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NUTRIENT CONTENT AND FERMENTATION CHARACTERISTICS OF ENSILED ITALIAN RYEGRASS AND WINTER CEREAL MIXTURES FOR DAIRY COWS

SADRŽAJ HRANJIVIH TVARI I ZNAČAJKE FERMENTACIJE SILIRANOG TALIJANSKOG LJULJA I ZIMSKIH SMJESA ŽITARICA ZA MLIJEČNE KRAVE

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SUMMARY

The interest in new alternative forages in Europe has increased in recent years. The nutritional composition and fermentation characteristics during different stages of ensiling were studied with Italian ryegrass (*Lolium multiflorum* Lam.) and winter cereal mixtures. The trial was carried out on a large-scale farm Galgamenti Agricultural Limited Company, Tura, Hungary. Two different forage mixes were studied: Mixture A (three types of Italian ryegrass 40% + two types of triticale 20%+ two types of oats 20%+ wheat 15%+ barley 5%) and Mixture B (three types of Italian ryegrass 55% + two types of winter oats 45%). Experimental field was 30.600 m^2 by the treatments, respectively. The two different forage mixes were sown on 11th September 2017 (Mixture A: 75 kg seed/ha; Mixture B: 75 kg seed/ha) with depth of 2-5 cm. Plant protection treatment was not applied during the growing season. Cutting was carried out in heading stage of triticale by hand at 10 cm stubble height. The fresh Mixture A (dry matter 189 g/kg; crude protein: 161 g/kg DM; NDF: 485 g/kg DM) and the fresh Mixture B (dry matter 195 g/kg; crude protein: 159 g/kg DM; NDF: 519 g/kg DM) were wilted to 28-32% DM (24h) without any movement on the windrow. The wilted forage was picked up by hand and chopped by a forage harvester (John Deere 7300) on concrete surface with theoretical chop length of 9 mm (weight: 800 kg). Wilted and chopped material of 510 g were packed by hand into a glass jars (0.00072 m^3 volume, n=5, total no. of minisilos = 15). Five laboratory silos per mixtures were opened on 7, 14 and 90 days after ensiling. Dry matter (DM), crude protein (CP), crude fiber (CF), neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL), ether extract (EE), ash, and total sugar of all treatments were determined. Additionally, pH and the concentration of ammonia-N, volatile fatty acids were measured in the ensiled mixtures. At the end of 90 days of ensiling in both mixture silages, there were significant differences ($p<0.05$) in all nutrient contents except for ADF in Mixture A and CP, ash and CF in Mixture B which was not affected by fermentation duration. Ensiling caused a significant decrease in pH ($p<0.05$), due to the production of lactic acid and succeeded to achieve lactic acid type fermentation. Values for ammonia-N, ethanol and acetic acid, butyric acid were all low. These results indicated that the fermentation quality of Italian ryegrass and winter cereal silages underwent rapid fermentation and were well-preserved.

Key words: fermentation, Italian ryegrass, winter cereals, silage, lactic acid

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INTRODUCTION

Nowadays climate change has induced multifaceted problem in corn production complicating corn silage demand for high-producing dairy cows particularly in Europe. Hence identifying viable optional forage crops to fill ecological niches prone to corn crop failure is urgent in the current dairy industry. Use of alternative fodder crops considering the yield safety of corn silage might be compromised in the future if the expected climate change characterized by the increase of summer heat waves and extreme water shortage. Based on this, interest in new alternative forages in Europe has increased in recent years. Information on the use of Italian ryegrass and winter cereals mixture for silage making is rare. However, silage making ability and nutritional quality of the individual forages are quite good (Van Duinkerken et al., 1999; Baldingar et al., 2012, 2014; Harper et al., 2017). Italian ryegrass and winter cereals can be sown together for different purpose (Baron et al., 2000; Bagg, 2014; Geren, 2014). Nutrient content and fermentation characteristics of silage made from the mixture of two forages have not been well studied and reported. Therefore, the present study is aimed at evaluating the nutrient content and fermentation characteristics of Italian ryegrass and winter cereal mixtures during the different stages of ensiling.

