EXPERIENCE OF FODDER GALEGA (*GALEGA ORIENTALIS* LAM.) AND TRADITIONAL FODDER GRASSES USE FOR FORAGE PRODUCTION IN ORGANIC FARM

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Summary. Fresh mass of fodder galega is protein rich and contains bio-active substances (vitamins, especially C, carotene, and minerals), and therefore is high valuable fodder. Moreover, fodder galega produce heavy yield (60–70 t ha^{-1} fresh mass, 15 t ha^{-1} hay, and 12 t ha^{-1} dry materials) without mineral fertilizer supplement, thus biomass is ecologically safe feed.

The main object of this study was to evaluate galega chemical composition, selective consumption as well as the effects of increasing cattle daily liveweight gain of stable feeding and grazing. Feeding and grazing experiments were carried out at organical farm conditions during years 2008–2009. Agrochemical analyses of timothy, red clover and galega biomass were done at Agrochemical Laboratory of Lithuanian Agriculture University.

Biomass of fodder galega has better chemical content and metabolisable energy (9.6 MJ kg^{-1}) than traditional feed grasses, namely timothy (8.1 MJ kg^{-1}) and red clover (9.3 MJ kg^{-1}). Moreover, galega fresh mass and hay of fodder galega were suitable for feeding due to good edibility (4–5 points). Galega enriched animal ration with protein' (223.2 g kg^{-1}), vitamins' as well as with Ca (12.41g kg^{-1}), Mg (3.62 g kg^{-1}), Fe (80 mg kg^{-1}) and Cu (8.0 mg kg^{-1}). Therefore galega improved feed value and selective consumption of animal feeds. The daily liveweight gains of free grazing and stall-feeding heifers came up to 634 and 863 g, respectively, and average increase by 70 and 61 g in comparison with heifers' intake of cultural pasture grass was observed.

Keywords: ecology, *Galega*, productivity, feed value, edibility, heifer, liveweight gain.

RYTINIO OŽIARŪČIO (*GALEGA ORIENTALIS* LAM.) IR TRADICINIŲ PAŠARINIŲ ŽOLIŲ PANAUDOJIMAS PAŠARUI EKOLOGINIAME ŪKYJE

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Santrauka. Šviežia rytinio ožiarūčio masė yra baltyminga ir turi bioaktyvių medžiagų (vitaminų, ypač C, karotino ir mineralų), todėl yra didelės pašarinės vertės. Be to, rytinis ožiarūtis išaugina didelį derlių (60–70 t ha^{-1} šviežios masės, 15 t ha^{-1} šieno ir 12 t ha^{-1} sausųjų medžiagų) nenaudojant mineralinių trąšų, todėl biomasė yra ekologiškai saugi.

Pagrindinis šios studijos tikslas buvo įvertinti ožiarūčio cheminę sudėtį, ėdamumą ir efektyvumą galvijų gyvojo priesvorio didėjimui šeriant tvarte ar ganant. Šėrimo ir ganymo bandymai atlikti ekologiniame ūkyje 2008–2009 metais. Agrocheminės motiejuko, raudonojo dobilo ir ožiarūčio analizės atliktos Lietuvos žemės ūkio universiteto Agrochemijos laboratorijoje.

Rytinio ožiarūčio biomasės cheminė sudėtis ir apykaitos energija (9,6 MJ kg^{-1}) buvo geresnė, negu tradicinių pašarinių žolių, būtent motiejuko (8,1 MJ kg^{-1}) ir raudonojo dobilo (9,3 MJ kg^{-1}). Be to, šviežia ožiarūčio masė ir šienas yra tinkami šerti dėl gero ėdamumo (4–5 balai). Ožiarūtis papildo gyvulių racioną baltymais (223,2 g kg^{-1}), vitaminais bei Ca (12,41g kg^{-1}), Mg (3,62 g kg^{-1}), Fe (80 mg kg^{-1}) ir Cu (8,0 mg kg^{-1}). Taigi ožiarūtis pagerina gyvulių pašarų vertę, padidina suvartojimą. Ganomų ir tvarte šeriamų telyčių paros prieaugis buvo 634 ir 863 g, o vidutiniškai padidėjo 70 ir 61 g palyginti su telyčiomis, ėdusiomis kultūrinės pievos žolę.

Raktažodžiai: ekologija, *Galega*, produktyvumas, pašarinė vertė, ėdamumas, telyčios, svorio prieaugis.

