FEED QUALITY ASSESSMENT AND RATION OPTIMIZATION IN A DAIRY FARM FROM MURES COUNTY

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RESEARCH ARTICLE

Abstract

The study is conducted on a dairy cattle farm in Târgu-Mureș. Assessments were made over the folder used to feed dairy cows and mycotoxin load. A total of 4 samples were collected from the farm. An organoleptic analysis was carried out on all feed samples and the quality of the feed examined was of good and very good quality, we determined the chemical composition (dry matter, protein, fat, cellulose, ash and nitrogen free extracts), and it can be observed that the protein values in the case of the meal mixture (7.13 %) were lower than the normal range and the percentage of nitrogen free extracts was higher - 72.38 %. Zearalenone, Aflatoxin, and Deoxynivalenol were also determined from each of the samples and all samples were positive but the level was below the maximum limit allowed by the European Community Directives, 2010. The level of zearalenone identified in the analyzed samples ranged from 167.68 µg/kg to 142.33 µg/kg, aflatoxin ranged from 1.20-3.10 68 µg/kg, and deoxynivalenol levels were between 718-1450 µg/kg. An optimizing ration formulation was implemented in order to improve the feeding conditions of the farm animals, for this we used the computer program Hybrimin Futter 5.1.

Keywords: chemical composition, dairy cows, forages, mycotoxins, ration optimization.
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INTRODUCTION

Over the past few years, mycotoxins and their effects on animals have drawn a lot of attention from scientists. Mycotoxins are toxic chemical compounds produced by molds that have a significant negative impact on human and animal health, including animal productivity (Rodrigues, 2013; Kemboi et al., 2020). It is estimated that mycotoxins are present in between 25-50 % of all products manufactured worldwide (Biscoto et al, 2022). Aspergillus, Fusarium, and Penicillium are the major mycotoxin-producing fungi (Zahra et al, 2019).

Environmental factors, damage to grains, and abiotic factors including feed pH and moisture content are all associated to mycotoxin development (Makau et al, 2016; Agriopoulou et al, 2020). Since mold infection can occur in nearly every sector involved, from crop cultivation in the field to the storage and distribution of completed goods, modern animal feed industry faces rising hazards of mycotoxin contamination. It is known that these compounds have harmful consequences when they induce processes that are mutagenic, carcinogenic, hepatotoxic, or estrogenic (Agriopoulou et al, 2016; Agriopoulou, et al, 2020). Aflatoxins (AFLA), deoxynivalenol (DON), fumonisins (FUMO), ochratoxin A (OTA), T-2 toxin (T-2), and zearalenone are the principal mycotoxins detected in animal feed (ZON) (Biscoto et al, 2022). Dairy cattle production is an important component of the food industry.

Nutrition is a key factor in the performance, health, and welfare of dairy cattle. The supply of feed, which accounts for up to 75 % of all direct costs, is one of the key economic issues affecting the profitability of dairy industries. Improving the feed efficiency of dairy cattle has the potential to increase producers' profitability while reducing production costs (Kenny et al, 2018). Given the wide variation in the types of dairy cattle and the different environments in which they are maintained, producers need to be increasingly concerned with optimizing feeding programs (Alqaisi and Schlecht, 2020; Clark et al, 2001).

MATERIAL AND METHOD

The nutrition of dairy cows plays an important role, especially in terms of farm economics, but also in terms of the health of the dairy herd. Unfortunately, on many farms, this aspect is treated superficially and economic

efficiency is not maximized in order to achieve the highest milk yields and efficient use of feed.

The study was carried out on a dairy farm in Mures County. Quality assessments were made on the quality of the feed and the mycotoxin contamination of the forage. A total of four samples were collected from the farm - 2 samples of alfalfa hay, 1 sample of maize silage and 1 sample of meal mix (bran, sunflower meal, soya, maize, oats, wheat). All the forages were analyzed from an organoleptic point of view, the crude chemical composition has been determined regarding - dry matter, crude protein, crude fat, crude ash, nitrogen free extracts. Crude protein analyses were performed by the Kjeldahl method, crude fat was determined by the Soxhlet method, and ash content was determined by incineration at 550 °C (AAOC, 2006; 1995). The crude fiber content was determined by the Weende method (Williams and Olmsted, 1935) and nitrogen-free extract (NFE) was calculated by subtracting ash, crude fiber, crude protein, and crude fat percentages out of 100 g of dry matter. The presence and level of contamination with aflatoxin, deoxynivalenol and zearalenone was also determined. Analyses were performed by ELISA method using the test RIDASCREEN® Aflatoxin B1; RIDASCREEN®FAST DON; RIDASCREEN® Zearalenona. The interpretation of the results was performed according to the EC Regulations No. 1881/2006 and No. 1126/2007 regarding the limits of mycotoxins in fodder and food.

