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Peculiarities of chemical composition of main types of silage prepared from grasses, legumes, and small grain crop mixtures

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Abstract

Forage crops serve as the main source of material for production of silage, which is the basis of most winter-feeding systems. The objective of this study was to evaluate the variation of diverse perennial grasses and the quality of small grain crop silage and to compare the nutritive value of selected pure and mixed silage groups. Silage samples were collected from 433 farms. They included perennial grass mix, cereal, alfalfa-perennial grass mix, clover, perennial ryegrass, perennial grass-clover mix, oat-common vetch mix, clover-alfalfa mix, legume mix, perennial grass-rye mix, and perennial grass-oat-common vetch mix silage, 1,626 samples in total. Analyses were carried out to determine the data on the content of dry matter (DM), crude protein (CP), water-soluble carbohydrates (WSC), neutral detergent fibre (NDF), acid detergent fibre (ADF), also crude fat (CF), crude ash (CA), and acidity (pH). According to the experimental results, perennial ryegrass silage had the highest CP (166 g kg^{-1} DM), NDF (550 g kg^{-1} DM) and CF (39.1 g kg^{-1} DM) contents and the lowest DM content (321 g kg^{-1}) compared to pure and mixed silage compositions. Among the silage, perennial grass-rye mix silage was shown to have the lowest pH (4.2). Both silage mixtures with oats and common vetch were characterised with higher pH: the pH of the oat-common vetch mix was 5, and the pH of perennial grass-oat-common vetch mix was 4.9. The oat-common vetch mix was high in NDF with 543 g kg^{-1} DM. Mixtures with clover silage were high in CP and NDF content. Overall, among the samples tested, the best results in nutritive value showed perennial ryegrass silage.

Keywords: silage quality, perennial grasses, legume, common vetch, crop.

Introduction

In the last ten years, forage yield grew by several times in Europe (Eurostat Statistics Explained, 2021) and in Lithuania (Statistics Lithuania, 2021). Types of forage also varied during the same period, and, with the change in climate, its amount is likely to further alter in the future.

In Lithuania, the harvest of cultivated plants used for green forage, hay, and silage increased from 1,897.5 thousand tonnes in 2010 to 2,776.9 in 2020, herbage used for silage increased from 9.6 to 64.9 thousand tonnes. This increase may be due to cereals providing flexible options for utilisation as grazed herbage or for feeding as silage. Throughout the ten-year period, the number of winter cereal yield also grew from 1,592 to 4,858 thousand tons, as it can provide feed earlier than annual grasses like *Lolium multiflorum*, etc., because they are generally more adaptable to early sowing due to higher tolerance of dry conditions. Cereals are also better suited to single-cut silage-making, whereas annual grasses require multiple cuts or grazing to be fully utilised. Oat yield increased almost three times, up to 264.3 thousand tons, while legumes yield rose from 70.1 up to 394.3 thousand tonnes (Statistics Lithuania, 2021). Yield of perennial grasses intended for silage making from multi-species swards increased from 9.6 in 2010 to 64.9 thousand tons in 2020. In temperate grass-based ruminant production systems, grass silage is the primary forage available for livestock during the winter period when weather conditions usually make grazing unavailable (Moloney et al., 2020).

In the Baltic countries, grasslands consist mainly of perennial species, and climate change and new biotic and abiotic stresses are expected to improve the conditions most likely for forage production owing to the longer growing seasons with milder and rainier autumns and winters (Magnolo et al., 2021). Therefore, perennial grass yield is expected to grow using forage crop species well adapted to changing climate such as *Festulolium* hybrids and perennial ryegrass (Østrem et al., 2015).

It is also expected that the European Green Deal will determine an increase in the amount in grass feed in the following years. The impacts of climate change on agriculture of the European Union vary in the nature of their impact and the locations that will be affected. To date, climate change impacts have largely been negative for crop yield with only a few positive impacts noted in higher latitude regions (IPCC, 2018). In future, warmer temperatures may increase productivity in northern Europe, while at the same time extreme heat events and droughts are expected to hamper crop productivity in southern Europe. As a result of varying weather patterns, pests, and diseases, higher yearly variations in productivity are also expected (EEA Report, 2020).