Introduction. Fodder galega (*Galega orientalis* Lam.) is one of the 8 species which belong to leguminous (*Fabaceae* Lindl.), genus of galega (*Galega* L.). These species originated from Balkan, Asia Minor, Iran (Vavilov, Kondratjev, 1975). Fodder galega originates from Caucasus forested slopes and river valleys (Fig. 1) at 305–1820 m above sea level starting at forest-steppe on foothills and ending at medium subalpine zone.

The other galega species – medicine galega (*Galega officinalis*) is usually cultivated as ornamental and medicinal plants in Europe. Plant name came from the Greek words, *Gala* - milk and *agen* – to increase, i.e. herb that promotes lactation. Therefore medicine galega was used in ethno medicine in Germany, France and other countries. At the end of the 18th century Germans attempted to use the medicine galega for feed, but it contains an alkaloid vasicine, therefore the species has not spread as fodder grass. Fodder galega contains a trace of this alkaloid (Susag et al., 2003). In addition, it is resistant to rugged climate. Northern Caucasian and Larijsk' forms of fodder galega are found in nature. Caucasian is an earlier form, characteristic with earlier seed maturation and a larger number of stem internodes, and therefore more preferable for cropping.

Fig. 1. ***Galega orientalis* Lam. native population in Crimea Nature Reservation, Valley of Alma River** (1996; personal archive)

Fodder galega is a perennial long persistent (25 year and more) herbaceous plant with tap root system composed of combined lateral rhizomes. At a depth of 7 cm the main roots produce 2–18 lateral offspring - rhizomes. They grow horizontally over 30 cm in length, and form buds, which are sprouting shoots. Thus fodder galega propagates vegetatively, making its stand thicker every year. The main mass of roots is located at a depth of 50–80 cm, at a maximum of 2 m. From 2 to 4 x 1.0 to 4.5 cm nodules formed on lateral roots. Root nodules contain endophytic *Rhizobia galegae* which perform nitrogen fixation and thus foster its accumulation in rhizosphere and increasing soil fertility (Baležentienė, 2005; Naeem et al., 2010). Noteworthy, metabolic products emerged during endosymbiosis are exchanged between bacteroids and host cells and thus support host plant productivity and protein increase (Heldt, Piechulla, 2011; Pawlowski et al., 1996; Markmann, Parniske, 2009). Therefore galega without application fertilizers could supply with ecologically safe and heavy yield: 60–75 t ha^{-1} green mass, 15–17 t ha^{-1} hay and 0.3–0.7 t ha^{-1} seeds (Šlepetys, 2008; Daugėlienė, 2010). Crude protein content ranged between 195-231 g kg^{-1} in dry materials, 190 g kg^{-1} in hay and 198 g kg^{-1} in grass flour (Baležentienė, 2008). Biomass metabolic energy ranged between 7.69–10.79 MJ kg^{-1}. Fresh mass is rich in biologically active substances: vitamins, especially C, pro-vitamin carotene, and minerals. Moreover, galega can increase milk production of cows by 13%, milk fat content by 0.2–0.3%, pig weight gain by 11% (Leikus, 1996).

The species is among the earliest fodder plants in Lithuanian agrophytocoenoses, with early beginning of vegetation (1–10 of April) and achieving flowering stage at the end of May. Thought average seed maturity duration takes 98–102 days in the Middle Lithuania, however duration of galega vegetation lasts long, and irrespective of meteorological conditions it finishes in the end of October – beginning of November. Thus fodder galega is suitable supplement as one of the first and the last for green conveyer. Galega is valuable for making silage, haylage, hay, leaf protein concentrate and grass meal (Baležentienė, Mikulionienė, 2006). Fodder galega cropping thus has a great ecological and economical importance.

The main aims of this study were to evaluate possibility to grow fodder galega (*Galega orientalis* Lam.) and to produce ecologically safe feed under organic farm agro-environment; to assess the quality and feed value through analyzing galega raw materials by reference methods in order to compare these properties with those of timothy (*Phleum pratense* L.), red clover (*T. pretense* L.) and their mixture; and to determine galega selective consumption and impact on cattle gains in organic farm.