A ration optimization was implemented to improve the feeding conditions of the farm animals. To determine the optimal ration, we used the computer program Hybrimin Futter 5.1.

RESULTS AND DISCUSSIONS

In order to carry out the organoleptic examination, it was necessary to collect the feed from separate points. The samples were examined to observe and determine irregularities related to storage, but no irregularities were reported, the quality of the feed examined from an organoleptic point of view is of good and very good quality (Tabel 1).

After determining the organoleptic analysis, the next step was to determine the physico-chemical analysis of the feed that makes up the ration, with the aim of determining as accurately as possible the nutritional quality.

From this point of view, it was found that the fodder presented moisture values within normal limits. Their composition in organic substances such as: protein, fat, cellulose, ash and nitrogen free extracts are close to the values or in the normal range of those specified in the international literature (Preston, 2013) (Sauvant et al, 2004), in the case of S1 and S2-alfalfa hay samples, and corn silage sample.

Given the scientific studies, for dairy cows, in addition to selected genetics, in order to achieve maximum milk yields, the amount of protein contained in the rations plays a special role. Therefore, in the present case it can be observed that the protein values in the case of the meal mixture (7.13 %) were lower than the normal range and the percentage of nitrogen free extracts was higher - 72.38 % (Table 2).

In other words, the amount of protein in the forages of the analyzed farms varies proportionally to the milk production (Assaminew and Ashenafi, 2015).

The presence of aflatoxin was identified in 3 of the samples but the level was below the maximum limit allowed by the European Community Directives, 2010, i.e. 20 µg/kg for complete feeding stuffs for dairy cows. The mycotoxin level in the maize silage sample was below the limit of quantification which is 1 µg. Of the 4 samples examined for deoxynivalenol, all were positive. Alfalfa hay sample 1 and maize silage had the highest level. Although all samples were positive, the level was within the maximum limits allowed by the European Community Directives, 2010 - 5000 µg/kg. The level of zearalenone identified in the analyzed samples ranged from 167.68 µg/kg to 142.33 µg/kg, and the level of the maize silage sample was below the limit of quantification (50 µg/kg). Also in the case of zearalenone, the values were below the maximum limit allowed by the European Community Directives, 2010 - 500 µg/kg (Table 3).

Table 1 Organoleptic characteristics

Samples	Organoleptic aspects			General appreciation
	Colour	Smell	Structure/Purity	
S1 - Alfalfa hay	Yellowish-green	Typical	Impurities - 2%	Good quality
S2 - Alfalfa hay	Green	Typical	Presence of weeds - 7%	Good quality
S3 - Meal mix	Yellow	Typical	Free of impurities	High quality
S4 - Corn silage	Galben-maroniu-verzui	Typical	Free of impurities	Good quality

Table 2 Chemical analysis result

Samples	D.M. %	Protein %	Fat %	Fiber %	NFE %	Ash %
S1 - Alfalfa hay	90.79	13.82	1.73	23,88	45.7	5.66
	100	15.22	1.90	26.30	50,33	6.23
S2 - Alfalfa hay	91.56	14.65	1.57	26.12	42.7	6.52
	100	16	1.72	28.53	46.63	7.12
S3 - Meal mix	87.86	7.13	2.28	4.12	72.38	1.95
	100	8.11	2.59	4.68	82.38	2.21
S4 - Corn silage	30.62	1.97	0.65	5.76	20.82	1.42
	100	6.43	2.12	18.81	67.99	4.64

D.M. – dry matter;NFE - nitrogen-free extract

Table 3 Concentrations of mycotoxins (µg/kg)

SAMPLES	DON µg/kg	ZEA µg/kg	AFB1 µg/kg
S1 - Alfalfa hay	1130	142.33	3.10
S2 - Alfalfa hay	718	123.96	2.79
S3 - Meal mix	954	167.68	1.20
S4 - Corn silage	1450	16.71	0.9
REGULATORY LIMITS (µg/kg) (2006/576/EC)	5000	2000	10-20

DON, deoxynivalenol; AFB1, aflatoxin B1; ZEA, zearalenone.