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Examining possibilities of the latest silage mixtures and establishing their quality and nutritional value compared to pure and single-species silage is a challenging area in the field of forage. Previous studies have shown that grass-legume mixtures are preferred over pure-grass forage, because they often increase the total yield of herbage and protein and offer balanced nutrition (Dewhurst et al., 2003). Grass-legume mixtures tend to provide a superior nutrient balance and produce higher forage yield. Previous research confirmed that the use of mixed silage could help complement nutrients between silage such as alfalfa and (whole-plant) maize (Wang et al., 2019).

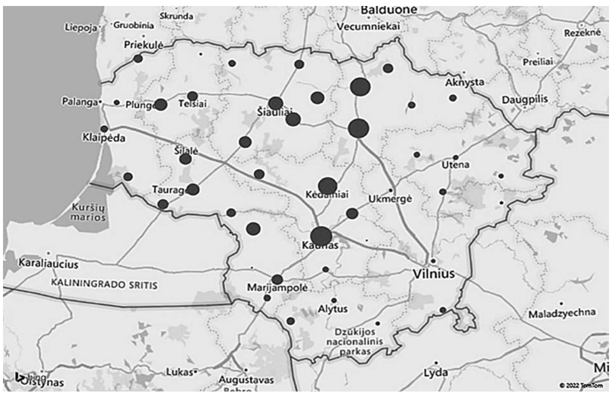
Previous nationwide research such as that conducted by Butkutė (2010) examined the quality of silage of different origin showing especially high variation in the quality of perennial grass silage. Jatkauskas et al. (2003) and Jatkauskas and Vrotniakiene (2004) also researched the quality of diverse types of silage. They showed that regularities of grass and other ensiled raw material influenced silage quality as well as fodder production method, degree of wilting, preservatives used and natural conditions. The quantity of nutrients accumulated in the plants depends on the composition and the stage of development of grass species. In order to ensure cattle wellness and high productivity, rations must be balanced according to the amount of energy and main nutrients such as protein, unstructured carbohydrate (starch, sugar), fibre, fat, minerals, vitamins, and water (Jatkauskas et al., 2003; Butkutė, 2010). However, majority of the research was done almost 20 years ago, and there were changes in grass cultivars and research methods. As a result, a necessity to renew silage database emerged.

The objective of this study was to evaluate the variation in the quality of diverse perennial grass and crop silage and to compare the nutritive value of selected pure and mixed silage mixtures using near-infrared spectroscopy (NIRS).

Materials and methods

Sampling. Silage was collected from 433 farms across Lithuania (Figure 1). According to Lithuanian pedological regionalisation, predominant pedological regions in the areas of farms were *Cambisol* and *Luvisol* region of the Central Lithuanian lowlands, *Retisol* and *Luvisol* region of the Samogitian highlands, and *Retisol* and *Luvisol* region of the Baltic highlands (Volungevičius, 2016).

Most of the samples came from the districts of Kaunas, Panevėžys, and Kėdainiai. The farms varied in size from 100 to 1200 dairy cattle. Silage was sampled over a four-year period from November 2017 to late September 2020. A total of 632 samples were taken in 2017, 547 samples in 2018, 208 in 2019, and 239 in 2020. Out of these samples, 498 were taken in winter, 369 in spring, 222 in summer, and 537 in autumn. Most of the green forage used for ensiling was harvested during daytime from grasslands on the 1st, 2nd, and 3rd harvest. Legumes were harvested at the end of butonisation period, and perennial grasses at the start of flowering period. There were 1,626 samples collected in total, including the following silage: (1) perennial grass: timothy (*Phleum pratense* L.), perennial ryegrass (*Lolium perenne* L.), smooth meadow grass (*Poa pratensis* L.), and red fescue (*Festuca rubra*), mix (n = 1,428), (2) cereal (n = 81), (3) alfalfa-perennial grass mix (alfalfa constituting up to 30–42 g kg^{-1} DM) (n = 28), (4) clover (n = 23), (5) perennial ryegrass (n = 17), (6) perennial grass-clover mix (n = 15), (7) whole plant oat-common vetch mix (n = 13), (8) clover-alfalfa mix (n = 11), (9) legume mix (n = 6), (10) perennial grass-rye mix (n = 3), and (11) perennial grass-oat-common vetch mix (n = 3). The samples were taken from trenches (n = 934), bales (n = 365), clamps (n = 144), frictions (n = 85), sleeves (n = 65), and pits (n = 33).