MATERIALS AND METHODS

The trial was carried out on a large-scale farm (Galgamenti Agricultural Limited Company, Tura, Hungary - 47.593637 N, 19.576483 E, altitude: 119 m). Two different forage mixes were studied: Mixture A (three types of Italian ryegrass 40% + two types of triticale 20% + two types of oats 20% + wheat 15% + barley 5%) and Mixture B (three types of Italian ryegrass 55% + two types of winter oats 45%). Experimental field was 30.600 m^2 (width: 36 m; length: 850 m) by the treatments. Deep loosening and disc + cylinder cultivation were done as stubble tillage after winter rapeseed (*Brassica napus* L.) as forecrop. Slurry (10 m^3/ha) and 300 kg/ha artificial fertilizer (NPK: 14:10:20) was applied before sowing in sandy soil. Seedbed was prepared by Kongskilde VibroFlex 7400 cultivator (lifted). The two different forage mixes were sown on 11th September 2017 (Mixture A: 75 kg seed/ha; Mixture B: 75 kg seed/ha) at depth of 2-5 cm with John Deere 740 A type seed drill. Plant protection treatment was not applied during the growing season. The annual precipitation was 718 mm in 2017. Weather conditions (precipitation by months during the growing season) are shown in Table 1.

Table 1 Total precipitation (mm) by months during the growing season of 2017-2018

Tablica 1. Ukupna količina oborina (mm) tijekom vegetacije 2017. – 2018.

Year Godina	Month Mjesec	Precipitation (mm) Ukupna količina (mm)
2017	September	167 mm
2017	October	64 mm
2017	November	51 mm
2017	December	38 mm
2018	January	17 mm
2018	February	85 mm
2018	March	55 mm
2018	April	5 mm

Cutting was carried out in heading stage of triticale (25th April), by hand at 10 cm stubble height. The fresh Mixture A (dry matter 189 g/kg; crude protein: 161 g/kg DM; NDF: 485 g/kg DM) and the fresh Mixture B (dry matter 195 g/kg; crude protein: 159 g/kg DM; NDF: 519 g/kg DM) were wilted to 28-32% DM (24h) without any movement on the windrow. The wilted forage was picked up by hand and chopped by a forage harvester (John Deere 7300) on concrete surface with theoretical chop length (TCL) of 9 mm (weight: 800 kg). Wilted andt chopped material of 510 g was packed by hand into glass jars (0,00072 m^3 volume, n=5, total no. of mini silos = 15). The applied density was 708 kg of wilted material/m^3 (Mixture A: 200 kg DM/m^3; Mixture B: 219 kg DM/m^3). Five laboratory silos per mixture were opened on 7, 14 and 90 days after ensiling. Dry matter (DM), crude protein (CP), crude fiber (CF), neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL), ether extract (EE), ash, and total sugar of all treatments were determined by laboratory analysis. Chemical analyses of the silages were done following the standard laboratory protocols; DM (Hungarian standard ISO 6496:2001), CP

(152/2009/EU decree), EE (152/2009/EU decree), CF (152/2009/EU decree), nitrogen free extract (calculated as 100 - (%EE+%CP+%Ash+%CF)), crude ash (Hungarian standard 5984:1992), NDF (Hungarian Feed Codex, 2004), ADF (Hungarian Feed Codex, 2004) and ADL (Hungarian Feed Codex, 2004). Additionally, pH and the concentration of ammonia-N, volatile fatty acids were measured in the ensiled mixtures. The pH was determined using a digital pH meter (Metrohm 744, Switzerland). Acetate, butyrate, propionate and ethanol were measured by gas chromatography (Crompak, Model CP 9002, The Netherlands) as described by Playne (1985). The lactic acid was estimated by high-performance liquid chromatography (HPLC) method developed by Megias et al. (1993). Ammonia nitrogen was measured using Kjeldahl method (Kjeltec Auto 1030 Analyzer, Sweden). Data were analyzed using the GLM of Statistical Analysis System (SAS Institute, USA, 2004). Tukey-test was employed for comparison of means. The statistical significance level was considered as P<0.05. Statistical analysis was carried out using the following model: $Y_i = \mu + \alpha_i + \varepsilon_i$, where Y_i is the observation in the i^{th} opening days, μ is the overall mean, α_i is the i^{th} opening days effect and ε_i is the random error.

