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Original Research

Effect of Replacing Soybean Meal with Distillers Dried Grains on Milk Production and Nitrogen Efficiency Use of Lactating Dairy Cows

N. Munyaneza[1]*, Z. Miburo[1] and Y. El Hachimi[2]

[1]Department of Health and Animal Production, Faculty of Agronomy and Bio-Engineering, University of Burundi, 2940, BUJUMBURA/BURUNDI
[2]Department of Biology, Faculty of Sciences and Technologies, University Cadi-Ayyad,112 Bd. Abdelkrim Al Khattabi, 549, Marrakech, MOROCCO

*Corresponding Author: munyaneza305@gmail.com

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Abstract

This study was conducted to investigate the effects of total replacing soybean meal with dried distiller grains in commercial dairy farm. Data were collected on fifteen lactating dairy cows divided equally into three groups according to their calving date. The experimental rations were calculated and equilibrated using the ALIM32 program (Numerical data was analyzed statistically using the Statistical Package for the Social Sciences (SPSS 20). Results revealed that inclusion of dried distiller grains in the ration increase the efficiency use of nitrogen and reduce significantly urinary nitrogen excretion ($p<0.05$). Indeed, the efficiency use of nitrogen was higher (25.8%±2.3) and urinary nitrogen excretion lower (178g±5.2) when rations included the dried distillers grains ($p<0.05$). Thus, offering dried distillers grains to lactating dairy cows as a major source of protein could increase their efficiency use of nitrogen associated to a little decrease of milk production that could not affect profitability in commercial dairy farms.

Keywords: Dairy Cows, Dietary Protein, Nitrogen Efficiency Use, Urinary Nitrogen Excretion

Introduction

Overfeeding protein is a common practice in commercial dairy farms. Usually, the diets for high producing dairy cows contain on average 18% of crude protein (Pacheco *et al*., 2012). In dairy cows feeding, nitrogen is one of the most expensive nutrients, and is one of the potential risks for environmental pollution. In dairy cows, the conversion of nitrogen in protein milk is approximately 25% and excess of crude protein distributed will mainly found in the urine (Munyaneza and El Hachimi, 2019).

In Marrakech district, the formulated rations for lactating dairy cows are generally composed of corn silage, fresh alfalfa and straw supplemented by concentrate mixture. The nitrogen supplementation is most often assured by soybean meal (SBM). Although SBM is widely used as main nitrogen supplement of cow's diet, only 34% of the proteins present in the SBM escape to the microbial degradation in the rumen (NRC, 2001).Using of SBM in the ration can result in considerable economic loss in dairy farm, because SBM is imported and so expensive.

Given the feed ingredients used in commercial dairy farms, the substitution of SBM with Dried Distiller Grains *(*DDGs) could be particularly interesting. Indeed, DDGs contain poorly soluble proteins (6% of total nitrogen) and are slightly degradable in the rumen (CIGI, 2011). In addition, Chibisa *et al.* (2012) observed that the DDGs could validly replace soya or canola meal in diets without affecting the performance of dairy cows. According to Wickersham *et al.* (2009), addition of DDGs in ration of corn silage increase the synthesis of microbial proteins and the recycling of urea nitrogen via saliva or the rumen wall. The nutritional factors of DDGs are known and their economic viability is now validated (Chibisa *et al*., 2012). The use of DDGs to formulate the diets of dairy cows could reduce amount of nitrogen released to the environment and increase the efficiency use of nitrogen in dairy farms. Thus, the main objective of this study was to determine the effect of SBM total substitution with DDGs in rations of lactating dairy cows.

Materials and Methods

Experimental Conditions

Fifteen lactating dairy cows were divided equally into three groups according to their calving date, especially a group of dairy cows at early of lactation (1≥12weeks), middle of lactation (12≥24 weeks) and at the end of lactation (≥24 weeks). The experimental trials were conducted in two period (from May to July for the first experiment and from October to December 2019 for the second). The Holstein lactating dairy cows were fed at fixed hours in three times before being milked at 6:00, 12:00 and 18:00 hours. In all trials, ground corn and barley grains crushed were used as energy supplement. The distilled grains were dried for 6 days and stored at room temperature. The SBM and DDGs as main nitrogen supplement were distributed as total mixed ration. Wheat straw and fresh alfalfa were offered in outdoor paddock.