Note. The round label size was mathematically calculated and proportionately reflects the amount of the samples collected from that area.

Figure 1. Lithuanian farm locations where silage samples were taken from

All samples were taken according to the standard procedures (EC, 2009). Using disposable gloves, each sample was taken from various points at a depth of about 30 cm. While collecting samples from bales, a coring probe was used to take samples from different sides of bale. An aggregate sample was about 4 kg in weight. The final sample (approx. 1 kg) was made from the homogenised aggregate sample. The sample was placed in a clean plastic bag, vacuumed, and sealed for transportation to the laboratory. All samples were stored at 4–8°C temperature. After opening the bag, organoleptic evaluation was carried out assessing the smell, colour, and texture of the silage. Chemical analysis was carried out using fresh samples in the Lithuanian Research Centre for Agriculture and Forestry.

Laboratory analysis. The dry matter (DM) content was determined by drying samples at 105 ± 2°C temperature in a forced-air oven until the weight of the samples was stable. For the prediction of crude protein (CP), water-soluble carbohydrates (WSC), neutral detergent fibre (NDF), and acid detergent fibre (ADF) data, near-infrared spectroscopy (NIRS) calibration equations (VDLUFA, Germany) were used using a NIRS-6500 device with a sample spinning module (Foss-Perstorp, USA) and selecting wavelengths between 400 and 2500 nm in reflectance spectra. For NIRS determination, the samples were oven-dried at 65 ± 5°C temperature to a constant weight and ground in an ultra-centrifugal mill ZM 200 (Retsch, Germany) to pass a 1 mm screen. Then the dried samples were scanned in three replications using cuvettes, and the acquired spectra were processed with equations used in the device (ADAS, UK). The crude ash (CA) content was determined as the mass left after sample incineration at 550 ± 10°C temperature. In accordance with a potentiometric method, acidity (pH) was measured in water extract using a pH meter (Horiba, UK).

Statistical analysis was conducted using packages from the software IBM SPSS Statistics, version 25 (IBM Corp., USA). Significant differences were calculated using one-way ANOVA (Duncan's multiple range test). If means do not have the same letter next to them, they are significantly different. To examine the quantitative relationship between the investigated variables, correlation analysis was performed. The strength of the correlation was estimated according to the value of correlation coefficient *R*. The significance level was calculated with a regression analysis tool in Excel, the data were significant at $P \leq 0.05$.

Results

Organoleptic evaluation. The evaluated silage did not have a strong, particular odour. The colour variated from light yellow to green-brown, and silage texture was firm with softer material indicating good quality silage.

Dry matter (DM), acid detergent fibre (ADF), neutral detergent fibre (NDF), and acidity (pH). As shown in Table 1, significant differences ($P \leq 0.05$) were found in DM content comparing perennial ryegrass silage that had the lowest DM content of 321 g kg^{-1} with perennial grass mix, cereal, and alfalfa-perennial grass mix silage, where the DM content was 428, 437, and 458 g kg^{-1}, respectively.

Further analysis showed that no significant differences ($P > 0.05$) were found between the investigated silage when evaluating ADF. The NDF content of alfalfa-perennial grass mix and clover silage was 447 and 450 g kg^{-1}, respectively, and it was significantly lower ($P \leq 0.05$) than in cereal, perennial ryegrass, and oat-common vetch mix silage, where the NDF content was 502, 550, and 543 g kg^{-1}, respectively. However, other types of silage did not stand out ($P > 0.05$). Even though pH mean values of oat-common vetch mix, clover-alfalfa mix, legume mix and perennial grass-oat-common vetch mix silage were high, no significant difference ($P > 0.05$) was found between investigated silage due to a non-homogenous sample size. pH was significantly lower ($P \leq 0.05$) in perennial grass-rye mix silage (4.2) than in perennial grass mix (4.6), cereal (4.6), alfalfa-perennial grass mix (4.9), clover (4.7), perennial ryegrass (4.7) and perennial grass-clover (4.6) silage.