Materials and methods. Assessments of the productivity and feed value of fodder galega (*Galega orientalis* Lam.), timothy (*Phleum pratense* L.), red clover (*Trifolium pratense* L.) and their mixture were carried out at organical farm of G. Jačionis (Ukmergė distr., Želva township, Kiaukliškis II vilage) during 2008-2009. The crops were sown without a cover crop and grown without N fertilizer, whereas the fertilizer backgrounds P_{60} and K_{60} were applied only in autumn. The 3- cut system was applied manually at the beginning of plant flowering stage. Forage plants were harvested during at the early flowering stage. Dry matter (DM), crude protein (CP), crude fiber (CF) were determined according to the commonly used Wende forage analyses, metabolic energy (ME, MJ kg^{-1}) and netto energy of lactation (NEL, MJ kg^{-1}) grasses was calculated by a formula Nauman and Bassler (1993).

Dry material (DM) was determined drying constant mass at 105°C. Total nitrogen was measured as Kjeldahl nitrogen (LST EN ISO 5983-1:2005), crude fibre (CF) by hydrolysis in HCl solution (Hindrichsen et al., 2006), crude lipid (CL) by extraction in Soxhlet apparatus, crude ash (CA) determined gravimetrically after biomass dry combustion at 600°C.

Element contents in dry materials (DM) were analyzed using near-infrared reflectance (NIR) spectroscopy (PSCO/ISI IBM-PC 4250; Pacific Scientific, USA) according to the database of assessed plants. Chemical analysis of examined crops raw materials was determined according reference methods of forage analysis in Chemical research laboratory of the Lithuanian research centre for agriculture and forestry (Faithfull, 2002; Grudfuttterbewertung, 1999).

Metabolisable energy (ME MJ kg $^{-1}$) of silages and examined forage grasses was express by a formula (Nauman, Bassler, 1993; AOAC, 1990):

$$ME = 14.07 + 0.0206 \times CR - 0.0147 \times CF - 0.0114 \times CP;$$

means:

CL – crude lipid g kg^{-1};
CF – crude fibre g kg^{-1};
CP – crude protein g kg^{-1}.

Experiments of galega fresh mass selective consumption, stable feeding and grazing were carried out at V. Kasperavičius organic farm (Šakiai distr., Slavikai). Each experiment consisted of an adaptation period of 2 weeks, followed by a measurement period of 26 (in edibility, stable feeding experiment) or 40 (in grazing experiment) days. Animals were weighed at the beginning and the end of the measurement periods.

Fresh mass of galega and of cultural pasture was used for cattle and pigs (*White* x *Danish Landrace* of 1st generation) feeding in selective consumption experiment (Savadogo et al., 2000). Additionally, galega hay was used for cows *Lithuanian black-white* feeding. 12 animals were selected for each experimental group. Every day of the measurement period, residuals of offered feed was analyzed before morning feeding. Feed edibility was evaluated visually by 5 point system: 5 - very good or 80–100 %; 4 - good or 60–80%, 3 - satisfactorily or 40–60%; 2 - poor edibility or 20–40 %, 1- bad or 5–20 % edibility and 0–totally inedible feed.

20 heifers with average weight of 310 kg and averaging 8 months of age were selected by analogue principle for stall feeding. Control group was fed with grass of cultural pasture and the experimental group - with mixture composed in 50 % galega and grass of cultural pasture, in which mean fibre content was 14.58 %. Heifers were weighted after 26 days and their body gains were evaluated.

For comparative experiment of galega grazing two groups of 12 heifers (weighing 220 kg) in each were selected. Animals were weighed at the beginning and at the end of the measurement periods. Control group was free-grazing in cultural pasture. Experimental group was grazing in sward composed of 50–55 % galega, 15% timothy, 15 % fescue and 15% other grasses.

The confidence limits of the data were based on one–way analysis of variance by ANOVA (in case of significant interactions) followed by post hoc Tukey theoretical criterion. The least significant differences between treatment means were determined using Fisher's least significant differences (LSD_{05}) calculated at level of statistical significance $p<0.05$. Results of chemical composition are presented as a mean of 2 independent analyses at the 0.05 probability level.

