Comparison of performance and health parameters of German and New Zealand dairy cows

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Summary

Milk consumption in large parts of the world depends on the import of dairy products. Besides New Zealand, as main exporter of dairy products, Germany - within the EU – is a major exporter of dairy products. The objective of the study was to compare health related traits of the dairy cattle breeds mainly used in both countries. These traits were recorded in six New Zealand farms, and eight German farms. A total of 745 lactating cows entered the study. A variance analysis was performed by using SAS 9.3 with a restricted maximum likelihood (REML) estimation method. Fixed effects were: Country, Breed/Crossbreed x Country, and Number of lactation in combination with covariates milking frequency and [day of lactation x day of lactation]. As expected, there are considerable phenotypic differences among the cows of both countries – depending on breed/crossbreed and/or farm management system. Besides milk yield (28.02 ± 1.07 l/d vs. 12.53 ± 1.00 l/d), cows in Germany and New Zealand differ significantly ($p<0.05$) in back fat thickness (1.70 ±0.07 vs. 0.68 ±0.05 cm), body condition score (3.64 ± 0.07 vs. 2.62 ± 0.05), and betahydroxybutyrate content (1.01 ± 0.05 vs. 0.67 ± 0.04 mmol/l). Starting the last third of lactation, German Holstein Friesians reach daily milk yields of about 33.7 (±0.7) litres in comparison to 13.8 (±1.2) litres of New Zealand Holstein Friesians (HF). New Zealand Jersey (J) reach the lowest daily milk yield with 9.8 (±2.8) l/day, while Kiwi Cross (HF x J) cows (12.4 ± 0.9 l/d) perform slightly below New Zealand HF. Additionally, higher daily milk yield estimates (least squares means) correspond with higher back fat thickness and body condition scores in German HF. German cows are allowed to higher concentrate intakes in contrast to mainly grass feeding in New Zealand. Unexpectedly, lameness scores do not differ significantly between New Zealand (1.35 ± 0.05) and German cows (1.39 ± 0.08). Therefore, pasture based dairy production must not necessarily be an advantage for dairy cows in terms of lameness and body condition. Indoor based dairy production, however, might have more issues with metabolic diseases and over conditioned cows.

Keywords: body condition score, lameness score, back fat thickness, ketone bodies, New Zealand, Germany, milk yield,

Introduction

Milk production worldwide is a topic which is of high interest for many different stakeholders from economy, politics, general public, environmental affairs and animal welfare. Nowadays, everything has to be faster, bigger and more efficient. Milk production is thereby no exception and apart from economic factors the demands on modern agriculture concerning animal health and welfare are very high. The aim of this study is to illustrate the

implementation of those demands using the example of the two most important milk exporting countries worldwide, New Zealand and Germany (FAO, 2017, Milchindustrieverband, 2017). The focus thereby is on performance and health parameters. No such comparison can be found in literature or other data sources like e.g. Interbull, VIT, or LIC.

In Germany, most of the dairy cows are held indoor (Statistisches Bundesamt, 2010) and fed mostly with concentrate. In New Zealand in contrast, almost all cows are on pasture, and farms only have a shed for milking. In Germany, dairy cows are large-sized and high-yielding. In New Zealand, instead, dairy cows are small, slender (Schori and Münger, 2009) and produce an average of about 15.7 litres per day (Dairy NZ and LIC, 2017) based on an average lactation length of 276 days (days in milk production).

Material and methods

The comparison is based on results of different farms in Germany and New Zealand, which were chosen due to their farm structure and following the "TIPI-CAL Model" (Hemme, 2015) of the International Farm Comparing Network (IFCN). The model defines important dairy industry regions of each country. For each region, an average as well as a larger farm is selected. So far, three farms in East Germany, three in South Germany, and two in North Germany have been visited to examine randomly selected cows. Per farm visited, a planned 10 % proportion of the number of cows was to be included in the study.