Table 1. Dry matter (DM), acid detergent fibre (ADF), and neutral detergent fibre (NDF) content and acidity (pH) in investigated silage

Type of silage	n	DM		ADF		NDF		pH	
		g kg^{-1} in DM							
		mean	SD	mean	SD	mean	SD	mean	SD
Perennial grass mix	1428	428 b	118	311 a	34	488 ab	65	4.6 b	0.5
Cereal	81	437 b	119	325 a	38	502 b	72	4.6 b	0.5
Alfalfa-perennial grass mix	28	458 b	122	302 a	32	447 a	71	4.9 b	0.4
Clover	23	375 ab	129	306 a	30	450 a	58	4.7 b	0.5
Perennial ryegrass	17	321 a	51	339 a	49	550 b	81	4.7 b	0.3
Perennial grass-clover mix	15	380 ab	72	307 a	31	461 ab	65	4.6 b	0.4
Oat-common vetch mix	13	446 ab	145	339 a	40	543 b	61	5.0ab	0.8
Clover-alfalfa mix	11	429 ab	140	309 a	42	512 ab	78	4.9ab	0.8
Legume mix	6	495 ab	176	288 a	33	455 ab	98	5.3ab	0.6
Perennial grass-rye mix	3	396 ab	123	321 a	39	522 ab	52	4.2 a	0.0
Perennial grass-oat-common vetch mix	3	512 ab	137	290 a	26	454 ab	60	4.9ab	0.6
Total mean		427		311		488		4.7	

Note. SD – standard deviation; different letters show significant differences between means ($P \leq 0.05$).

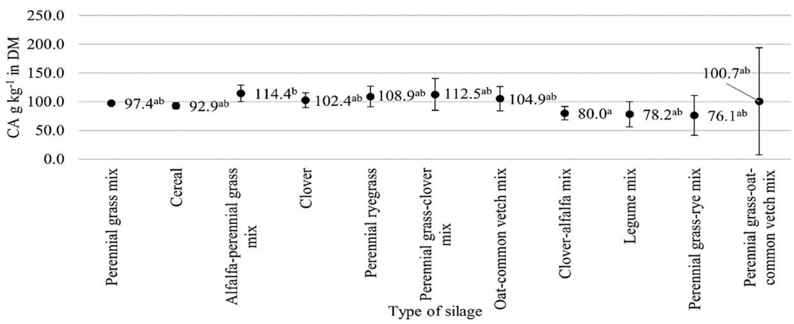
Water-soluble carbohydrates (WSC), crude protein (CP), and crude fat (CF). Table 2 illustrates significant differences in the CP content, which were only noticed between cereal silage, where the CP content was 131 g kg^{-1}, and alfalfa-perennial grass mix, clover, and perennial ryegrass silage, where the CP content was 165, 158, and 166 g kg^{-1}, respectively ($P \leq 0.05$). There was also a negative correlation between CP and WSC content (−0.33), yet it was not significant. Likewise, while evaluating the WSC content, no significant differences were found ($P > 0.05$). The CF content was significantly higher ($P \leq 0.05$) in perennial ryegrass silage by 28% and 21% compared with clover and perennial grass-clover silage. Other types of silage did not show any significant results ($P > 0.05$).

Crude ash (CA). As can be seen from Figure 2, a difference in the CA content was found in clover-alfalfa mix and alfalfa-perennial grass mix silage with the CA content higher by 43% in the latter compared to the former ($P \leq 0.05$).