Diet Formulation

The ALIM32 program (APC, Liege University, license 2009) was used as the ration evaluator/balancer for the dairy cows selected for experimentation. The basic rations (Table 1) consisted of corn silage and fresh alfalfa. The SBM and DDGs ingredients were used as source of protein supplement of the rations.

Table 1: Ingredients and nutrients composition of feedstuffs distributed in trials

Group of Dairy Cows	Diet/SBM			Diet/ DDGs		
	Early of lactation	Mid-lactation	End of lactation	Early of lactation	Mid-lactation	End of lactation
Ingredients composition(%)						
DDGs	-	-	-	8.9±1.1	7.9±0.8	8.3±0.3
Ground corn	4.3±0.2	3.8±0.7	4.6±1.1	2.0±0.7	2.5±0.3	2.0±0.6
Barley, grain	3.1±0.4	2.6±0.4	2.0±0.7	1.7±0.4	1.8±0.2	1.5±0.2
Fresh alfalfa	20.1±1.2	23.2±1.7	36.2±2.5	19.8±2.3	22.7±2.0	36.8±1.5
Silage, Corn	34.0±0.7	32.5±3.3	33.9±3.2	33.4±1.0	34.0±1.2	31.0±1.1
Wheat straws	3.8±1.8	4.4±0.6	6.9±0.2	3.8±0.1	4.3±1.0	7.1±0.3
Compound feed	25.6±2.6	25.2±1.3	9.8±1.1	28.6±2.2	24.7±1.1	10.0±0.4
SBM	5.4±0.6	4.1±0.5	3.2±0.8	-	-	-
Cereal bran	3.7±0.2	4.2±0.2	3.4±1.0	1.8±0.7	2.1±0.5	3.3±0.3
Nutrient density (/kg DM basis)						
CP, %	18.7±2.9	18.7±2.1	17.3±1.0	16.2±1.1	16.1±0.9	16.9±1.9
NEL, UFL	0.99±0.3	0.98±0.4	0.86±0.2	0.98±0.1	0.97±0.4	0.82±0.1
PDIN, g	107.2±10.2	103.5±9.2	82±7.0	103.7±12.2	99.3±13.2	79.5±10.2
PDIE, g	111.0±12.2	108.5±10.0	88.9±4.2	112.4±13.3	109.1±7.1	89.3±11.1
OEB, g	-4	-4.9	-6.9	-8.6	-9.7	9.7

NEL=net energy for lactation expressed in forage unit for lactating dairy cow (1 UFL = 1730 K calories); PDIN= protein digestible in the intestine with nitrogen as limiting factor for rumen microbial growth; PDIE = protein digestible in the intestine with energy as limiting factor for rumen microbial growth; OEB = On bestendige Eiwit Balans in the Dutch system expressed in rumen protein degradable balance; CP= crude protein. SBM =soybean meal DDGs= dried distiller grains; DM = dry matter.

Data Collection and Analyzes

Individual control of ingestion, refusal and distributed feeds were carried out daily. Dairy cows were systematically weighed on the first day of experiment and on sampling milk day. The body condition scoring (BCS) was taken after two weeks. Individual milk production was weighed and sampled after each milking. Milk samples were transferred to the laboratory for analysis. Urea milk concentration was measured twice a month using a calorimetric p-dimethyl-amino-benzaldehyde (4-DMAB) procedure descripted by Dhali *et al.* (2005).The N ingested (Ni) was calculated by considering the amount of total CP in the diets (CP = N x 6.25). Urinary nitrogen excreting (UNE) and nitrogen N involved in milk protein synthesis (N milk) were determined using predictive linear regression equations described in a meta-analysis of Wattiaux and Ranathunga (2015) as follow:

UNE (g/d) = - 32+16.1*Milk urea nitrogen (MUN)
N milk (g/d) = 188 - 0.25*CP

To determine the efficiency, use of nitrogen (EUN), N in milk was divided by N ingested (Calsamiglia *et al*., 2010). Numerical data was analyzed statistically using the Statistical Package for the Social Sciences (SPSS 20). The significant differences were analyzed using the ANOVA, Scheffé test.