Results and discussion. ***Productivity and feed value of fodder galega.*** Galega persists and completely covers bare plots in spring by intensive formation of creeping rhizomes given its intensive growth and vegetative spread, galega forms dense and pure stand, which, in turn, shade out and eliminate other species. Therefore weeds and forbs compose only 2–3%. Furthermore, a clean enough stand thus indicates a highly competitive and suppressive capacity of galega. Nonetheless, galega development is slow during the first year and hence it should be sown with a cover crop on a purpose to suppress weeds. Galega completes ramification on the 3rd year by forming continuous cover which is resistant to weed or forbs establishment in crop field. Galega vegetation and regrowth starts on the 1–10 APR, i. e. that is earlier than other perennial legumes and grasses; and thus could be cut for fresh mass at the end of May.

Botanical composition of the sown grass stand mainly depends on the biological characteristics of grass. During the first three years the plant density (average by 216–241 stems m^{-2}) was lower in the pure sown legume swards than in mixtures. In this period 3-component mixture showed continuous and dense ground cover already in the sowing year as well as during later years. The highest average plant density (614 steams m^{-2}) has formed in the fodder galega, r. clover and timothy mixture. The density of red clover in the stands began to decline in the second year. Therefore red clover is less persistent in comparison with the investigated long-persistent legume fodder galega.

Nutrient material content and metabolisable energy density change in relation to both plant species and growth season (Butkute, Paplauskiene, 2004; Mikulionienė, Stankevičius, 2002). Accordingly, these indices had also varied across different galega vegetation stages as well as cuttings 1 to 3 (Table 1). CF content ranged between 218.0 and 246.2 g kg^{-1} at early growth stages, namely at tillering and budding, and culminated at flowering by reaching 258.0 g kg^{-1} due to lignification of plant stem (Butkutė, 2010; Cassida et al., 2000; Baležentienė, 2003). In order to produce higher quality feed galega the 1st cutting should be performed as early as possible, e.g. at plant budding-beginning of flowering stage, until plant is lignified and plant digestibility rate has decreased. In addition, CP, mineral and ME content in biomass also declined while galega matures. Nonetheless, galega calcium (8.9–10.9 g kg^{-1}) and phosphorus (3.5–3.7 g kg^{-1}) ratio remains quite favourable for cattle nutrition, even in flowering stage of different cuttings (NRC, 2001; McDowell, 1996).

In difference chemical composition of galega was observed in the 1st–3rd cuttings (Table 1). The best crop quality was obtained at the 1st cutting due to favourable growth conditions, namely sufficient soil moisture, and temperature and the increasing intensity of solar radiation (Adamovics, 2000). Nonetheless, the insignificant differences in galega mean chemical composition between cuttings were determined. Therefore galega chemical composition was more dependent on plant maturity, than on number of cutting. Moreover, due to sufficient regrowth of galega, three cuttings during the vegetation period at plant flowering stage should be recommended (Cassida et al., 2000). The higher number of cuttings has not been tested, because the plants did not used to overgrow. Given the 2nd harvest was followed by decrease in both plant and environment resources, the slowest regrowth of atoll was observed. It can therefore be concluded that three harvests is the optimum of galega crop use for green feed amidst our agroclimatic conditions.

Comparison of feed value of galega, timothy and red clover. The highest CP (223.2 g kg^{-1}) and CL (26.8 g kg^{-1}) content were obtained for galega biomass (Table 2). As recorded in references (Fulkerson et al., 2007; Trevaskis et al., 2004), the lowest share of CP (189.8 g kg^{-1}) was observed in timothy biomass as compared with legumes: galega (223.2 g kg^{-1}) or red clover (219.4 g kg^{-1}). The lowest CL content (24.4 g kg^{-1}) was determined in DM of red clover. Nonetheless, medium content of organic materials and minerals was observed in biomass of 3-component mixture.

Table 1. **Chemical composition** (g kg^{-1} DM) **of fodder galega biomass at different growth stages and cuttings** ($p<0.05$)