Table 2. Water-soluble carbohydrates (WSC), crude protein (CP), and crude fat (CF) content in investigated silage

Type of silage	n	WSC		CP		CF	
		g kg^{-1} in DM					
		mean	SD	mean	SD	mean	SD
Perennial grass mix	1428	44 a	25	145 ab	33	33.9 ab	9.6
Cereal	81	43 a	24	131 a	41	33.0 ab	4.8
Alfalfa-perennial grass mix	28	45 a	39	165 b	41	32.8 ab	6.0
Clover	23	30 a	23	158 b	29	30.6 a	5.2
Perennial ryegrass	17	28 a	17	166 b	35	39.1 b	6.8
Perennial grass-clover mix	15	28 a	18	148 ab	33	32.4 a	3.6
Oat-common vetch mix	13	31 a	16	129 ab	32	32.2 ab	7.3
Clover-alfalfa mix	11	51 a	23	122 ab	32	30.1 ab	7.3
Legume mix	6	71 a	25	133 ab	58	27.8 ab	9.6
Perennial grass-rye mix	3	55 a	37	107 ab	24	39.8 ab	4.7
Perennial grass-oat-common vetch mix	3	50 a	6	160 ab	30	37.0 ab	6.9
Total mean		43		145		33.8	

Note. SD – standard deviation; different letters show significant differences between means ($P \leq 0.05$).



Note. DM – dry matter; significant differences were calculated using one-way ANOVA (Duncan's multiple range test), different letters show significant differences between means ($P \leq 0.05$).

Figure 2. Boxplot analysis (mean ± 95% confidence intervals) representing the crude ash (CA) content in investigated silage

Discussion

Silage analysis can be used to help farmers formulate the correct rations for their particular on-farm needs. There are various analytical methods used to calculate the chemical composition of silage such as NIRS or wet chemistry. However, the obtained results need interpreting to understand their significance, no matter which method is used. Examining the potential of the silage prepared from grass mixtures, establishing their quality and nutritional value, and comparing them to pure and single-species silage is a demanding field in the scope of forage. Recent studies confirmed that the use of mixed grass silage could help supplement nutrients between silage and provide both production and ecological benefits (Burton et al., 2021).

DM content. Among all silage, the lowest DM content had perennial ryegrass silage (Table 1). In silage DM content, the major role plays field and pre-ensiling conditions (Borreani et al., 2018), and although ensiling and fermentation patterns are also important, these findings need to be interpreted with caution.

pH. Lower pH values (<4.5) indicate higher acidity levels, which are required to preserve silage helping retain the original forage feed value. Silage with higher pH values (>5.0) may have undergone poor fermentation and may be of a lower quality or prone to spoiling (Moloney et al., 2020). In perennial grass-rye mix silage, low pH may be partly explained by rye harvesting time. Rye silage harvested at the dough stage has higher pH with lower organic acid concentration than rye silage harvested at heading or flowering stages. Lower pH is also caused by low ammonia-nitrogen with high acetate concentration (Paradhipta et al., 2019). In rye silage, pH is also highly correlated with the DM content (Kim et al., 2001), while the DM content in perennial grass and rye mix silage was quite low in the present research. Also, the DM content and pH are important factors that affect the physical characteristics and quality of silage (Rajabi et al., 2016).

NDF content. Perennial ryegrass silage distinguished itself by the highest NDF content (Table 1). This result agrees with the ones obtained by Sun et al. (2011); however, it is slightly higher than found by Cooke et al. (2008). Pasture NDF is relevant in grazing-based dairy systems because it is negatively associated with potential intake. To maintain rumen fermentation and cow health, the study Nutrient Requirements of Dairy Cattle (2001) recommends feeding dairy cattle a minimum of 25% dietary NDF.

Oat-common vetch mix silage had a high NDF content (Table 1). Although very little was found in the literature on the question of the chemical composition of oat-common vetch mix silage, in the experiment, the NDF content was found to be higher than that mentioned by some other researchers. Chen et al. (2015) found that the NDF content of oat-common vetch mix silage varied from 30.3% to 39.5% DM (mixed with 43–44% concentrate). This result may partly be explained by the fact that oats are usually rich in NDF. In a recent study by Romero et al. (2017), oat silage had a NDF content equal to 67.0% DM. So, depending on the concentration of oats added to the mixture, the NDF content may vary significantly. Another reason for this may be lower fibre concentrations, possibly resulting from the presence of the exogenous fibrolytic enzymes found in certain inoculant products that have the potential to solubilise fibre releasing mainly WSC, available for fermentation during ensiling. In addition, possible immaturity of the oats used in other studies results in NDF that is more susceptible to enzymatic hydrolysis as less mature forage is more amenable to fibrolytic enzyme action (Romero et al., 2017).

