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Original Paper

Nutritional value of hybrid *Rumex patientia* L. × *Rumex tianschanicus* A. Los (Rumex OK 2) in different periods

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The aim of this study was to determine the nutritive value of hybrid *Rumex patientia* L. × *Rumex tianschanicus* A.Los (Rumex OK 2). Rumex OK 2 can be considered as a technical or energetic plant for renewable production of biomass or as a feed as source of nutrients for animals. In this study two harvestings were planned, firs cut was realised in June (growth from March to June) and second cut was realised in November (growth from July to November). Samples of Rumex OK 2 plants were collected in the 20th day of the month in March to June and in September to November. Concentration of nutrients were detected according to Regulation no. 2145/2004-100. Fresh Rumex OK 2 samples from March 7.42%, April 8.71% and September 4.89% had very low concentration of dry matter (DM). On the other hand samples from March, April, September and October had high concentration of crude protein in range from 31.42 to 24.54% of DM. From start of growth in spring to time of firs cut in June increased both concentration of dry matter from 7.42 to 56.62% and concentration of crude fibre from 14.86 to 47.38% of DM. Concentration of fat in Rumex OK 2 is low and similar to that of maize plant or alfalfa, whereas concentration of nitrogen free extract in Rumex OK 2 plant is similar only to alfalfa. Results of this article bring compact view over nutritional characteristic of Rumex OK 2, which can be according to gained results about nutritional value used as a source of nutrients in animal nutrition, or as a source of renewable biomass for bioenergy production.

Keywords: Rumex OK 2, months, nutrients, fiber complex

1 Introduction

Production of agricultural biomass as a renewable energy is very important part of sustainable development of countryside. It is planned to replace a part of agricultural land in intensive farming with agricultural land used for production of technical or energetic plants. Usťak (2007) as well as Rakhmetov (2018) consider hybrid of *Rumex patientia* L. × *Rumex tianschanicus* A.Los (Rumex OK 2) as one of most perspective energetic plant in climatic condition of V4 countries. Gross energy concentration in Rumex OK 2 plant as well as in silage made from wilted plants were published in our previous publications (Rolinec et al., 2018a and 2018b). Ignore the content of oxalic acid, Rumex OK 2 can be utilised as well as a source of nutrients for ruminants. Unique results of experiment with Rumex OK 2 were published by Petříková (2012). She claimed that Rumex OK 2 can be used for green feeding, as a pasture or in form of silage, and she concluded, that feeding of Rumex OK 2 to dairy cows positively affected the production and composition of milk (Petříková, 2012). Usťak (2007) characterised Rumex OK 2 as plant with 4 to 6 stalks and with leaves in clump. Average high of Rumex OK 2 is 235 centimetres and leaves in clump are high 45 to 60 centimetres in average. Weight of 1000 seeds is 3.02 (2.8 to 3.3) grams. Dry matter ideal for production of biogas or for feed producing is according Usťak (2007) from 18 to 22%. Harvesting by this dry matter can provide 3 cuts per year with average production of 30 to 50 tons of biomass per hectare. For better know about nutritional parameters of hybrid *Rumex patientia* L. × *Rumex tianschanicus* A.Los (Rumex OK 2) we aimed to determine the concentration of basic nutrients of this plant in selected months.

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2 Material and methods

This experiment was realized with fresh plant of hybrid *Rumex patientia* L. × *Rumex tianschanicus* A.Los (Rumex OK 2). Rumex OK 2 plants were grown in experimental fields under Institute of Biodiversity Conservation and Biosafety (SUA in Nitra). It was planned with two cuts. First after mature of seeds in June and second in late autumn. After first cut, Rumex OK 2 starts with growth after rains in summer months. Samples of fresh matter were collected always around 20th day of the month. Samples were collected during autumn months of the year 2017 (September, October and November) and spring months of the year 2018 (March, April, May) and in June 2018. In each sampling time six samples were analysed. Sample of fresh plant collected in October was not analysed because of mistake in predrying. Samples of fresh plant material were cut, the theoretical length of cut was 1 cm and then predried in a hot air oven at 60 °C for two days. After predrying samples were homogenized by laboratory mill. The size of particles after homogenisation was less than 1 mm. The concentration of nutrients were detected according to Regulation no. 2145/2004-100. Concentration of dry matter was determined by the gravimetric method, crude protein by the Kjeldahl's method, fat: extraction by light petroleum, crude fiber: gravimetrically as the residue remaining after extraction in acid and alkali reagent, acid detergent fiber (ADF): gravimetrically as the residue remaining after extraction in acid detergent solution, neutral detergent fiber (NDF): gravimetrically as the residue remaining after extraction in neutral detergent solution, acid detergent lignin (ADL): gravimetrically as the residue remaining upon ignition after 72% H_2SO_4 treatment, ash: ashing with the use of a muffle furnace by 550 °C. Cellulose (CEL) and hemicellulose (HE) were calculated, CEL = ADF - ADL; HE = NDF - ADF. Content of nitrogen free extract (NFE) and organic matter (OM) were calculated NFE = dry matter - crude protein - crude fiber - fat - ash; OM = dry matter - ash (Juráček et al., 2011). Results were statistical analyzed in statistic program IBM SPSS v. 20.0. Differences of means between months within nutrient were tested by Tukey HSD test. P <0.05 was considered as significant.