RESULTS AND DISCUSSION

Chemical composition of silages

Tables 2 and 3 show the mean nutrient content of Mixture A and B silage as fresh forage and at 7, 14 and 90 opening days. At the end of 90 days of ensiling for both mixture silages, there were significant differences (p<0.05) in all nutrient contents except ADF in Mixture A and CP, ash and CF in Mixture B which was not affected by fermentation duration. The observed DM, CP and fiber fractions (NDF and ADF) was all similar and better than the range of typical and target value of DM, CP and fiber fraction contents of all grass silage described by AHDB Dairy (Agricultural and Horticultural Development board of the United Kingdom) (2012). However the sugar content was by far lower and ash content was higher than the described target value. After the 90 days fermentation, the DM content of Mixture A and Mixture B silage increased from 18.90% (fresh) to 27.46% and 19.5% (fresh) to 31.34% respectively. This increase in DM content was consistent with the whole corn crop silage after 120 days ensiling (Li and Nishino, 2013). However as compared to the DM content (28-32%) of wilted silage, the observed

Table 2 Chemical composition of Mixture A silage at fresh, 7, 14 and 90 opening days

Tablica 2. Kemijski sastav silaže A u svježem stanju te 7., 14. i 90. dana od otvaranja

Parameters Parametri (%DM)	Opening days - Dani od otvaranja					
	Fresh Svježe stanje	Day 7 Dan 7	Day 14 Dan 14	Day 90 Dan 90		
		(mean± SD)	(mean± SD)	(mean ± SD)	RMSE	p value
DM/ST	18.90[a]	28.30±0.76[b]	27.36±0.47[c]	27.46±0.49[bc]	0.514	<.0001
CP/SP	16.10[b]	15.48±0.19[a]	14.98±0.32[a]	15.24±0.43[a]	0.286	<.0001
EE	3.50[a]	4.32±0.13[c]	3.82±0.13[b]	4.00±0.12 [b]	0.111	<.0001
CF	27.80[ab]	27.86±0.39[b]	27.82±0.65[b]	27.06±0.32[a]	0.415	0.0211
Ash/Pepeo	13.10[a]	14.02±0.38[b]	14.28±0.54[b]	15.58±0.51[c]	0.418	<.0001
NDF/NDV	48.50[ab]	49.30±0.59[bc]	49.80±0.50[c]	48.10±0.60[a]	0.494	0.0002
ADF	32.50	32.24±0.99	31.74±0.48	32.04±0.39	0.588	0.2553
ADL	2.10[a]	10.88±1.68[b]	16.46±0.40[c]	9.82±5.39[b]	2.831	<.0001
Sugar/Šećer	13.70[c]	0.32±0.23[ab]	0.12±0.18[b]	0.12±0.18[a]	0.170	<.0001
NFE	39.50[c]	38.32±0.42[b]	39.10±0.79[ab]	38.12±0.90[a]	0.638	0.0108

DM – dry matter, CP – crude protein, EE – ether extract, CF – crude fat, NDF – neutral detergent fiber, ADF – acid detergent fiber, ADL – acid detergent lignin, NFE – nitrogen free extract, SD – standard deviation, RMSE – root mean square. a,b,c: p<0.05
ST – suha tvar, SP – sirovi protein, NDV – neutralna deterdžent vlakna, ADF- kisela deterdžentska vlakna, ADL - kiseli deterdžentski lignin