The mean of NDF in cereal silage was consistent with other studies (Geren, 2014). Similarly, the NDF content in clover silage agreed with that obtained by Dewhurst et al. (2003), where red clover had 41.9% DM, and by Albrecht and Beauchemin (2003). Depending on silage maturity, typical nutrient content of legume silage varied from 36.7% to 50.0% DM. The NDF fraction is the constituent most likely to be affected by water stress in perennial legumes. The NDF content in stems decreases under drought conditions because of reduced incorporation of carbon into cell walls, which might affect the NDF content in clover silage (Albrecht, Beauchemin, 2003). In alfalfa-perennial grass mix silage, the NDF content is in line with previous studies (Albrecht, Beauchemin, 2003; Dewhurst et al., 2003).

Evaluating ***ADF content*** means, no significant differences were found.

CP content. Among other silage, the highest CP content had perennial ryegrass silage (Table 2). These results seem to be consistent with similar research. The CP content of ryegrass pasture can often be even too high; Dong et al. (2020) stated that the CP content ranged from 20.9% to 28.6% DM. It is commonly found that WSC and CP contents are strongly negatively related in plants (Loaiza et al., 2017). In perennial ryegrass silage, the correlation between WSC and CP contents was not significant, which might be due to the modest sample number (n = 18). The results also showed that CP content in alfalfa-perennial grass mix silage was very similar to that of perennial ryegrass silage. The alfalfa silage is usually higher in CP with 18% DM or above (Besharati et al., 2020). This result may be explained by the fact that perennial grass silage mix is lower in CP, which is also seen in the current experiment. De Boer et al. (2019) established that monoculture yield of alfalfa was higher in CP than its mixture with perennial grass depending on the grass species and the percentage of alfalfa in the mixture. However, in reviewing the literature, very little data was found on alfalfa-perennial grass mix silage quality. Clover silage was also high in CP, whereas as a silage crop it has similarities to alfalfa. However, previous studies have shown that silage made from wilted red clover usually contains less non-protein nitrogen. So, a unique mechanism is present in red clover but is absent in alfalfa (red clover causes fewer processes of proteolysis, both in the silage and in the rumen) that affects proteolysis during ensiling (Ni et al., 2019). This result also differs from the study of Dewhurst et al. (2003), where red clover silage was higher in CP with 19.3–20.3%. These results are likely to be related to increased protein degradation during ensilage, which happens due to either a direct effect of protein on silage fermentation or the protease profile of the crop. Therefore, increased protein degradation with high protein herbage like white or red clover may also be a consequence of changing protease profiles with changing protein content (Xu et al., 2021). Cereal silage had a lower protein content, which is characteristic of this type of silage including barley, oats, wheat, and triticale (Nair et al., 2016).

CF content. The results obtained from the CF analysis showed (Table 2) the CF mean in perennial ryegrass silage to be the highest, and the results match those observed in earlier studies (Cooke et al., 2008). The CF content in the perennial grass-clover mix silage is in accord with the study of De Boever et al. (2009), where the CF content varied from 2.6% to 3.4% DM. Arvidsson et al. (2008) found that perennial grass silage (pure grass sward, consisting mainly of timothy) had the content of 3.39% DM CF, which is very similar to the mixture of the current experiment.

CA content in alfalfa-perennial grass mix silage was the highest among the silage (Figure 2). Alfalfa silage usually has a high CA content (Rajabi et al., 2016; Silva et al., 2016), but perennial grasses tend to have a lower CA content, which is around 8.0% DM (Udén, 2017). Unfortunately, there is a lack of information about CA content in alfalfa-perennial grass mix silage. Clover-alfalfa mix silage had a significantly lower CA content. This seems to be consistent with other research, which found that the CA content in clover and grass silage mix was 8.3% DM (Johansson et al., 2014). However, in reviewing the literature, no data was found on the CA content in the clover-alfalfa mix silage.

CA in forage comes from two sources: internal, e.g., minerals, and external, e.g., dirt, bedding. The average internal CA content in alfalfa is 8%, and in grasses it is about 6%. Additional CA in silage usually indicates contamination with dirt (Undersander, 2016). It is speculated that a large amount of dirt in silage has a negative effect on cattle lactation performance (Hoffman, 2014).

