Effect of dietary protein level on milk yield, milk composition and blood metabolites in organic sows on pasture summer and winter

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**Abstract**

Normal and low protein level was tested in 47 organic 1st and 2nd parity sows in summer and winter under Danish weather conditions. There were no differences between the two dietary regimens on milk yield, milk composition or blood metabolites (P>0.05). In contrast, sow performance was higher during summer than in winter (P<.001).Casein concentration was greater (P=0.01) and protein concentrations tended to be higher (P=0.10) in milk from sows fed with NP diet than the LP diet. In conclusion, a 13% lower protein level did not impair sow performance, milk composition or blood metabolites, when sows were fed iso-energetic (ME) concentrate and had ad libitum access to fresh clover grass during summer and grass silage during winter.

**Keywords**: energy, clover grass, silage, sow performance, season

**Introduction:**

Organic sows are exposed to a wide range of changes in the environmental conditions. (photoperiod, thermoregulation, locomotive activity and grass/roughage intake). Recommendations for organic sows are based on knowledge obtained for conventional sows, but an adjustment on the protein to energy ratio in organic sow diets could be considered to match the demand of nutrients for thermoregulation and physical activity and to reduce the negative environmental impact from organic pig production. It is suggested that organic sows might need more energy (kg feed/d) but less protein (DM protein/kg), because they ingest a considerable amount of protein from grazing in summer and from roughage in the winter.

**Materials and methods**

Forty-seven lactating LY sows were randomly assigned into low protein (12.8% of DM) or normal protein (14.7% of DM) diets. Two periods (winter or summer) were tested. The two diets were adjusted to be iso-energetic (14 MJ ME/d) and were of 100% organic origin. To meet the extra demand for thermoregulation and locomotory activity, the energy allowance from both treatments was increased by adding 15% to the recommended feeding curves for indoor sows (Danish Pig Research Centre). During summer, sows were fed 4.7 kg/d on 1-3 days in milk (DIM), from 4-14 DIM, the feed allowance increased by 0.5 kg/d, reaching a plateau of 11.1 kg/d from 14 DIM until weaning at 47 DIM. On top of that, sows had ad libitum access to clover grass sward in the summer period and grass silage in winter (November 1st to April 15th).

All sows and piglets were individually weighed and milk/blood samples were collected from the sow in early, peak and late lactation (d 5, 20, and 40 DIM). Blood samples were collected by jugular vein puncture. The chemical composition of milk for DM content, protein, casein, lactose, and fat was analyzed in triplicate by infrared spectroscopy using a Milkoscan 4000 instrument. Milk yield was estimated by Hansen et al. (2012), based on the daily gain of the piglets and litter size, and calculations were extrapolated from 30 to 49 DIM.

**Results and discussion**

Milk yield, litter size and daily litter gain were not affected by protein level, but it was greater during summer than in winter (P<.001;Table 1).Casein concentration was greater (P=0.01) and protein concentrations tended to be higher (P=0.10) in milk from sows fed with NP diet than the LP diet. Milk BHBA showed to be slightly higher, when sows were fed NP diet (P=0.05). Milk content of DM, fat, lactose and energy was not affected by dietary regime. Concentrations of Glu6P, uric acid, BHBA and NAGase in milk, tended to be higher during winter than in summer (P≤0.05). Dietary treatments did not show any effect on the measured plasma metabolites (P=0.10). On the other hand, a seasonal effect was observed on plasma concentrations of creatinine and lactate, as creatinine was greater in sows during summer than winter (P= 0.01). In contrast, plasma lactate concentrations were higher in winter than during summer (P=0.003).