3 Results and discussion

The concentration of dry matter of Rumex OK 2 increased from 7.42% in March to 56.62% in June. Depends on weather condition and dry matter concentration, the harvesting of Rumex OK 2 for direct combustion is the best at the end of June or during July (Rolinec et al., 2018b), when is the concentration of dry matter the highest. With enough water in soil starts growth of Rumex OK 2 in few weeks after first harvesting. In this case produced Rumex OK 2 in autumn months second crop, however autumn crop is characteristic with very low concentration of dry matter (Table 1). As published Hejduk and Doležal (2004) genus *Rumex* L. is generally known to have very low content of dry matter. Derrick et al. (1993) determined DM content of *Rumex* on value 11.4% and Bockholt and Kannewurf (2001) published DM content in May from 13.0% to 27.0%.

The concentration not only of dry matter but also of other nutrients is affected by fertilisation (Hric et al., 2018; Kovár et al., 2017). According to concentration of crude protein and crude fiber is nutritional quality of Rumex OK 2 in March and April very good (Table 1). Similar statement published also Hejduk and Doležal (2004). Then in May and June came to high decrease in crude protein and high increase in crude fiber concentration, which means decrease of the nutritional value. Interesting was the highest concentration of crude protein in September, at the start of growth of second crop. Crude protein content of Rumex OK 2 plant in early growth stages (Table 1) is

Table 1 Nutritional characteristic of Rumex OK 2 (whole fresh plant)

Month	DM	CP	CFa	CFi	NFE	OM	Ash
	g.kg^{-1}	g.kg^{-1} of DM					
March 2018	74.2^{ab}	261.7^{a}	22.3^{ac}	148.6^{a}	553.8^{ac}	986.4^{a}	13.6^{a}
April 2018	87.1^{a}	245.4^{a}	16.4^{ab}	218.6^{a}	481.6^{ab}	962.0^{a}	38.0^{a}
May 2018	169.1^{c}	100.9^{b}	11.6^{b}	384.9^{b}	438.2^{b}	935.4^{ab}	64.6^{a}
June 2018	566.2d	52.2^{b}	8.9^{b}	473.8^{b}	416.8^{bc}	951.7^{ab}	48.3^{ab}
September 2017	48.9^{b}	314.2^{a}	25.3^{ac}	152.5^{a}	363.5^{c}	855.5^{c}	144.5^{b}
November 2017	77.0^{ab}	302.3^{a}	26.9^{c}	115.0^{a}	444.5^{bc}	888.7^{bc}	111.3^{b}
SEM	47.2	26.4	1.9	35.1	16.2	12.5	12.5
P	≤0.001	≤0.001	≤0.001	≤0.001	≤0.001	≤0.001	≤0.001

DM – dry matter; CP – crude protein; CFa – crude fat; CFi – crude fiber; NFE – nitrogen free extract; OM – organic matter; SEM – standard error of the mean; P – effect of sampling time on nutrient content in that column at P value; ^{ab}… – means within a column bearing different superscript differ significantly at P <0.05

Table 2 Fiber characteristic of Rumex OK 2 (whole fresh plant)

Month	ADF	NDF	ADL	CEL	HE
	g.kg^{-1} of DM				
March 2018	172^{a}	216^{a}	18.4^{a}	153^{ab}	43.8
April 2018	267^{a}	337^{ab}	54.5^{ab}	212^{b}	70.3
May 2018	452^{b}	511^{bc}	115^{bc}	337^{c}	59.6
June 2018	593^{b}	665^{c}	199^{c}	394^{c}	72.8
September 2017	196^{a}	258^{a}	46.4^{ab}	149^{ab}	62.1
November 2017	133^{a}	170^{a}	21.5^{a}	111^{a}	37.1
SEM	43.6	46.7	17.2	27.0	5.0
P	≤0.001	≤0.001	≤0.001	≤0.001	>0.05