Conclusions

1. Among the samples tested, the best overall results in nutritive value showed the perennial ryegrass silage. This type of silage had one of the highest contents of crude protein (166 g kg^{-1} DM), neutral detergent fibre (550 g kg^{-1} DM), and crude fat (39.1 g kg^{-1} DM) and the lowest content of dry matter (321 g kg^{-1} DM) compared to pure and mixed silage compositions.

2. Both oat-common vetch mix and perennial grass-oat-common vetch mix silage has higher acidity (pH) than other types of silage, with pH 5 and 4.9, respectively. Oat-common vetch mix silage was high in NDF with 543 g kg^{-1} DM. Perennial grass-rye mix silage was shown to have the lowest pH (4.2) among the silage.

3. The alfalfa-perennial grass mix silage had a low pH of 4.9, was high in contents of crude protein (165 g kg^{-1} DM) and crude ash (114.4 g kg^{-1} DM). Mixtures with clover silage were comparatively high in crude protein: perennial grass-clover mix silage had 148 g kg^{-1} DM, legume mix silage had 133 g kg^{-1} DM, and clover-alfalfa mix silage had 122 g kg^{-1} DM; it was also rich in NDF with 461, 455, and 512 g kg^{-1} DM, respectively. The crude fat content of the perennial grass-clover mix silage was also on the higher side (32.4 g kg^{-1} DM).

Further investigation and experimentation into differences in the quality of pure and mixed silage is recommended.

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Įvairių rūšių siloso, pagaminto iš miglinių bei pupinių žolių ir javų, cheminė sudėtis

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Santrauka

Pagrindinė siloso gamybos žaliava yra pašariniai augalai, o silosas – daugelio žieminio pašaro sistemų pagrindas. Tyrimo tikslas – įvertinti įvairių daugiamečių žolių bei viso augalo javų siloso kokybės varijavimą ir palyginti pasirinktų grynų bei maišytų silosų mitybinę vertę. Siloso pavyzdžiai buvo surinkti iš 433 ūkių. Tirta 11 rūšių silosai: (1) daugiamečių žolių mišinio, (2) javainio, (3) liucernų ir daugiamečių žolių mišinio, (4) dobilų, (5) daugiamečių svidrių, (6) daugiamečių žolių ir dobilų mišinio, (7) avižų ir vikių mišinio, (8) dobilų ir liucernų mišinio, (9) pupinių augalų mišinio, (10) daugiamečių žolių ir rugių mišinio, bei (11) daugiamečių žolių, avižų ir vikių mišinio, iš viso 1626 mėginiai. Siloso mėginių tyrimai buvo atlikti, siekiant nustatyti sausųjų medžiagų (SM), žalių baltymų (ŽB), vandenyje tirpių angliavandenių (VTA), neutraliame tirpale tirpios ląstelienos (NDF), rūgščiame tirpale tirpios ląstelienos (ADF), žalių riebalų (ŽR), žalių pelenų (ŽP) kiekius ir rūgštumą (pH). Tyrimo duomenimis, daugiamečių svidrių silosas pasižymėjo didžiausiu ŽB (166 g kg^{-1}), NDF (55 g kg^{-1}) ir ŽR (3,91 g kg^{-1}) ir mažiausiu SM (32,1 g kg^{-1}) kiekiais, lyginant su grynu silosu ir mišiniais. Iš tirtų silosų mažiausias pH (4,2) buvo daugiamečių žolių ir rugių mišinio siloso. Abu silosų mišiniai su avižomis ir vikiais pasižymėjo didžiausiu pH – avižų ir vikių mišinio siloso pH vertė buvo 5, daugiamečių žolių, avižų ir vikių mišinio siloso – 4,9. Avižų ir vikių mišinio silosas turėjo didelį kiekį NDF (54,3 proc.). Siloso mišiniai su dobilais turėjo didelį kiekį ŽB ir NDF. Iš tirtų silosų geriausia mitybine verte pasižymėjo daugiamečių svidrių silosas.

Reikšminiai žodžiai: siloso kokybė, daugiametės žolės, pupiniai augalai, vikiai, javai.