

Effect of feeding of different sources of NPN on production performance of dairy cows

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The aim of the study was to analyse the effect of feeding of different sources of NPN on nutrient utilization and production performance of dairy cows under field conditions. Balancing diets for crude protein without consideration of protein quality or rumen degradability often led to overfeeding of nitrogen and less than optimum production. High yielding dairy cows separated in two groups with 85 resp. 80 cows in each were set up for the trial. Groups were consistent according the stage of production and reproduction cycle as well as age structure. Both groups were fed concentrate mixture with the same composition with only difference in NPN/ microbial protein source, with same dosage of 100 g per cow and day. Field trial was performed for period of 3 subsequent months. Performance data were collected in accordance with official milk recording. In both groups majority of cows were on first lactation. Significant differences in daily milk production were observed 2.87 kg ($P < 0.01$) for group 2, in fat content 0.07% for group 2 non-significant, whereas in protein content 0.18% for group 1 significant ($P < 0.01$) in case of first lactations. If considering first tree lactations, group 2 produced 1.7 kg milk per day more ($P < 0.08$), with 0.05% fat more and 0.002% protein less than group 1. The space created in dry matter intake by a concentrated slow-release NPN can be filled with high quality forage that could reduce the cost of feeding while maintaining levels of production.

Keywords: Holstein, slow-release urea, microbial protein, milk yield

1 Introduction

One of the main factors which limit performance potential of dairy cows is management of nutrition not only in quantity but either in sufficient quality and regular intake of feed, energy and other nutrients in accordance with physiological needs of organism along the production and reproduction cycle. Increase of grain and protein sources prices made nutrition of animals costly. Over the past 30 years, a number of technologies have been developed to synchronize rumen NPN release with carbohydrate degradation in rumen and maximize rumen microbial need.

Crude protein belong to the structural nutrients, either part of it can be used in organism as energy source as well (Zeman et al., 2006). Crude protein is essential in animal nutrition. Excess of nitrogen in diet of animal, those substances must leave the body, because they cannot be stored. Excess of nitrogen causes overloading of detoxification capacity of liver, amino acids deamination and damage of excretion systems. Deficiency in nitrogen slow animal growth and decreases feed conversion ratio. One of the traits signaling level of crude protein in the diet is urea level in blood. Final products of crude protein breakdown in ruminants are ammonium, CO₂ and water.

Urea enters rumen in form of feed and from hepato-urinal cycle. Concentration of urea in blood is primarily affected due to surplus of ammonium in rumen. Urea leaves body in urine or in milk (Kudrna and Homolka, 2009). Even dairy cows with average production 50 kg and more shouldn't intake more than 190 g CP kg⁻¹ dry matter of the diet. Dairy cows fed surplus protein, present higher level of urea in blood and lower pH in the vulva which could cause decrease of conception rate (Bouška et al., 2006). Study of Cantalapiedra-Hijar et al. (2014) showed that decreasing the dietary CP proportion from 16.5% to 12.0% increases and decreases considerably the MNE and the urinary N excretion, respectively. Moreover, present results show that at similar digestible OM and PDIE intakes, diets rich in starch improves the MNE and could partially compensate for the negative effects of Low CP diets on milk protein yield. Studies to determine the effect of different biological and biochemical additives on the final nutritive quality, fermentation process and concentration of mycotoxins in feed of dairy cows performed Bíro et al. (2009) or Šimko et al. (2010).

Balancing diets for crude protein without consideration of protein quality or rumen degradability often led to overfeeding of nitrogen and less than optimum

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production. Recognition that rumen synthesis of bacterial protein was not sufficient to meet the needs of high producing dairy cows led to the concept of bypass protein and a requirement for rumen undegradable protein (Harrison and Karnezos, 2005). Soybean meal is together with rapeseed meal main source of concentrated nitrogen with good level of essential amino acids (Homolka and Kudrna, 2006) in conventional feed management. The most important by-product of bio-ethanol production from grains is dried distillers grains and solubles (DDGS). In the United States DDGS is mainly based on maize, whereas in Europe and Canada both wheat and maize and also grain blends are used as substrate (De Boever et al. 2014). One of the most promising technologies using slow release NPN release from urea is a polymer-coated urea (Optigen™, Alltech) which has been demonstrated to have a nitrogen disappearance rate similar to that of soybean meal (Harrison and Karnezos, 2005). Rumagen™ (Alltech) is a combination of slow release nitrogen source and highly digestible microbial protein source, due to its unique composition, this product meets both the nutritional and economical requirements. Urea additives were provided to meet 100% of the degradable intake protein requirement while soybean meal supplements were provided on an isonitrogenous basis by Cappellozza et al. (2013). As suggested providing a urea-based supplement, was an effective alternative to a soybean based meal supplement in maintaining acceptable ruminal fermentation of steers consuming low-quality, cool-season forage.