Result and Discussions

During experimentation, each lactating dairy ingested 576±62gN/d of SBM compared to the lactating dairy cow, which consumed 522±43g/N/d of DDGs. A total substitution of SBM with DDGs reduced significantly the CP content from 18.2 to 16.4% (DM basis). An inclusion of DDGs in the diet of dairy cows increase ingestion of DM (0.6 kg) associated on reduction of Nitrogen ingested (54 gN/d/cow). Chibisa *et al.* (2012) reported that the DDGs in diets resulted in an increase of DM ($p<0.01$) and CP intake in lactating dairy cows. The neutral detergent fibre (NDF) content of DDGS is high (from 25.7 to 51.5 %), whereas its lignin content is typically less than 5% and their high digestibility is associated to the low degradable protein in the rumen (Nuez-Ortin and Yu, 2009).

It has been noted that the type of protein source is main factors that could influenced the rumen fermenting process and alter the flow of microbial proteins to the small intestine (Ipharraguerre and Clark, 2005). After all, diet

imbalanced in degradable proteins in the rumen (negative value of OEB) implies that microflora did not get enough ammonia compared to fermentable energy available in the ration. This situation causes the wasting of carbohydrates because of the deprived microflora in the rumen, which disturbs the bacteria activities in fermenting of structural carbohydrates (Calsamiglia *et al*., 2010).

Table 2: N intake and dietary composition of treatments (SBM and DDGs)

Parameters	Groups of Lactating Dairy Cows						Means and SE	
	Diet/SBM			Diet/DDGs				
	Early of lactation	Middle of lactation	End of lactation	Early of lactation	Middle of lactation	End of lactation	Diet/SBM	Diet/DDGs
DMI, kg/d	23.8±1.0	20.7±0.6	14.3±1.2	24.2±0.5	21.1±0.3	14.6±0.1	19.4±0.92	20±0.21
NEL, UFL/d	23.5±1.0	20.3±0.7	12.3±0.5	23.8±0.7	20.5±1.0	12±0.4	18.7±0.87	18.8±0.87
PDIN, g/d	2552±187	2144±142	1173±98	2511±221	2097±187	1162±158	1956±158	1923±203
PDIE, g/d	2642±258	2246±321	1272±193	2721±109	2303±201	1304±126	2053±298	2109±197
OEB, g/d	-96±58	-102±33	-99±62	-209±57	-205±37	-142±43	-99±54	-185±42
CP, %	18.7±2.9	18.7±2.1	17.3±1.0	16.2±1.1	16.1±0.9	16.9±1.9	18.2±2.1	16.4±1.1
Ni, g/d	712± 63	619±78	396±45	627±49	544±41	395±37	576±62	522±43

CP= crude protein; DMI= dry matter ingested; Ni= nitrogen ingested

Generally, offering an unbalanced diet in degradable proteins and energy affects the microflora fermentation activity level of ingestion and limits animal performance (Beckers, 2013; Umashankar *et al*., 2020). However, the growing-fattening cattle have high capacity to recycle N blood *via* the rumen wall and thus, overcome to a possible deficiency of N supply compared to the lactating dairy cows (Decruyenaere *et al*., 2009). The dairy cows are also able to recycle a large amount of nitrogen in its rumen (Marini *et al.,* 2008), but it important to maintain a positive value of the OEB in the diet of lactating cows, given its high protein requirements (Calsamiglia *et al*., 2010). Based on these results, DDGs may replace SBM if they are mixed with a source of degradable protein in the rumen like Oilseed meal or leaves of green fodder. The results presented in Table 3 reveal that total substitution of SBM with DDGs resulted in non-significant reduction of daily milk yield ($p<0.06$). However, others authors observed a significant increasing in milk production of 1.5 kg /d/ cow when DDGs were included in the diet (Chibisa *et al.*, 2012).