In New Zealand, farms were chosen by the same procedure. One of the most important regions for milk production in New Zealand is the Waikato District (Dairy NZ and LIC, 2017). Therefore six farms were visited in that region.

The focus thereby was in both countries on auxiliary parameters of animal health such as back fat thickness (BFT), body condition score (BCS), lameness score (LS) and betahydroxybutyrate (BHB) concentration in blood in combination with the milk yield (MY). The back fat was measured with an ultrasonic device (KX5200, Kaixin Electronic Instrument CO, Xuzhou, Jiangsu, China) using a linear probe (6.5 MHz). The measurement point was chosen on an imaginary line between the tuber ischii and the tuber coxae about 10 cm cranial of the tuber ischii (Schröder and Staufenbiel, 2006). The body condition score was determined with the help of a breed specific 5-point-scoring system by looking at various body regions such as pelvic outlet, spinous processes and transverse processes and palpating them to evaluate the condition of the cow and her body fat reserves. Marks from 1 (cachectic) up to 5 (adipose) were awarded. The ketone bodies in blood were measured by a BHB measurement device from Pharmadoc (Lüdersdorf, Germany). The lameness-scoring (LS) was carried out with the help of a 5-point scoring system by looking at the cow while standing and walking. Again, cows received marks between 1 (no lameness, back straight in standing and walking, normal treading) and 5 (severe lameness, back is bent in walking and standing, with one or more legs only partially or no treading).

The variance analysis was performed by SAS 9.3 using a REML estimation methodology with the fixed effects Country, Breed x Country, Number of lactation (LNR) and the covariates milking frequency (as simple indicator for herd management) as well as [day of lactation x day of lactation] to correct for the lactation stage. The t-test of least squares means (LSM) was performed after a Tukey-Kramer adjustment in order to correct the significance level ($p<0.05$) for multiple testing. Lactation numbers ≥ 6 were grouped together. In total, 745 lactating dairy cows were examined, out of which 665 could be used for the evaluation of the parameters BFT and BCS, 521 for the parameter MY, 653 for LS and 649

for BHB, respectively.

Results and discussion

The comparison between the countries illustrates that the average BCS and BFT of German dairy cows is significantly higher ($p<0.05$) than of New Zealand dairy cows. Regarding the MY in both countries, it can be seen - as expected - that New Zealand dairy cows produce significantly less milk than German dairy cows. The BHB concentration in German dairy cows is significantly higher ($p<0.05$) than in New Zealand dairy cows. Looking at the LS in both countries, there is no apparent statistical significant difference.

Table 1. Body condition score (BCS), Back fat thickness (BFT), Milk yield (MY), BHB concentration (BHB) and Lameness score (LS) in relation to the breed/crossbreed and country (LSM±SEE) at an average day of lactation = 205.

Country	Breed/ Cross	BCS [Score 1-5]	BFT [cm]	MY [l/day]	BHB [mmol/l]	LS [1-5]
GE	total	3.64 ± 0.07^{a}	1.70 ± 0.07^{a}	28.02 ± 1.07^{a}	1.01 ± 0.05^{a}	1.39 ± 0.08
NZ	total	2.62 ± 0.05^{b}	0.68 ± 0.05^{b}	12.53 ± 0.99^{b}	0.67 ± 0.04^{b}	1.35 ± 0.05
GE	GFV	4.05 ± 0.11^{a}	1.84 ± 0.11^{a}	21.56 ± 1.66^{b}	1.13 ± 0.08^{a}	1.29 ± 0.13^{ab}
GE	HF	3.17 ± 0.04^{b}	1.42 ± 0.04^{a}	33.74 ± 0.69^{a}	0.88 ± 0.03^{a}	1.56 ± 0.05^{a}
NZ	HF	2.62 ± 0.08^{c}	0.71 ± 0.07^{b}	13.76 ± 1.23^{c}	0.66 ± 0.06^{b}	1.40 ± 0.09^{ab}
NZ	J	2.67 ± 0.10^{c}	0.74 ± 0.09^{b}	9.84 ± 2.80^{c}	0.57 ± 0.07^{b}	1.41 ± 0.11^{ab}
NZ	KiCr	2.59 ± 0.05^{c}	0.65 ± 0.05^{b}	12.37 ± 0.87^{c}	0.69 ± 0.04^{b}	1.26 ± 0.05^{b}