In order to improve the feeding conditions of the animals on the farm, model rations for the lactating cow categories were developed which not only cover the nutritional requirements of the animals but also represent an efficient use of the feed resource. To determine the optimal ration, we used the computer program Hybrimin Futter 5.1. The ration used at farm level is shown in figure 1 (for maximum production of 25 l milk) and the optimized rations are shown in figures 2. Figure 1 (ration used on the farm), shows that the dry matter exceeds the requirement of 20750 g, the amount in the ration being 22326 g DM, the protein is also

well above the requirement - 3785.50 g instead of 2650 g, and the ruminal balance which is the ratio between protein and energy is unbalanced in favour of the protein part, which could lead to ruminal alkalosis. As regards the ration used on the farm, it can be said that it is an uneconomical ration, especially due to the fact that far too much lucerne hay is fed (15 kg/day/animal), which results in significant economic losses. In Figure 2, the optimized ration is shown, in which it can be seen that the

amount of alfalfa hay required is much lower and the rumen balance, dry matter and protein are balanced.

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9. Dairy cow, weight: 700 kg, maintenance requirement
Weight: 700.000 kg / Fat: 4.00 % / Protein: 3.40 % / Milk yield: 25.00 kg

Number	Total ration	DM	Total DM	Rate kg
311	Lucerne hay, cut 2	860	12,900	15.000
93	Wheat	870	870	1.000
273	Maize silage 30, medium grains	300	4,500	15.000
97	Wheat bran	880	440	0.500
30	Oats	870	1,305	1.500
49	Maize	870	1,305	1.500
87	Sunflower seed extract. 34% CP	899	629	0.700
81	Soya bean, extracted 42 % CP	870	261	0.300
400	Mineral 22+6+7+2	960	96	0.100
327	Sodium chloride	970	19	0.020
			22,326	**35.620**

Nutrient-	Unit	min	Content	max
Dry matter	g		22326	20750
Basic r. max DM 86	g		10324.73	
Basic r. max DM 05	g		10837.30	
DM-basic ration	g		17400.00	15900.00
NEL	MJ	122.00	122.99	
Crude protein	g	2650.00	3785.50	
Usable crude protein	g	2595.00	3103.15	
RNB	g	10.00	109.18	70.00
Crude fat	g		619.10	1050.00
Starch	g	2100.00	3096.00	7000.00
Sugar	g		846.10	3500.00
%-undegrad. Protein			25.68	
%-Starch non-degra			20.45	
XZ+XS-bXS/ kg DM	g		148	
%Crude fibre/ DM		15.00	22.74	
%str. crude fibre/ DM			19.23	
Milk from NEL	l		25.30	
Milk from prot	l		38.36	
Milk from uCP	l		30.98	
Calcium	g	108.964	265.800	
Phosphorus	g	71.012	77.190	

9. Dairy cow, weight: 700 kg, maintenance requirement
Weight: 700.000 kg / Fat: 4.00 % / Protein: 3.40 % / Milk yield: 25.00 kg

Sodium	g	25.181	27.617	
Magnesium	g	29.181	60.436	
Calcium : Phosphon			=3.44 : 1	
Crude fibre	g		5077.00	4410.00
Struct. crude fibre	g	2800	4293	
Structure value / kg		1.00	2.23	
NEL/ DM	MJ	6.50	5.51	
Cereals	g		4000.00	
Starch+Sugar	g		3942.10	8750.00
Starch non-degrada	g	525.00	633.00	1750.00
Volumes	g		35620.00	
Vitamin A	IE		40000	
Vitamin D	IE		6000	
Vitamin E	mg		100	
Zinc	mg		400.00	
Iron	mg		400.00	
Manganese	mg		300.00	
Copper	mg		65.00	
Cobalt	mg		2.00	
Iodine	mg		2.00	
Selenium	mg		1.00	

Figure 1 Farm ration for dairy cow 700 kg, 25 l milk

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9. Dairy cow, weight: 700 kg, maintenance requirement
Weight: 700.000 kg / Fat: 4.00 % / Protein: 3.40 % / Milk yield: 25.00 kg

Number	Total ration	DM	Total DM	Rate kg
311	Lucerne hay, cut 2	860	6,020	7.000
93	Wheat	870	870	1.000
273	Maize silage 30, medium grains	300	4,500	15.000
97	Wheat bran	880	880	1.000
30	Oats	870	2,163	2.486
49	Maize	870	2,610	3.000
87	Sunflower seed extract. 34% CP	899	899	1.000
81	Soya bean, extracted 42 % CP	870	870	1.000
320	Oat straw	860	1,032	1.200
401	Mineral 24+4+5+2	960	96	0.100
333	Salt lickstone + MGO	970	29	0.030
			19,969	**32.816**

