Adapted vs. conventional cattle genotypes: suitability for organic and low input dairy production systems

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Abstract

In this study the response of different dairy genotypes is examined to a systematic restriction of nutrient and energy supply. This shall indicate the ability of different breeds or strains to adapt to an important aspect of organic and low input systems. While differences exist between genotypes in some traits, it is difficult to derive a clear conclusion on general differences regarding their suitability for organic and low input dairy production systems at this stage.

Introduction

Conventional genotypes have been bred by selecting primarily for milk production within high concentrate input systems where forages, especially pasture, have accounted for only 50 % or less of the total ration. Dairy cow strains arising from these breeding programmes are often perceived unsuitable for organic and low input milk production systems. While farmers have identified a number of breeds and strains as being 'adapted' to low input systems, there is often little scientific evidence to prove that these breeds are more appropriate than conventional genotypes.

The purpose of this study (part of FP7-project "SOLID", g.a. n° FP7-266367) is to examine the response of "conventional" versus "adapted" dairy genotypes to a systematic restriction of nutrient and energy supply, including metabolic response traits. This would indicate the extent to which different breeds or strains can adapt to an important aspect of organic and low input systems.

Material and methods

Genotypes identified by organic and low input producers as being adapted to these systems were compared with conventional breeds in studies in Austria, Finland and Northern Ireland. The studies undertaken in each country examined productivity and several other traits of adapted and conventional genotypes when managed on diets supplying either normal (i.e. system-specific levels) or reduced quantities of energy and nutrients. These three cases serve as examples of different approaches to breeding for adaptation to low input milk production systems.

- Adaptation through selection for lifetime performance: a strain of Holstein cattle selected on low input farms for lifetime performance for more than 50 years (HFL) was compared with conventional Brown Swiss cattle (BS) in an organic, low-input milk production system within an alpine environment in Austria. Data from 30 and 21 lactations were included in the study for HFL and BS, respectively.
- Adaptation through crossbreeding: 36 Jersey x Holstein x Swedish Red crossbred dairy cattle were compared with 36 conventional Holstein cows in an intensively managed grassland based system in Northern Ireland.
- Adaptation through selection for fertility and health traits: 16 Nordic Red (Finnish Ayrshire) cows, which had been selected within a controlled multi-trait selection programme for over 30 years were compared with 32 conventional Holstein cows in a Finnish milk production system.

Within each experimental site, cows of each genotype were managed within one experimental herd. Half of the cows of each genotype were assigned to either a control diet or a diet in which concentrate inputs had

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been reduced by at least 40 % (low input). Traits analysed include forage and total feed intake for the indoor period, milk production and quality, milk fatty acid profiles, milk somatic cell count, body condition changes, animal health and selected metabolic indicators and cow fertility. Samples of venous blood of each cow were taken 14 days pre calving and on days 4, 15, 29 and 43 post calving and were analysed for indicators of energy status, urea and uric acid contents. Milk samples were collected at 4 times during early lactation for fatty acid analysis.

Results

As the experiments and analyses have just been completed, or are in their final stages, preliminary results are presented (Tables 1, 2 and 3 for the experiments conducted in Austria, Northern Ireland and Finland, respectively). Statistically analysed results and conclusions based on the analysis of the final data sets will be presented at the conference.

Differences in productive performance reflect the effects of both breed and feeding regime in the Austrian trial, but do not seem to indicate an interaction between those (Table 1). There was a breed × feed effect on milk palmitic acid (C16:0) proportion, a significant treatment effect on oleic acid (C18:1), but no effects on stearic acid (C18:0). Based on blood NEFA values, it seems that cows with reduced dietary concentrate supplementation on average mobilized fatty tissue at a higher rate than the control cows, while the BS showed lower average values than HFL. Both NEFA and BHB values showed a high variability across all treatments. Results for NAGase (mastitis indicator) appear to be driven by breed effects, rather than by feeding regime.