Growth stage / Cutting	CP	CF	CA	CL	P	K	Ca	ME, MJ kg^{-1}
I cutting								
Tillering	267.0	210.8	109.5	29.9	5.9	15	10.9	10.79
Bud phase	247.5	246.2	98.3	26.7	4.4	10.8	9.7	9.73
Beginning of flowering	226.4	258.8	79.2	24.6	4.0	9.1	9.8	8.64
Full flowering	189.9	285	70.3	21.5	3.5	8.3	9.9	7.69
Mean	232.7	250.2	89.3	25.7	4.5	10.8	10.1	9.2
LSD $_{05}$	10.3	12.1	8.79	3.41	0.47	1.01	0.92	1.03
II cutting								
Tillering	233.7	252.9	80.6	25.1	4.2	9.5	9.1	9.41
Bud phase	234.0	252.1	80.0	25.2	4.0	9.4	9.2	9.45
Beginning of flowering	234.4	251.5	80.9	25.3	4.1	9.3	8.9	9.38
Full flowering	234.6	250.8	81.0	25.4	3.5	9.1	8.9	9.36
Mean	234.2	251.8	80.6	25.3	4.0	9.3	9.0	9.4
LSD $_{05}$	9.87	11.4	7.01	0.19	0.04	0.12	0.14	0.91
III cutting								
Tillering	239.1	247.5	84.3	25.9	4.2	9.3	9.4	9.61
Bud phase	229.0	248.7	84.0	24.3	4.0	8.9	9.1	9.43
Beginning of flowering	220.2	248.9	83.1	21.7	3.9	8.7	9.0	9.31
Full flowering	219.7	251.0	80.1	21.0	3.7	8.5	9.0	8.69
Mean	227.0	249.0	82.9	23.2	4.0	8.9	9.1	9.3
LSD $_{05}$	9.02	9.11	2.97	2.61	0.45	0.11	0.10	0.87

Mineral deficiencies and imbalances for cattle are reported from almost all regions of the world, therefore it is actual determine its concentration in forage plant. If focusing on mineral composition across treatments, the highest P, Ca, and Na content (4.84; 12.41 and 0.64 g kg^{-1} respectively) was observed in galega DM. Thus sufficient average mineral content confirmed galega importance for supplying cattle with essential elements and for ensuring their normal metabolic and vital functions (Marçal et al., 2001; Naeem et al., 2010). Sufficient P content (4.51 g kg^{-1}) was observed for dairy cows ration in red clover, but was too low in timothy DM (NRC, 2001). According to NRC, 2001 guidelines, 3.3–4.8 g kg^{-1} P in a feed is adequate for all classes of beef and dairy cattle. Noticeably, not only the content of calcium and phosphorus, but also their ratio is important. For ruminant the optimal Ca:P ratio is considered to be that between 1.5 and 4 (NRC, 2001). While this ratio ranged between 2.3 in timothy and red clover, 2.5 in galega and 2.6 in 3-component mixture, the tested feed did not required additional supplement with P and guarantee sufficient Ca supplement for the maintenance as well as fetal skeletal development (Kume et al., 2001). Nonetheless, the latest data referred that P requirement for dairy cows is not associated with Ca (Taylor et al. 2009). Additionally, broiler chicken better convert minerals when Ca:P ratio in feed ranged between 2.0 and 2.4 (Jarulė et al., 2008), and thus treated crops are appropriate feed for broiler also.

K and Na has great importance in the feeding regime for high producing cows as the main strategy to increase milk production and reduce urine volume (Kume et al., 2008; Swift et al., 2007). Optimal rates of K (10.6–15.5 g kg^{-1}) and Na (0.30–0.64 g kg^{-1}) have been accumulated in biomass of all tested crops and thus enhanced feed positive balance (NRC, 2001; Kume et al., 2001).

Means for Mg ranging from 3.61–4.20 g kg^{-1} showed satisfactory content on the requirement of 1.89 g kg^{-1} for cattle according to NRC (2005).

The highest ME of 9.6 MJ kg^{-1} was found in DM of fodder galega. The content of ME varied between 8.1 MJ kg^{-1} in timothy, 8.4 MJ kg^{-1} in grass mixture and 9.3 MJ kg^{-1} in red clover. The requirements for maintenance of a typical 600 kg cow producing 30 kg milk with 4.04% milk fat and 3.28% milk protein encompass 1697 g metabolisable protein and 220 MJ cow^{-1} day^{-1} (AFRC, 1993). To meet this requirement, the cow would have to eat 19.1 kg DM day^{-1} of a feed containing 89 g metabolisable protein and 11.5 MJ kg^{-1} ME. The present study has shown that all forage species would provide sufficient protein (189.4–223.2 g kg^{-1}). However, metabolisable energy is the primary limitation for milk production in all tested grasses and their mixture, even if their top quality can be provided.