The Aim of the study was to analyse the effect of feeding of different sources of NPN on nutrient utilization and production performance of dairy cows under field conditions.

2 Material and methods

Field trial was set up on dairy farm in western part of Slovakia, under commercial conditions. Herd consisted of 400 cows, housed in free cubicles with straw bedding. High yielding dairy cows separated in two groups with 85 resp. 80 cows in each were set up for the trial. Groups were consistent according the stage of production and reproduction cycle as well as age structure (table 1).

Table 1 Age structure of the test groups

	Group 1	Group 2
Lactation	<i>n</i> = 85	<i>n</i> = 80
1 st	42.0	44.0
2 nd	23.5	25.0
3 rd	19.0	17.5
4 th and more	15.5	13.5

Maximum parity of cow in dataset was 5. Animals were fed once a day TMR based diet (table 2, 3). Milking was performed three times a day.

Animals in both groups were fed same ration in form of TMR which consisted of:

Table 2 Component of TMR fed to the dairy cows in the test groups

Component	Weight head ⁻¹ (kg)	DM (%)
Supplementary feed	9.1	88.0
Gurmit (DDGS)	4.0	32.0
High Moisture Corn	5.0	65.0
Cotton Seed	1.0	88.0
Maize silage	18.52	35.0
Alfalfa silage	13.0	35.0
Total	50.62	–

Both groups were fed concentrate mixture with the same composition with only difference in NPN/ microbial protein source, with same dosage of 100 g per cow and day.

Composition of supplementary feed concentrate mixture in both groups:

Table 3 Composition of dairy cows concentrates mixture feed used in test groups during the trial

Component	%	kg KD ⁻¹	EUR
Barley	57.6	5.000	0.55
Sunflower ext.	31.0	2.690	0.80
Rumagen/ Optigen	1.2	0.100	0.28
Feed fat	2.3	0.200	0.21
Premix ALLTECH dairy	2.3	0.200	0.22
Feed Ca	2.3	0.200	0.02
Natrium hydroxycarbonate	2.3	0.200	0.06
NaCl	0.8	0.070	0.01
MYCOSORB	0.3	0.026	0.23
Total	100.0	8.686	2.37

Field trial was performed for period of 3 subsequent months. Performance data were collected in accordance with official milk recording made on farm by Breeding Services of Slovak Republic s. e. Performance recording was and milk sample collection was made once per month.

Collected data on daily milk production in kg, fat and protein content as well as somatic cell count were analysed using software SAS EG v 5.1. Significance of

differences between groups for analysed parameters were tested using Student two-sample *t*-test.

3 Results and discussion

Calculation of nutritional requirements in the herd has been adapted according the live weight of 650 kg for multiparous resp. 600 kg primiparous dairy cows, with daily production of 40, resp. 33 kg of milk, fat content 4%. According the nutritional requirements was Group1 fed 100% of crude protein with PDIE being 95.87%, 100% of fibre, NEL of 100.81%. Ration between PDIN and PDIE was 1.155, NEL to DM 6.712,% CP to DM 16.151. In comparison Group2 animals were fed 100% of crude protein with PDIE being 98.51%, 100% of fibre, NEL of 100.73%. Ration between PDIN and PDIE was 1.096, NEL to DM 6.708,% CP to DM 15.588 (Table 4).

Table 4 Nutritional composition of the TMR in the trial groups according to calculation in KDS v.2450 (AgroKonzulta s.r.o, 2016)

Trait	Group1	Group2
Crude protein (g)	4073.39	3930.72
PDIE (g)	2178.66	2238.56
Fiber(g)	4009.54	4009.54
NEL (MJ)	169.273	169.139

In both groups majority of cows were on first lactation. In case of first lactations significant differences in daily milk production were observed 2.87 kg ($P < 0.01$) for group

2, observed differences in fat content 0.07% for group 2 was non-significant, whereas in protein content 0.18% for group 1 was significant ($P < 0.01$).