Nutrient-	Unit	min	Content	max
Dry matter	g		19969	20750
Basic r. max DM 86	g		10739.37	
Basic r. max DM 05	g		9708.68	
DM-basic ration	g		11552.00	15900.00
NEL	MJ	122.00	122.00	
Crude protein	g	2650.00	3209.69	
Usable crude protein	g	2595.00	2917.54	
RNB	g	10.00	46.72	70.00
Crude fat	g		626.93	1050.00
Starch	g	2100.00	4516.71	7000.00
Sugar	g		669.06	3500.00
%-undegrad. Protein			27.65	
%-Starch non-degra			20.52	
XZ+XS-bXS/ kg DM	g		213	
%Crude fibre/ DM		15.00	19.60	
%str. crude fibre/ DM			14.19	
Milk from NEL	l		25.00	
Milk from prot	l		31.58	
Milk from uCP	l		28.79	
Calcium	g	107.998	156.178	

9. Dairy cow, weight: 700 kg, maintenance requirement
Weight: 700.000 kg / Fat: 4.00 % / Protein: 3.40 % / Milk yield: 25.00 kg

Phosphorus	g	70.499	78.678	
Sodium	g	25.000	26.148	
Magnesium	g	29.000	52.933	
Calcium : Phosphon			=1.99 : 1	
Crude fibre	g		3914.89	4410.00
Struct. crude fibre	g	2800	2834	
Structure value / kg		1.00	1.77	
NEL/ DM	MJ	6.50	6.11	
Cereals	g		6486.00	
Starch+Sugar	g		5185.77	8750.00
Starch non-degrada	g	525.00	926.72	1750.00
Volumes	g		32816.00	
Vitamin A	IE		35000	
Vitamin D	IE		3500	
Vitamin E	mg		900	
Zinc	mg		400.00	
Iron	mg		400.00	
Manganese	mg		300.00	
Copper	mg		65.00	
Cobalt	mg		2.00	
Iodine	mg		2.00	
Selenium	mg		1.00	

Figure 2 Optimized ration for dairy cow 700 kg, 25 l milk

There are studies in the literature that have shown that milk composition, body mass growth, immunity and reproductive performance are affected in dairy cows by aflatoxin-contaminated feed (Xiong et al, 2015). Field and experimental aflatoxicosis have been previously described in dairy cattle. A van Halderen et al reported an outbreak mortality of 7 out of 25 calves in South Africa in cows fed maize rations containing 11,790 µg/kg aflatoxin. Clinical signs included weight loss, coarse hair, diarrhea and rectal prolapse (A van Halderen et al, 1989). More recently, Umar et al., 2015, reported 45 field cases of aflatoxicosis on a local farm in Okara. Cows were fed maize-rich feed containing 33,500 µg/kg aflatoxin. Clinical signs were anorexia, depression, photosensitization and diarrhea,15 animals died. Experimental studies described aflatoxicosis, clinical signs were low feed intake, reduced milk production, reduced reproductive capacity, lameness, immunosuppression, hepatotoxicity and nephrotoxicity (Goncalves et al, 2015). Applebaum et al. reported a significant decrease in milk production in cattle fed 13 mg aflatoxin per day for 7 days (Applebaum et al, 1982). Zearalenone, binds to estrogen receptors and exerts estrogenic effects in different animal species (Metzler et al, 2010). A 2015 study by Fushimi et al. showed that in breeding cows, a low level of dietary zearalenone (0.1 mg/kg in straw) did not affect fertility, but did affect anti-Mullerian hormone levels (Fushimi et al, 2015). Zearalenone has an oestrogenic response in cattle causing miscarriages and changes in the reproductive system. Abnormal estrous cycle, vaginitis, behavioral estrus in pregnant animals,c mammary gland development in pre-pubertal heifers and sterility have also been reported in cattle fed feed containing 1.5 mg ZEN/kg feed (Coppock et al, 2012). Deoxynivalenone, also called vomitoxin, induces anorexia and vomiting in animals. It is achieved by affecting chemoreceptor trigger centers and causes gastrointestinal damage. It affects ruminal fermentation and causes decreased milk production (Whitlow et al, 2008).

In calves, Valgaeren et al, reported severe liver failure in 2-3 month old calves without functional rumen Indus of 1.13 mg DON/kg feed, indicating the significance of rumen microbiota in DON degradation (Valgaeren et al, 2019).

CONCLUSIONS

The feeding situation on the farm proved to be uneconomical with significant losses due to the feeding of alfalfa hay in too high quantities even for cows whose milk production was 25 l/day, with crude protein levels far exceeding requirements. We recommend the composition of complete and correct rations to optimize the feeding of dairy cows, with computerized rations helping to achieve feed savings if empirical rations are used on the farm, and the use of mycotoxin inhibitors in dairy rations to avoid problems caused by accidental consumption of mycotoxins in feed, as well as storage facilities that comply with animal health standards.

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