Boron (B) was first reported to be essential in the completion of the lifecycle in several leguminous plants (Warrington, 1923). For instance, it was proposed that B could affect gene expression through its interaction with transcription factors (Camacho-Cristóbal et al., 2011). Moreover, its deficiency causes an alteration in the expression of a wide range of genes involved in several physiological processes, i. g. in N_2 fixation in legume plants (Yamagishi and Yamamoto, 1994). Therefore B content was assayed and determined of 1.23–1.92 mg kg^{-1}which could be reported as a safe range for animals in all tested feed crops (Table 3). Though recent studies indicate that dietary B may affect immune responses (Armstrong et al., 2001; Nielsen, 2002), substantial evidence also suggests that mammals require B. A specific biochemical role for B, however, has not been established (NRC, 2005) yet. Noteworthy, Fry et al. (2011) recorded, that a basal diet containing 13.3 mg B kg^{-1} did not affect immune response, whereas B rate of 15 mg kg^{-1} does not have a negative impact on animal.

Table 2. **Comparison of chemical composition and metabolisable energy of fodder galega** (*Galega orientalis*)**, red clover** (*Trifolium pratense*)**, timothy** (*Phleum pratense*) **and their three component mixtures** ($p<0.05$)

Treatment	Content, g kg^{-1} in DM										*ME, MJ kg^{-1}*
	DM	Crude protein	Crude fibre	Crude ash	Crude lipid	P	K	Ca	Na	Mg	
G. orientalis	220.0	223.2	256.8	95.0	26.8	4.81	10.6	12.41	0.64	3.62	9.6
Ph. pratense	214.1	189.8	249.0	106.3	26.5	3.3	10.8	7.6	0.31	4.20	8.1
T. pretense	212.3	219.4	240.0	91.0	24.4	4.51	15.5	10.2	0.30	3.61	9.3
G. orientalis + T. pratense + Ph. pratense	215.1	194.2	194.2	90.0	25.2	4.6	13.8	12.0	0.35	3.60	8.4
LSD_{05}	9.4	7.3	8.5	1.3	1.1	0.7	0.9	2.0	0.01	0.01	0.9

Cu with average ranging from 3.50 mg (timothy) to 8.00 mg (galega) showed deficiency only of 25% in timothy for applications ranging from 6–10 mg Cu kg^{-1} DM according to NRC (2005). In a very recent study carried out by our research group (García-Vaquero et al., 2010) it was found that in intensively reared beef cattle, supplementation of 15 mg Cu sulfate in kg DM in the diet (a routinely Cu supplementation in intensive beef cattle all over the world) led to a significant decrease in As, Pb and Hg residues in offal (liver and kidney).

The NRC (2001) suggested a feed Zn concentration of 30 mg kg^{-1} as a critical level for beef cattle. For dairy cattle a much higher (40 mg kg^{-1}) feed Zn concentration is required. Galega (15 mg kg^{-1}), timothy (10.0 mg kg^{-1}) and red clover (18.5 mg kg^{-1}) samples, however, had extremely low Zn concentrations (Table 3). This is consistent with the findings of a previous study that reported Zn deficiency in crop residues produced in Lithuania (Mikulionienė, Stankevičius, 2002). Generally, trace element deficiency can be explained by the composition of the soil (Anguelov, Anguelova, 2009; Oishi et al., 2011). Typically the greatest impairment of Zn and other trace element deficiencies may be on immune function, but in cases of severe deficiencies production traits such as reproduction efficiency and other performance parameters can be impacted (Siciliano-Jones et al., 2008). Appropriate solution for compensation of element deficiencies is use of mineral supplements in ratio (Formigoni et al., 2011; Pal et al., 2010). The variation of Mn showed averages deficiency of 7.50 mg kg^{-1} (timothy) to 15. 00 mg kg^{-1} (clover) represented the attendance requirements of 80 mg kg^{-1} DM. The low quantity and quality of minerals available grazing livestock are the main causes of low output rate on the farm and is responsible for the appearance of many diseases linked to malnutrition, energy, vitamins and minerals. Therefore supplementation to correct the deficiencies of Mn required in accordance with the category the animal. Fe showed sufficiency in all tested crops compared to the standards of NRC (2005) of 50 mg kg^{-1}.

Very small concentrations (0.07–1.87 mg kg^{-1}) of non-essential toxic trace element (Cr, Cd, Pb and Ni) were observed in tested crops, and thus have not exceeded safe limits established for ensuring animal health (Council Directive 86/278/EEC) (Table 3).