ADF – acid detergent fiber; NDF – neutral detergent fiber; ADL – acid detergent lignin; CEL – cellulose; HE – hemicellulose; DM – dry matter; n.a. – not analysed SEM – standard error of the mean; P – effect of sampling time on nutrient content in that column at P value; ab… – means within a column bearing different superscript differ significantly at P <0.05

like that of alfalfa before flowering, which is 240 g.kg^{-1} of DM (Gálik et al., 2016). Young plants, mainly the leaves of Rumex OK 2 offers feed and pasture with high content of crude protein. Questionable is the pasture intake by animals. Derrick et al. (1993) published, that by sheep is intake of fresh feed from *Rumex obtusifolius* L. worse than that of wilted or dried feed. Hejduk and Doležal (2004) claimed that mowed *Rumex obtusifolius* L. is grazed by beef cattle, whereas no mow *Rumex obtusifolius* L. go unnoticed. On the other hand Petříková (2012) published results where dairy cows were fed during summer with grass silage (2/3) together with pasture on Rumex OK 2 (1/3) had mote fat and protein in milk compared to dairy cows in control group fed without Rumex OK 2. The intake of Rumex OK 2 by animals neither in form of pasture or silage need further research as well as its effect on performance of animals. Concentration of ash in Rumex OK 2 samples from April to June (Table 1) is similar to that of maize plant 57 to 84 g.kg^{-1} of DM however samples from autumn months contains similar concentration of ash like alfalfa 129 g.kg^{-1} of DM (Třináctý et al., 2013). Concentration of fat in all Rumex OK 2 samples was compared to maize and alfalfa on lower values (Gálik et al., 2016; Juráček et al., 2012). Concentration of nitrogen free extract was in Rumex OK 2 samples similar as in alfalfa (Gálik et al., 2016) bud lower than in maize (Juráček et al., 2012).

The fiber complex, structural polysaccharides, is in forages an important component and source of energy for ruminants. Fiber complex form 40 to 60% of the dry matter of forages. The content of ADF and NDF are used for the quantitative representation of components of fiber complex (Šimko et al., 2010). Crude fiber content of Rumex OK 2 varied and depends on growth phase and sampling time (Table 1). For comparison, average content of crude fiber is in alfalfa 278 g.kg^{-1} of DM and in maize 225 g.kg^{-1} of DM (Gálik et al., 2016; Petrikovič et al., 2000). Determined values of fiber complex of Rumex OK 2 samples are shown in Table 2. The development of concentration of ADF, NDF, ADL, CEL and HE (Table 2) is similar to crude fiber development (Table 1), the lowest values were detected at start of growth and then increased. ADF, NDF and HE concentration of alfalfa in first cut are in range from 245.6 to 339; from 372.8 to 468.4 and from 127.2 to 129.4 g.kg^{-1} of DM respectively (Třináctý et al., 2013). Silage maize contains following concentrations of ADF 189.2 to 237.5 g.kg^{-1} of DM, NDF 367.7 to 465.1 g.kg^{-1} of DM and ADL 16.3 to 26.5 g.kg^{-1} of DM (Juráček et al., 2012). All crops are typical for its concentration of fiber and its components. The concentration of fiber components develop similar, the older crop means the higher concentration of fiber components (Table 2). This support also results of this study. Significant (P <0.001) effect of sampling time on DM content as well as on content of all nutrients and fiber components (except HE) was detected (Table 1 and 2). Differences of average means of basic nutrients and fiber components between months are shown and marked with superior character in Table 1 and 2. Changes of nutrients as well as fiber components concentration of Rumex OK 2 are caused due to aging effect of plant.

4 Conclusions

Results of this article bring compact view over nutritional characteristic of Rumex OK 2. Nutritional value of Rumex OK 2 was compared to that of fresh maize or alfalfa plants. From this results is clear, that young Rumex OK 2 contains in March, April and then after first harvesting in September and November very low dry matter content but with interesting content of crude protein. Concentration of crude fat in Rumex OK 2 is similar to that in maize. Concentration of crude protein in early growth

stage of Rumex OK 2 is similar to that of alfalfa. For better understanding of protein quality, analyze of the amino acids is needed. Anyway, Rumex OK 2 can be used as a source of nutrients in animal nutrition, or as a source of renewable biomass for bioenergy production.

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