Table 1. Effects of feeding organic lactating sows on pasture either normal or low dietary protein diet on performance, milk composition and plasma metabolites during summer and winter

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Diet | | | Season | | | P-value | |
|  | LP1 | NP | SEM1 | Summer | Winter | SEM | Diet | Season |
| Milk yield, kg/d | 12.1 | 12.3 | 0.36 | 13.7a | 10.8b | 0.36 | NS | <.001 |
| Litter size | 11.7 | 11.9 | 0.37 | 12.8a | 10.8b | 0.37 | NS | 0.001 |
| Litter ADG, Kg/d | 3.1 | 3.1 | 0.09 | 3.4a | 2.8b | 0.09 | NS | <.001 |
| Milk composition |  |  |  |  |  |  |  |  |
| Dry matter, % | 19.1 | 19.2 | 0.28 | 18.7b | 19.6a | 0.26 | NS | 0.02 |
| Protein, % | 5.2b | 5.4a | 0.08 | 5.3 | 5.3 | 0.08 | 0.10 | NS |
| Casein, % | 4.0b | 4.2a | 0.06 | 4.1 | 4.1 | 0.05 | 0.01 | NS |
| Lactose, % | 4.9 | 4.9 | 0.03 | 4.9 | 4.9 | 0.03 | NS | NS |
| Fat, % | 8.4 | 8.4 | 0.28 | 8.0b | 8.8a | 0.26 | NS | 0.01 |
| Energy, KJ/g | 524 | 531 | 11.10 | 510b | 545a | 10.37 | NS | 0.01 |
| Milk metabolites |  |  |  |  |  |  |  |  |
| Glu6P, mM | 0.15 | 0.15 | 0.01 | 0.14b | 0.16a | 0.01 | NS | 0.002 |
| Glucose, mM | 0.12 | 0.12 | 0.02 | 0.14 | 0.11 | 0.02 | NS | NS |
| Uric acid, µM | 31.7 | 33.4 | 1.18 | 29.8b | 35.4a | 1.19 | NS | 0.001 |
| BHBA, µM | 22.5 | 26.3 | 1.1 | 22.9b | 25.9a | 1.10 | 0.01 | 0.05 |
| Isocitrate, mM | 0.10 | 0.10 | 0.00 | 0.10 | 0.10 | 0.00 | NS | NS |
| NAGase, U/l | 13.4 | 13.1 | 0.58 | 11.1b | 15.4a | 0.57 | NS | <.001 |
| LDH, U/l | 1.42 | 1.30 | 0.09 | 1.26 | 1.45 | 0.09 | NS | NS |
| Plasma metabolites |  |  |  |  |  |  |  |  |
| Creatinine, µM | 127.7 | 125.7 | 2.88 | 132.2 | 120.5 | 3.33 | NS | 0.01 |
| Glucose, mM | 4.09 | 4.27 | 0.11 | 4.20 | 4.16 | 0.13 | NS | NS |
| Urea, mM | 3.25 | 3.39 | 0.09 | 3.36 | 3.28 | 0.11 | NS | NS |
| Lactate, mM | 2.07 | 2.25 | 0.14 | 1.85b | 2.47a | 0.17 | NS | 0.003 |
| Triglyceride, mM | 0.44 | 0.42 | 0.02 | 0.44 | 0.42 | 0.03 | NS | NS |
| NEFA, µM | 1146 | 1041 | 91.30 | 1123 | 1065 | 105.70 | NS | NS |

a, b Within a row and within a main effect, means with different superscripts differ (P<0,05)

The DIM affected all milk and blood metabolites in the present study (data not shown). Milk L-lactate dehydrogenase (LDH) and NAGase as biomarkers for determination of coliform mastitis, showed higher concentrations in early lactation. Milk Glu6P, milk BHBA, plasma NEFA and plasma creatinine concentrations were higher in early lactation as comparised with late lactation (P<0.10). Plasma creatinine and glucose concentrations were highest at d 5, and then declined until the end of lactation (P=0.001). Plasma urea, lactate, triglyceride and NEFA concentrations were greater at peak lactation (P=0.004).

In conclusion, it was possible to reduce dietary protein concentration to organic sows with 13% without impairing milk yield, litter size, or daily litter gain, when the animals had ad libitum access to fresh clover grass in summer and grass silage in winter.