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Original research paper

NUTRIENT CONTENT IN DIFFERENT MORPHOLOGICAL PARTS OF MAIZE AND THEIR ORGANIC MATTER DEGRADABILITY

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ABSTRACT: The aim of our study was to determinate nutrient's content and organic matter degradability of different morphological parts (whole plants, stalks, leaves) of maize hybrids dent and dent x flint. Hybrids dent x flint - Mesnil, Chambord, Queen, and hybrids dent- Aude, Meridien, KX 1393, Omero were used. Concentration of crude protein (CP) in leaves was twice higher than in stalks (in average 117.0 $g.kg^{-1}$ DM and 53.0 $g.kg^{-1}$ DM, resp.). The differences in CP were also among hybrids in all plant parts. *In sacco* experiment was carried out on three rumen canullated cows. Hybrids dent x flint had in average higher effective organic matter degradability in whole plants (56.1 %), stalks (38.8 %) and leaves (49.2 %) than hybrids dent (53.8 %, 35.2 % and 43.3 %). Also, the rate of degradation of organic matter (OM) was higher for hybrids dent x flint than for dent. Organic matter in the stalks was degraded more slowly than in leaves.

Key words: *morphological parts of maize, dent; dent x flint, organic matter- rumen degradability, in sacco method*

INTRODUCTION

Maize with her chemical composition and nutrient content is one of the carbohydrate feedstuffs. Maize is characterized with a high content of energy, which is basic assumption of nutrition, although it does not cause abnormalities, but significantly reduces the utility (Sommer et al., 1985).

Individual morphological parts of the plant maize according Struik (1983) is followed: 43 % grain, 16 % leaves, 1 % panicle, 10 % stems and 12 % bracts and have very different nutrients content, which implies the different content of energy. The differences in the content of ADF, NDF and lignin found Kohler et al. (1990) among the hybrids as well as between morphological parts.

In assessing of the feed quality for ruminants is important degradability of nutrients in the rumen. Effective degradability characterizes the changes of feed, the kinetics of its degradation, taking into account the rate of passage from the rumen to duodenum (Ørskov and McDonald, 1979). *In sacco* method allows to obtain these data for several feeds at the same time.

The aim of our study was to determinate nutrient content of different morphological parts of maize hybrids dent and dent x flint and degradability of organic matter in different morphological parts of maize by *in sacco* method.

MATERIAL AND METHODS

Maize hybrids with the type dent (Aude, Meridien, KX 1393, Omero) and dent x flint (Mesnil, Chambord, Queen) were used in our experiment. Organic matter degradability in the morphological parts of maize was determined by *in sacco* method (Harazim and Pavelek, 1999). All the maize hybrids are stay green with different FAO. The samples of maize hybrids were harvested at the time of milk-waxy maturity. The samples were divided into different parts whole plants (stalks + leaves + stems), leaves and stalks. In the whole plant and individual morphological parts were determined original dry mater (DM) and chemical composition. Material designed to degradability determination was freeze-dried and ground. These samples were weighed (approx. 2.50 g dry matter) into bags (9 x 15 cm) made of Uhelon 130T (HEDVA, "Moravská Třebová", the Czech Republic) with pore size of 48 μm. Minimum of three separate bags for hybrids, incubation time and animals were used. The bags with samples were incubated for 2, 3, 4, 6, 9, 16, 24, 48, 72 and 96 hours. The 0 h time bags were only washed in water to determine washing losses.

In sacco experiments were carried out in three nonlactating cows with large rumen cannulae (an average of 10 cm). The animals were fed twice a day with a diet consisting of 70 % forage and 30 % concentrate on a dry matter basis at maintenance level. The ration consisted of maize silage, alfalfa hay, wheat, barley meal (1:1) and Vitamix S1. Access to water was *ad libitum.*

The content of nutrients was analyzed according to Decree MP 2145/2004- 100. Content of ADF, NDF and lignin was determined according to Van Soest (Lutonská and Pichl, 1983). The parameters of degradability (a: rapidly soluble fraction; b: potentially degradable fraction; c: rate constant of degradation; Edg: effective degradability) were calculated using the equations by Ørskov and McDonald (1979) with outflow rate of $0.06.h^{-1}$. The obtained data on nutrients and degradability of organics matter in morphological parts of maize hybrids were evaluated statistically using models in statistical package Statistix 8.0.

RESULTS AND DISCUSSION

The nutritional value of different morphological parts of the plant is decreased with increasing of maturity (Pesch and Gross, 1980). At the time of maize harvesting (milk - waxy stage), leaves had higher content of dry matter than stalks, regardless of the type of hybrids.

Differences among hybrids in the nutrient content of whole plants and dry matter too are not caused only actual differences between morphological parts, but also share various morphological parts of ripeness at harvest (Verbič et al., 1995). Harika *et al.* (1995) asserted that the quality of maize stover depends on the proportions of leaf and stem fractions of the stover.

Starch in whole plants was the highest in hybrid Mesnil (329 $g.kg^{-1}$ DM) and the lowest in Meridien (193 $g.kg^{-1}$ DM).

The differences in the content of ADF, NDF and lignin found Kohler et al. (1990) among the hybrids as well as between morphological parts. It corresponds with our results (Table 2).