DM for both mixtures was decreased. The decrease in DM content was consistent with the direct by cut Italian ryegrass and Guinea grass silage after 120 days of ensiling (Li and Nishino, 2013) and corn silage after 56 days of ensiling (Ulger and Kaplan, 2017). As compared to DM content of Italian ryegrass silage (NRC 2001, Baldingar et al. 2012; 2014) and winter cereals silage (NRC 2001, INRA 2017 and Orosz et al. 2019), the DM content of the mixtures used in the present study was low, even though efficient fermentation in the presence of lactic acid eliminated those DM loss factors such as undesirable VFAs (Table 4 and 5). In this regard Kung and Shaver (2001) reported that, further fermentations that produce lactic acid result in the lowest losses of DM from the crop during storage. However the observed DM content of the present silage mixture was similar and higher than the typical and target DM value (25-30%) of all grass silage described by AHDB, (2012). The observed CP content of Mixture A and Mixture B silage was higher than the CP content of Italian ryegrass silage and winter cereal silages ensiled alone (NRCt 2001, Baldingar et al. 2012; 2014, INRA, 2017 and Orosz et al. 2019). This could be attributed to high fermentation efficiency (Table 4 and 5) of silage mixes which produced lactic acid that rapidly reduced silage pH resulting in low protein breakdown. The highest CP value was also a direct reflection of the quality of the present mixture forages at the time of harvest (heading stage) before ensiling. After the end of 90 days fermentation the CP content decreased ($p<0.05$) from 16.1% (fresh) to 15.24% in Mixture A silage. However there was no significance difference ($p>0.05$) in CP content in Mixture B.

Under normal ensiling condition, EE and ash should not be affected since it is least utilized by the microbes during the fermentation process. However, there was a regular increase ($p<0.05$) in EE content for both silage mixtures. The increase in EE with increasing ensiling was similar to the finding of Benton et al. (2005) and Bodine et al. (1983) who reported similar increase in EE with increasing ensiling duration. The ash content of Mixture A was significantly affected ($p<0.05$) by fermentation duration. But ash content of Mixture B silage was not affected ($p>0.05$) which is consistent with the report of Ulger and Kaplan (2017) who reported the ash content of corn silage was not affected ($p>0.05$) at the end of 56 days fermentation period.

Table 3 Chemical composition of Mixture B silage at fresh, 7, 14 and 90 opening days

Tablica 3. Kemijski sastav silaže B u svježem stanju te 7., 14. i 90. dana od otvaranja

Parameters Parametri (%DM)	Fresh Svježe stanje	Opening days - Dani od otvaranja				
		Day 7 Dan 7	Day 14 Dan 14	Day 90 Dan 90		
		(mean± SD)	(mean± SD)	(mean ± SD)	RMSE	p value
DM/ST	19.50[a]	30.98±0.84[b]	31.30±1.07[b]	31.34±0.97[b]	0.840	<.0001
CP/SP	15.90	15.84±0.24	15.50±0.35	16.08±0.79	0.294	0.265
EE	2.70[a]	4.06±0.32[bc]	3.82±0.13[b]	4.20±0.07[c]	0.177	<.0001
CF	28.90	28.46±0.71	28.62±0.52	28.60±0.82	0.602	0.708
Ash/Pepeo	12.50	12.20±0.20	12.92±0.99	13.14±0.79	0.647	0.138
NDF/NDV	51.90	51.60±0.38	51.80±1.36	50.36±1.12	0.901	0.054
ADF	31.80[a]	32.08±0.41[a]	32.74±0.99[ab]	33.72±0.70[b]	0.643	0.001
ADL	2.90[a]	4.14±1.03[a]	16.08±3.84[b]	4.46±2.05[a]	2.234	<.0001
Sugar/Šećer	13.80[b]	0.36±0.32[a]	0.16±0.26[a]	0.04±0.09[a]	0.211	<.0001
NFE	40.00[b]	39.44±1.05[ab]	39.14±0.93[ab]	37.98±0.90[a]	0.835	0.012

DM – dry matter, CP – crude protein, EE – ether extract, CF – crude fat, NDF – neutral detergent fiber, ADF – acid detergent fiber, ADL – acid detergent lignin, NFE – nitrogen free extract, SD – standard deviation, RMSE – root mean square. a,b,c: $p<0.05$
ST – suha tvar, SP – sirovi protein, NDV – neutralna deterdžent vlakna, ADF- kisela deterdžentska vlakna, ADL - kiseli deterdžentski lignin

The effects of fermentation duration on NDF (Mixture A), both NDF and ADF (Mixture B) were found to be significant ($p<0.05$). However its effect on ADF (mixture A) content was not significant ($p>0.05$). This result was in agreement with Ulger and Kaplan (2017) who reported ADF content of maize silage was not found to be significant ($P>0.05$) at the end of 56 days of fermentation. The observed residual sugar was assumed to be the source of energy for the rumen microbes was significantly ($p<0.05$) affected by ensiling duration. At the end of 90 days fermentation, the sugar content was reduced from 13.7% (fresh) to 0.12% and 13.8% (fresh) to 0.04% in both Mixture A and B silage respectively. This could be attributed to efficient fermentation with excessive production of lactic acid by Lactobacillus bacteria at the expense of high sugar consumption right from the start of fermentation period.