If taking first three lactations into consideration, group 2 produced 1.7 kg milk per day more ($P < 0.08$), with 0.05% fat more and 0.002% protein less than group 1 (table 5).

Table 7 Significance of differences between Group 1 and Group 2

Trait	Diff. Gr1 – Gr2	t-stat	P
Milk kg 1. lact	2.868	0.012	+
Fat % 1. lact	0.070	0.504	-
Protein 1. lact	-0.181	0.007	++
Milk kg 1–3 lact	1.700	0.080	-
Fat % 1–3 lact	0.045	0.380	-
Protein 1–3 lact	0.002	0.041	+

The value of slow – release NPN products extends beyond the potential impact of changing microbial protein synthesis and nutrient digestion. As confirmed by Harrison and Karnezos (2005) increased milk production by introduction of slow-release NPN has been observed. Introduction of slow-release NPN allowed for a reduction of soybean meal, urea, Soy-Pass, soy hulls and corn gluten meal. As concluded in the study net space of 1.1 kg was created and filled with 0.8 kg of wheat middling and 0.3 kg of finely ground corn with increase of the RDP by 4.12% and starch content of 3.06%. In total 9.47%

Table 5 Milk recording results of dairy cows in both groups at first lactation

Group	n	Variable	\bar{x}	s.d.	x_{\min}	x_{\max}
1	37	milk kg	29.08	5.06	14.30	37.60
		fat %	3.11	0.68	1.41	4.40
		prot %	3.25	0.33	2.35	3.90
2	35	milk kg	31.95	5.47	20.60	45.90
		fat %	3.18	0.48	1.98	4.09
		prot %	3.07	0.29	2.38	3.63

Table 6 Milk recording results of dairy cows in both groups at first 3 lactations

Group	n	Variable	\bar{x}	s. d.	x_{\min}	x_{\max}
1	72	milk kg	33.02	7.85	14.30	55.40
		fat %	3.07	0.70	1.41	4.74
		prot %	3.20	0.38	2.35	4.24
2	69	milk kg	34.72	7.03	20.60	48.40
		fat %	3.11	0.70	1.59	5.55
		prot %	3.20	0.37	2.38	4.75

increase of milk production, 8.9% of protein yield with no change in milk fat was observed. Hazuchová and Kasarda (2010) observed higher milk yield in first 100 days of lactation when introducing slow release NPN into diet of dairy cows. Hazuchová and Kasarda (2010) parity significantly influenced observed results, where observed coefficients of determination varied from 22.45% of BCS resp. 22.67% of M to 32.23% by BW. Results of McGuire et al. (2013) suggest that supplements containing urea or soybean meal as the supplemental N source can be used by cattle without adversely affecting N efficiency, nutrient intake, or nutrient digestibility, even when provided every-other-day. Holder et al. (2013) observed that although slow release urea did not improve N retention at either crude protein level, rumen ammonia and plasma urea concentrations were reduced, which may indicate that slow release urea may carry a lower risk for toxicity when compared to urea when fed at higher dietary concentrations.

Due to protected nitrogen in the diet ratio of CP/RDP rises, which translates into higher level of soluble protein of the total protein reaching rumen, which is beneficial for amylolytic bacteria, but especially for the fibrolytic bacteria which use ammonia nitrogen as the nitrogen source. Due to the highly digestible microbial protein content, it is possible to work with lower protein input and move from conventional 19–20% in the diet down to 15–16% of dry matter.

4 Conclusions

The space created by a concentrated slow-release NPN can be filled with high quality forage that could reduce the cost of feeding while maintaining levels of production. Extra space created allows for increase of forage/ fibre levels in the diet and maintain rumen health and prevent from metabolic disorders. By using high quality protein sources (slow release NPN, microbial protein with almost the same amino acid profile as rumen bacteria), it is possible to reduce the amount of protein sources from various meals and raise forage level, which is otherwise hard to do when speaking about high yielding dairy cows. This concept is leading to more cost effective diets and higher efficiency by reducing feeding cost per litter of milk, not taking into account the benefits of reproduction parameters being improved.

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