Table 3. **Comparison of trace and heavy element content** (mg kg^{-1} DM) **in biomass of galega, timothy and red clover** ($p<0.05$)

Element	Galega	Timothy	Red clover	LSD_{05}
B	1.23	1.34	1.92	0.43
Cu	8.00	3.50	6.00	1.01
Zn	15.00	10.00	18.50	8.02
Mn	12.00	7.50	15.00	3.01
Fe	80.00	35.00	75.00	14.06
Cr	0.95	1.25	0.90	0.10
Cd	0.15	0.07	0.17	0.01
Pb	1.37	0.75	1.15	0.11
Ni	1.87	0.72	1.12	0.13

Testing galega feeding and selective consumption. Selective consumption is a complicating factor in the measurement of intake and digestibility of forages (Savadogo et al., 2000). Therefore it is actual to evaluate edibility of non-traditional feed plant galega. Investigations found that galega is quite well edible feed plant for all of tested animals (Table 4). Indeed, selective consumption resulted in the highest rates of the consumed galega green mass intake for dairy cows, fed steers and pigs (60 to 80%, or 4 points). The selective consumption ratios for galega hay intake, however, were lower if compared to those for galega fresh mass and ranged between 40 and 60 % (3 points) for the withered galega stems are quite bulky and rigid. However it was found, that galega is suitable for use in animal feed, for both cattle and pigs.

Effectiveness of galega feed value was evaluated by daily liveweight gains of stall-feeding and free grazing heifers. Daily liveweight gains of stall-feeding heifer came up to 863 g (Table 5). This value significantly ($p<0.05$) exceeded control by 61 g.

Similar results have been obtained for grazing heifers (Table 6). Weight gains of free-grazing heifers were lower than those of stall-fed, but good enough and ranged around 564–634 g. Daily gains of free-grazing heifers on galega and grass mixtures came up to 70 g more than those on usual cultural grazing pasture. Given that, heifers increased gains confirm galega importance for cattle feeding, possibly due to sufficient protein content (Rutter et al., 2002). Moreover, unfertilized galega can be considered as the ecologically safe outcome of the organic agriculture (Fraser et al., 2009).

Conclusions. The carried out studies confirmed successful adaptation of fodder galega to organic farming environment. Moreover, this species is valuable protein rich (189.9–267.0 g kg^{-1}) fodder between tested crops. General feed productivity of galega biomass can be achieved at budding-beginning of flowering of the 1st cutting.

Table 4. **Evaluation of selective consumption of fodder galega**

Animal species	Feed	Selective consumption	
		%	Points
Dairy cow	Green mass	60–80	4
Dairy cow	Hay	40–60	3
Fed steer	Green mass	60–80	4
Pig	Green mass	60–80	4

Table 5. **Impact of galega fresh mass on stall-feeding heifer daily liveweight gain** ($p<0.05$)

Heifer group	Liveweight, kg		Daily gain, g	Comparing with control, g
	Before feeding	After feeding		
Control	315	349	802	-
Experimental	310	385	863	61
LSD_{05}	10.6	27.3	34.7	

Table 6. **Testing of galega on daily liveweight gain of free-grazing heifer** ($p<0.05$)

Heifer groups	Liveweight, kg		Daily gains, g	Comparing with control, g
	Before grazing	After grazing		
Control	228	268	564	-
Experimental	212	279	634	70
LSD_{05}	11.4	14.2	30.6	

The present study showed that all forage species would provide sufficient protein (189.4–223.2 g kg^{-1}). Nonetheless, metabolisable energy density (8.1–9.3 MJ kg^{-1}) is insufficient for milk production in all tested grasses. Protein, mineral and ME content in biomass declined during galega maturity. Nonetheless, galega calcium (5.9–7.0 g kg^{-1}) and phosphorus (3.5–3.7 g kg^{-1}) content as well as their ratio (2.5) remain quite favourable peculiarities for cattle nutrition, even at flowering stage of different cuttings.

High selective consumption (40–80%) is indicator of the high feed value of galega (both green mass and hay) in rations of different animal groups. Moreover, galega forages have a potential to improve heifers production in comparison with cultural pasture biomass. For heifer liveweight gains obtained consistently higher (61 g for stall-feeding and 70 g for free-grazing) after applying galega feeding ($p<0.05$). The results from the present study led to the conclusion that galega is acceptable resource for feeding of different animal groups in organic farm.

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