Table 1: Production traits and milk fatty acids for conventional and "adapted" dairy cows under a control and a low input feeding regime in Austria

	Brown Swiss (conventional)		Holstein (adapted)	
Trait	Control diet	Low input	Control diet	Low input
Concentrate per lactation, kg	686 ±250.3	285 ±125.5	625 ±207.2	286 ±80.8
Lactation milk yield, kg	6371 ±1833.5	5716 ±1192.7	5840 ±759.5	5384 ±838.0
Milk solids, kg	467 ±131.9	409 ±77.1	422 ±66.2	393 ±63.6
Milk C16:0, g/g	0.39 ±0.039	0.35 ±0.042	0.36 ±0.038	0.36 ±0.030
Milk C18:0, g/g	0.11 ±0.026	0.11 ±0.027	0.10 ±0.026	0.12 ±0.032
Milk C18:1, g/g	0.16 ±0.031	0.20 ±0.064	0.16 ±0.043	0.19 ±0.051
Ø BW, kg	606 ±80.5	613 ±63.0	540 ±60.3	544 ±53.8
Days to concept.	76 ±37.3	64 ±34.9	78 ±39.9	74 ±40.4

Crossbred cows had a lower lactation milk yield than the conventional Holstein cows in the experiment in Northern Ireland, with a trend towards a breed x system interaction (Table 2). However, the crossbred cows produced milk with a higher fat and protein content, the overall effect being that milk solid yield was similar for both breeds, while being higher with cows offered the control diets. Milk proportions of C16:0 and C18:0 were significantly affected by diet but not breed, whereas breed affected C18:1. Reproductive performance was the same for both genotypes.

Table 2: Production traits and milk fatty acids for conventional and "adapted" dairy cows under a control and a low input feeding regime in Northern Ireland

	Holstein (conventional)		Swedish Red x Jersey x Holstein (adapted)	
Trait	Control diet	Low input	Control diet	Low input
Concentrate per lactation, kg	1670	713	1644	720
Lactation milk yield, kg	7647 ±1298.2	6368±1209.5	7118 ±1358.7	5324 ±939.9
Milk solids, kg	511 ±101.1	410 ±95.4	526 ±103.3	395 ±75.1
Milk C16:0, g/g	0.34 ±0.041	0.37 ±0.037	0.36 ±0.032	0.39 ±0.043
Milk C18:0, g/g	0.10 ±0.022	0.11 ±0.016	0.10 ±0.019	0.11 ±0.014
Milk C18:1, g/g	0.21 ±0.040	0.20 ±0.033	0.19 ± 0.038	0.19 ±0.037
Ø BW, kg	574 ±59.3	551 ±48.0	548 ±41.0	515 ±36.8
Days to concept.	91		91	
SCC (1000/ml)	82	135	206	121

Preliminary results from the Finnish experiment (first 100 days of lactation; Table 3) indicate that the the adapted Nordic Red cows had a lower milk yield than the Holstein cows (29.2 vs. 31.5 kg/day), but fewer claw disorders. There was no significant effect of breed or treatment on milk C16:0, C18:0, but breed tended to have an effect on C18:1.

Table 3: Production traits and milk fatty acids for conventional and "adapted" dairy cows under a control and a low input feeding regime in Finland

	Holstein (conventional)		Nordic Red (adapted)	
Trait	Control diet	Low input	Control diet	Low input
Concentrate per lactation, kg	2833 ±102.9	1395 ±99.0	2926 ±138.4	1323 ±154.1
Lactation milk yield, kg	9997±279.7	8516±282.0	9089±399.6	7970 ±428.8
Milk solids, kg	1373±35.6	1158.8±35.9	1306±50.8	1092±54.6
Milk C16:0, g/g	0.32 ±0.033	0.34 ±0.040	0.35 ±0.034	0.33 ±0.046
Milk C18:0, g/g	0.13 ±0.018	0.13 ±0.027	0.12 ±0.016	0.13 ±0.020
Milk C18:1, g/g	0.27 ±0.077	0.25 ±0.069	0.20 ± 0.047	0.24 ±0.059
Day to concept.	113±38.6	94±38.6	130±59.7	101±15.4

Discussion

The preliminary data available appears to confirm that a reduction in concentrate supplementation reduces milk yield, but does not have a detrimental effect on health and reproductive traits. The responses of different genotypes to a reduced nutrient and energy intake were not consistent across the different studies. This is likely due to varying degrees of differences between both the genotypes studied and the feeding regimes implemented. Published studies examining possible genotype by feeding system interactions have also found inconsistent results (Delaby et al. 2009, Hammami et al. 2009, Horan et al. 2005), and this makes it difficult at this stage to derive a clear conclusion on general differences between conventional and alternative genotypes with regards to their suitability for organic and low input dairy production systems.

Suggestions for tackling the future challenges of organic animal husbandry

In pasture and forage-based systems, concentrate input can be reduced without affecting reproductive and health traits. The associated loss in milk yield presents an economic challenge unless balanced by lower production costs.

Efforts to identify genotypes that fit better to organic and low-input dairy production systems are still important and are likely to become even more relevant as production environments (i.e. conventional vs. organic/low input) and breeding goals (i.e. conventional vs. adapted) diverge.

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