, two statistical analyses were used sequentially. Estimates of MY for classes of HH from the first analysis were used in the second analysis. The first analysis included the fixed effects of age-parity, days in milk at the time of measurements, and year of lactation. The MTDFREML programs (Boldman et al., 1997) were used for obtaining the MY solutions by HH classes. The second analysis fit the solutions of MY by HH classes, from the first analysis using non-linear regression, where HH was the explanatory variable. PROC nlin procedure of SAS (SAS, 2005) was used for the second analysis.

Results and Discussion

Summaries of number and frequencies of records by class of HH are shown in Table 1. About 85% of the buffalo had HH between 3 cm and 6 cm. The other 15% of records was distributed between 1.5 cm and 2.5 cm, and between 6.5 cm and 8.5 cm. In Table 2 are shown the number of records, adjusted means and standard deviations for the two groups of buffalo: 1) buffalo with CO and 2) buffalo without CO. 54% of the recorded buffalo showed CO foot disorder (400 buffalo over 740); whereas, the other 46% did not show any CO. Buffalo with CO showed smaller ($P< 0.0001$) HH value (3.80 cm) compared to that of Buffalo without CO (4.34 cm). Thus, buffalo with HH ≤ 4.34 cm tend to be more susceptible to claws overgrowing, compared to animals with higher HH.

The nonlinear regression model was statistically significant ($P < 0.0001$) (Table 3). The intercept (a) was equal to 2,312.8 kg, the linear coefficient (b) was equal to 185 kg and the quadratic coefficient was equal to -2.19 kg. Also the estimated coefficients a, b, and c, were statistically significant.

Solutions of MY by HH classes from the management adjusted model and the predictions from the nonlinear model are shown in Table 4. HH classes 8.5 cm, showed the lowest MY. However, the small number of observations in this HH class could have affected this outlier.

Solutions by HH on MY from the management adjusted model and the predictions from the nonlinear model are shown in Figure 1. Prediction from the nonlinear model was a good fit of the curve of MY solutions by HH classes. Milk production tends to increase from 2,540.4 kg for HH 1.5 cm to 2,697.8 kg, for HH of 4 cm. Then, milk production gradually decreases up to 2,282.1 kg for HH class of 8.5 cm. This result suggests that the proper HH to obtaining the highest milk production is between 4 cm and 4.5 cm.

Selecting for HH of 4- 4.5 cm, would improve not only MY, but also buffalo welfare. In fact, this HH range, will diminish the number of animal that suffer from the CO painful foot disorder. Generally, low MY and presence of CO, lead to buffalo culling. Claws overgrowing may cause long-lasting and intense pain. Consequently, the animal will experience difficulties in walking, lying down, and standing up, affecting the ability of dairy buffalo to perform their natural behavior and their productive potential (Warnick et al. 2001) and decrease reproductive performance. Buffalo suffering from foot disorders have a higher probability of being culled.

Conclusion

Selection for buffalo with HH of 4-4.5 cm could lead to improving of buffalo welfare at farm level. This HH range will reduce in the population the number of buffalo suffering from claws overgrowing. Selecting for HH of 4-4.5 cm will also improve milk yield in the population. Due to the fact that animals can better express their productive potential. Therefore, HH trait is an important factor to consider in the setting up of the Buffalo Welfare Index.

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Table 1. Number of records (N) and frequencies of records (%) for Heel Height classes (HH)

HH	N	Frequency
1.5	4	0.19
2	68	3.27
2.5	175	8.41
3	361	17.34
3.5	279	13.40
4	369	17.72
4.5	256	12.3
5	256	12.3
5.5	96	4.61
6	96	4.61
6.5	57	2.74
7	41	1.97
7.5	6	0.29
8	9	0.43
8.5	9	0.43

Table 2. Number of records, adjusted means, standard deviations (SD) and contrast (YES *vs* NOT) between buffalo with claws overgrowth (Yes) and the group of buffalo without claws overgrowth (NOT)

Claws overgrowing	N	Adjusted mean (cm)	SD (cm)
YES	400	3.80 [a]	1.18
NOT	340	4.34 [b]	1.16
(YES- NOT)		0.54	1.17

[a,b]: differences between the groups are statistically significant at P< 0.0001

Table 3. Parameters of the equation [1] $yij = a + bxj + cx^2j$ to predict milk yield (MY) from heel height (HH) classes

Parameter	**Estimate**	**Std. Error**	**Pr > t**
a	2,312.8	72.17	<.0001
b	185	32.14	<.0001
c	-22.19	3.15	<.0001

[1]y= MY; x= Height Heel

Table 4. Management adjusted solutions[a] and linear predictions [b] of MY by HH

	MY solutions	
HH	Management adjusted	Non Linear prediction
1.5	2,503.2	2,540.4
2	2,659.2	2,594.0
2.5	2,689.4	2,636.6
3	2,682.4	2,668.1
3.5	2,610.7	2,688.5
4	2,635.1	2,697.8
4.5	2,678.3	2,696.8
5	2,694.3	2,683.1
5.5	2,650.4	2,659.1
6	2,610.8	2,624.0
6.5	2,659.4	2,577.8
7	2,576.2	2,520.5
7.5	2,457.1	2,452.2
8	2,561.7	2,372.7
8.5	2,100.1	2,282.1

[a] Effects included in management adjusted model were: age-parity class, Days in milk, and year of lactation as fixed effects; and residual error as random effect.

Figure 1. Plots of average solutions for MY on HH classes from management adjusted model (M1) and predictions from nonlinear prediction model (P1)