Table 3: Effects of total substitution of SBM with DDGs during feeding trial

Group of cows	Diet /SBM			Diet/DDGs			Overall means	
	Early of lactation	Middle of lactation	End of lactation	Early of lactation	Middle of lactation	End of lactation	SBM	DDGs
LW, kg	618±36	585±23	623±42	638±18	613±41	689±48	608±29^{a}	646±40^{b}
DMY, kg	24.3±3.1	16.2±1.8	7.8±1.2	22.8±0.9	15.4±1.2	7.6±1.7	16.1±2.3	15.3±1.7
N Milk, g/d	141.3±0.3	141.4±0.6	139.0±0.2	139.3±0.7	139.5±0.4	140.0±0.3	140.5±0.6	139.6±0.4
MUC, mg/dl	32.7±1.7	28.9±0.8	28.7±1.3	29.2±1.1	28.6±0.8	27.3±1.2	30.1±1.3^{a}	28.3±0.9^{b}
EUN, %	19.8±3.8	22.7±5.6	32.9±4.9	21.1±1.2	23.3±3.2	33.2±2.6	25.1±4.6^{a}	25.8±2.3^{b}
UNE, g/j	210.1±9.7	182±13.1	180.5±11.4	184.2±7.3	179.8±3.7	170.0±2.7	191±12.8^{a}	178±5.2^{b}

Different superscripts in the same row imply that such treatments were significantly different at 5 % level; LW = live weight; DMY = daily milk yield; MUC = milk urea concentrations. EUN= efficiency use of nitrogen, UNE= urinary nitrogen excreting.

During experiments, mean values of urea milk concentration (MUC) ranged from 27.3 ±1.2 to 32.7±1.7mg/dl. A significant difference was observed between two trials of lactating dairy cows ($p<0.05$). The higher value of MUC was observed in dairy cows in early lactation and when the SBM were distributed as main source of nitrogen supplement. This observation signify that more portion of the proteins contained in SBM are degraded by the bacteria in the rumen, which increase the ammonia in the blood and the urea excreted in milk. Otherwise, urea in milk increases linearly when proportion of degradable protein in dairy cows diets is high in relation to nonstructural carbohydrates available in diet (Huhtanen and Hristov, 2009).

Based on the stage of lactation, MUC level was high at the early of lactation and lower at the end of lactation ($p<0.02$). Thus, the variation of MUC follows the evolution of the lactation curve in a dairy herd in which the farmers try to maintain the level of milk production around a peak of lactation by distributing of excessive of crude

proteins in the rations of lactating dairy cows (Arunvipas *et al*., 2003). According to Wattiaux *et al*. (2005), stage of lactation may influence variation of the MUC when the rations distributed to the dairy cows based on their daily milk production. An analysis of variance (ANOVA) showed a significant decrease of UNE when the rations containing a part of DDGs proteins, which reveals an evident environmental and economic benefit of using DDGs as nitrogen supplementation in commercial dairy cows.

During this study, averages of EUN were 25.1 and 25.8 % for diets containing the SBM and DDGs respectively ($p<0.05$). The highest EUN was observed within dairy cows fed with DDGs at the end of lactation. This observation may suggest that the proteins of DDGs in ration have a natural equivalent of a tanned soya meal whose major part of proteins is absorbed in the small intestine (Zhang *et al*., 2010). In agreement with Olmos Colmenero and Broderick (2006), the EUN was significantly high in diet with DDGs but daily milk production slightly decreased comparing to the diet with SBM. Based to present study, the proteins of DDGs are less degraded in the rumen, which influence positively the EUN through the increasing in amino acids uptake in the small intestine.

Conclusion

The present study revealed the possible total substitution of SBM with DDGs rations which is coupled with the efficiency use of nitrogen. Compared to SBM, the utilization of DDGs as source of nitrogen in the dairy cow's rations had advantage of formulating rations containing between 16 and 17 % of crude protein, optimization of milk production and reduce urinary nitrogen excretion to the environment. Therefore, the use of other source of protein like DDGs as rations of dairy cows is recommended to increase the profitability of commercial dairy farm and reduce environmental risks due to nitrogen wastes.

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Conflict of Interests

There is no conflict of interest.

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