Fermentation characteristics of silages

Tables 4 and 5 show the mean fermentation characteristic attributes of Mixture A and B silages at 7, 14 and 90 opening days. There were no significant differences ($p>0.05$) in DM, ethanol and acetic acid contents. However those major fermentation quality descriptors like pH, ammonia and lactic acid was affected ($p<0.05$) by opening day. Silage pH is an important parameter in the long term stability of ensiled forages. A pH below 4.0 is considered satisfactory for long term storage of ensiled material (Jaster, 1995). The observed pH value of both silage mixtures was reduced and in contrast the lactic acid content was increased at the end of 90 days fermentation. This could be attributed to following ensiling after 14 days of fermentation, the produced lactic acid reduced the pH of the silage and acted as a preservative and restricted the production of undesirable volatile fatty acids. Similar decreases in pH with increasing ensiling durations were reported in previous studies (Shao et al. 2002; Shao et al., 2005; Bal, 2006; Herrmann et al., 2011; Li and Nishino, 2013 and Ulger and Kaplan, 2017). With advancing ensiling time lactic and acetic acids increased. All the undesirable VFA like butyric, valeric and caproic acid were not detected. Acetic acid was the only observed VFA in both silage mixture blends in the current study.

Table 4 Fermentation characteristics of Mixture A silage at 7, 14 and 90 opening days

Tablica 4. Fermentacijske karakteristike silaže A u svježem stanju te 7., 14. i 90. dana od otvaranja

Parameters Parametri (%DM)	Opening day - Dani od otvaranja				
	Day 7 Dan 7	Day 14 Dan 14	Day 90 Dan 90		
	(mean±SD)	(mean± SD)	(mean± SD)	RMSE	p value
NH_3-N	0.047±0.002[a]	0.038±0.003[a]	0.088±0.015[b]	0.009	<.0001
pH	4.36±0.03[b]	4.32±0.02[b]	4.26±0.02[a]	0.027	0.0001
Ethanol	0.30±0.28	0.20±0.01	0.16±0.01	0.165	0.412
Acetic acid	2.06±0.16	2.10±0.20	2.25±0.23	0.202	0.336
Propionic acid	0.00	0.00	0.00	0.00	0.00
i – butyric	0.00	0.00	0.00	0.00	0.00
Butyric	0.00	0.00	0.00	0.00	0.00
i – valeric	0.00	0.00	0.00	0.00	0.00
Valeric	0.00	0.00	0.00	0.00	0.00
i – caproic	0.00	0.00	0.00	0.00	0.00
Caproic acids	0.00	0.00	0.00	0.00	0.00
Lactic acid	5.59±0.73[a]	6.18±0.45[a]	8.92±082[b]	0.688	<.0001
LA/AA	2.88±0.21[a]	2.95±0.22[a]	3.97±0.16[b]	0.204	0.0001
%LA/TFA	74.20±1.40[a]	74.60±1.47[a]	79.84±0.68[b]	1.243	<.0001

DM – dry matter, SD – standard deviation, AA – acetic acid, LA – lactic acid, TFA – total fermentation acid, RMSE – root mean square. a,b: $p<0.05$

After 90 days of fermentation, lactic acid was the major fermentation product with a small production of acetic acid (AA), resulting in the high value of LA/AA over the storage periods (Tables 4 and 5). The observed percent age of lactic acid per total fermentation acid (%TFA) at each opening day in both silage mixtures was above 72%. The 90 opening day result was consistent with the report of AHDB (2012) for grass silage analysis, described that for well fermented silage lactic acid as the proportion of total acids should be >75%. However the overall %TFA value at each opening day for both mixtures silage was higher than the report of Kung and Shaver (2001), lactic acid should be the primary acid and in good silage it should be at least 65 to 70% of the total silage acids.