GE=Germany, NZ=New Zealand; Different superscripts within columns show either significant differences ($p<0.05$) between countries or among breeds/crossbreds.
GFV=German Fleckvieh (Simmental), HF=Holstein Friesian, J=Jersey, KiCr=Kiwi Cross

Comparing the different breeds, it can be seen that German Fleckvieh (GFV) cows attain the highest BCS, followed by German Holstein Friesians, New Zealand Jersey, New Zealand Holstein Friesians and lastly New Zealand Kiwi Cross. It is particularly interesting here to note that German Holstein Friesians have a significantly higher BCS (on average 0.55 score points) than New Zealand Holstein Friesians. The effect of the breed (within country) on BCS is significant ($p<0.0001$). BFT shows similar results. With an average of 33.7 l/day, German Holstein Friesians produce the highest amount of milk followed by German Fleckvieh, New Zealand Holstein Friesians, New Zealand Kiwi Cross and at last New Zealand Jerseys, which produce on average only 9.8 l milk /day around the 205th day of lactation. A likely positive heterosis effect, however, leads to an only slightly reduced milk yield for Kiwi Cross in comparison with New Zealand Holstein Friesians. The breed within country has no significant effect on the BHB concentration though dairy cows between Germany and New Zealand differ significantly (1.01 ± 0.05 vs. 0.67 ± 0.04 mmol/l). LS of the different breeds/crossbreds show no significant differences, though Kiwi Cross and German Fleckvieh cows seem to have a slight advantage. Older cows (LNR≥6) had significantly higher LS with 1.78 ± 0.09 than younger cows (LNR 1 + 2) with an average LS <1.16 (±0.09).

Additional results from a linear regression analysis show a significant positive linear relationship between BFT and MY only across breeds/crossbred lines and countries. The higher the MY, the higher is the BFT ($r=0.26$). There is, however, only a small (non-

significant) correlation (r=0.04) between the BCS and MY across breeds and countries, even though German dairy cows show higher BCS at high MY levels. This is due to different feeding and housing systems of both countries. A New Zealand dairy farmer produces less milk with relatively low production costs per kg milk (Hemme, 2015), but with very high levels of fat and protein. That can be attained by feeding mainly grass and the choice of purebred or crossbred cows containing Jersey "blood". The "New Zealand dairy cow" consumes mainly grass as energy and protein source. During grazing at all seasons, the cow needs large parts of the feed energy mainly for the maintenance of the heat balance and for the daily walking distances. That might be the reason why the BCS and BFT are rather low in New Zealand dairy cows. For those conditions, small, slender and solid cows are most suitable (CRV, 2016). Kiwi Cross (crossbreed of J and HF) with a proportion of 48 % contributes to the majority of New Zealand's dairy population followed by 33 % Holstein Friesians and 9.3 % Jersey (Dairy NZ und LIC 2017). In Germany, Holstein Friesians are predominant with 47 % followed by German Fleckvieh (Simmental) with 29% (Elfrich and Roesicke, 2015). These German dairy cows are being fed with high energy food to obtain such high milk yields. Since German dairy cows need to move comparatively little, and since they are not exposed to serious environmental conditions because of mainly indoor housing, the cows can use a high amount of food energy for the production of milk, and for the renewal of body fat reserves. That is one reason of the high milk yield as well as the comparatively high BFT and BCS in Germany. It must be underlined, nevertheless, that - especially in Germany, extremely obese dairy cows have a lower milk yield than average conditioned ones.

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