A similar course was observed in leaves and whole plants. Tolera and Sudstøl (1999) found that the highest content of fiber, ADF, NDF and lignin had stalks, follow leaves and then whole plants, which also confirmed with our results. We also determined a higher content of NDF and lignin in the stalks like Verbič et al. (1995). A higher content of ADF, NDF and lignin was found in the stalks of dent hybrids than dent × flint hybrids (Table 1), except hybrid Queen.

The concentration of crude protein in leaves ranging from 101 to 126 $g.kg^{-1}$ DM of hybrids dent and from 108 $g.kg^{-1}$ to 144 $g.kg^{-1}$ DM of dent x flint hybrids. An average crude protein content in whole plant was higher in dent hybrids as in dent × flint hybrids (85 $g.kg^{-1}$ vs. 78 $g.kg^{-1}$ DM), the quality of maize proteins is poor because they are deficient at the essential amino acids, lysine and tryptophan (Shewry, 2007).

Among the morphological parts of maize plants and also among maize hybrids are the differences in the chemical composition and it results in the differences of the effective organic matter degradability. Many authors (Negi et al., 1988; Susmel et al., 1990; Mir et al., 1991) referred to the differences in degradability of morphological parts maize plant.

The effective OM degradability (Edg) was found the highest for whole plants of maize (from 51.9 to 56.1 %). The differences were statisticaly significant between the hybrids dent x flint and hybrid dent KX 1393 (Table 2).

The effective OM degradability for leaves was in the range from 41.9 to 52.8 % but they were not statistically significant.

A higher amount of lignin in the stalks was reflected in low levels of all parameters OM degradability.

In particular fraction "a" and effective degradability were lower in the stalks than in leaves and whole plants. The differences among dent and dent x flint hybrids were significant for parameter „a“ and „c“, the effective OM degradability in the whole plants and for Edg (effective degradability) in the stalks. Higher soluble fraction "a" for organic matter in the milk-waxy stage of maturity explain some authors (Verbič et al., 1995) with higher concentration of soluble carbohydrates is in the stalk, and whole plants, resp. We found that the hybrid Meridien with the highest concentration of lignin in whole plants and stalks had the lowest rate of degradation (parameter c) of organic matter.

Table 1. Nutrient content of morphological parts of selected maize hybrids (g.kg^{-1} DM)

	Dry matter			Crude protein			Organic matter			Starch	ADF			NDF			Lignin		
Maize hybrids	WP	S	L	L	WP	S	L	WP	S	WP	WP	S	L	WP	S	L	WP	S	L
Mesnil	374	228	268	78	54	144	965	959	911	329	232	363	287	429	585	537	23	45	25
Chambord	372	281	323	74	35	116	964	965	855	246	231	380	282	436	599	520	28	46	26
Queen	403	287	356	83	52	108	957	947	896	312	252	462	294	455	737	559	32	49	21
Aude	436	300	384	80	57	101	953	952	883	261	246	382	296	480	646	562	27	32	25
KX 1393	375	275	338	90	52	126	953	960	898	205	258	414	314	490	683	576	29	46	29
Meridien	375	274	337	84	62	122	955	951	903	193	287	455	318	566	714	589	24	55	23
Omero	376	234	370	87	56	104	948	938	882	253	280	440	336	549	721	603	30	51	37

WP – whole plants, S- stalks, L- leaves

Table 2. Characteristics of degradability and effective degradability of organic matter morphological parts of selected maize hybrids

Parameter		Maize hybrids						
		Mesnil	Chambord	Queen	Aude	Meridien	KX 1393	Omero
a (%)	WP	41.3[d]	37.8	28.3[bd]	34.6[a]	46.9[abc]	37.1	35.1[c]
	S	27.7	31.0	27.5	25.8	25.2	25.6	23.7
	L	36.3	32.3	23.2	34.7	25.6	27.0	29.6
b (%)	WP	41.0	43.7	52.7	45.8	42.0	48.9	49.6
	S	32.2	36.2	46.1	37.5	44.5	37.8	43.8
	L	49.6	51.7	55.2	52.4	55.5	59.1	48.6
c (%.h^{-1})	WP	0.056[c]	0.042	0.063[ab]	0.047	0.021[c]	0.027[a]	0.036
	S	0.046	0.027	0.024	0.022	0.023	0.037	0.028
	L	0.031	0.038	0.070	0.021	0.028	0.030	0.038
Edg (%)	WP	56.4[d]	56.1[c]	55.9[b]	55.3[a]	54.6	51.9[abcd]	53.2
	S	40.4[abcdef]	40.1[cghijk]	36.0[bh]	33.9[ag]	35.1[ej]	36.8[di]	35.0[fk]
	L	52.8	49.0	49.1	41.9	43.2	42.9	45.2

WP-whole plants, S-stalks, L- leaves. Means with the same letters in the same row are significantly different at $P<0.05$ and $P<0.01$

CONCLUSIONS

The content of nutrient was different in hybrids and changed with morphological parts of maize hybrids. We found the lowest effective degradability of organic matter in stalks then followed leaves and the highest effective degradability of OM had whole plants. From our results follow that between morphological parts of the maize plant as well as among maize hybrids are differences in chemical composition and differences in effective degradability of maize.

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