The acetic acid content of both silage blends remained the same throughout the fermentation period with no significant variation ($p>0.05$) among the opening days. However it steadily increased as ensiling period advanced. This gradual increase in AA would greatly improve the aerobic stability of the silage mixes during the feed out phase because acetic acid is the strong acid which restricts the growth of undesirable microbes such as yeast during the feed out phase. The NH_3-N concentration increased steadily from 7 to 90 days in both silages. NH_3-N is a product of bacterial deamination of amino acids rather than a product of acid hydrolysis of silage VFA. Silage is considered excellent and good when the NH_3-N/total N is below 7 g/100 g total N. As per the criteria, silage ensiled for 90 days in the present study may be categorized as excellent and good quality, respectively.

After the 90 days of fermentation, the observed NH_3 – N, pH and ethanol content of the present silage mixtures was consistent with the target value described in NRC (2001), Kung and Shaver (2001) and AHDB (2012). The lactic acid (<10%DM), acetic acid (<2.5 %DM) and complete absence of other VFAs like butyric acid were consistent with target values of grass silage (AHDB, 2012). On the other hand lower VFA (<25%) in terms of percentage of total fermentable acid (%TFA) as well as high lactic acid (>75%) per percentage of total fermentable acid in the present study were quite consistent with the target value. However the ratio of lactic to acetic acid was lower as compared to the target value after the end of 90 days fermentation period. Particularly the value for Mixture B were lower than the target value, however for Mixture A the observer LA/AA was consistent and comparable with the target value.

Table 5 Fermentation characteristics of Mixture B silage at 7, 14 and 90 opening days

Tablica 5. Fermentacijske karakteristike silaže B u svježem stanju te 7., 14. i 90. dana od otvaranja

Parameters Parametri (%DM)	Opening days - Dani od otvaranja				
	Day 7 Dan 7	Day 14 Dan 14	Day 90 Dan 90		
	(mean± SD)	(mean± SD)	(mean ± SD)	RMSE	P value
NH_3-N	0.042±0.005[a]	0.046±0.006[a]	0.081±0.004[b]	0.005	<.0001
pH	4.47±0.01[c]	4.43±0.01[b]	4.39±0.02[a]	0.015	<.0001
Ethanol	0.11±0.01	0.12±0.02	0.11±0.02	0.016	0.843
Acetic acid	1.81±0.37	1.97±0.57	1.91±0.21	0.031	0.834
Propionic acid	0.00	0.00	0.00	0.00	0.00
i – butyric	0.00	0.00	0.00	0.00	0.00
Butyric	0.00	0.00	0.00	0.00	0.00
i – valeric	0.00	0.00	0.00	0.00	0.00
Valeric	0.00	0.00	0.00	0.00	0.00
i – caproic	0.00	0.00	0.00	0.00	0.00
Caproic acids	0.00	0.00	0.00	0.00	0.00
Lactic acid	5.18±0.37[a]	5.34±0.71[a]	7.03±0.93[b]	0.711	0.002
LA/AA	2.68±0.19[a]	2.83±0.52[a]	3.67±0.25[b]	0.353	0.001
%LA/TFA	72.75±1.40[a]	73.47±3.78[a]	78.59±1.19[b]	2.429	0.0048

DM – dry matter, SD – standard deviation, AA – acetic acid, LA – lactic acid, TFA – total fermentation acid, RMSE – root mean square. a,b: $p<0.05$

CONCLUSION

The results indicated that lactic acid was the dominant fermentation acid produced (>72% of the total acids at each opening days) resulting the ensiled material to underwent lactic acid fermentation type. This high lactic acid was most effective in lowering pH, and helps to reduce protein breakdown as well as strongly restricts the production of undesirable VFAs. The efficient fermentation improves the recovery of most nutrients and reduces the NH_3-N and ethanol production. As per the criteria, silage ensiled for 90 days in the present study may be categorized as excellent and good quality, because the NH_3-N/total N is below 7 g/100 g total N. In general fermentation quality of Italian ryegrass and winter cereal silages underwent efficient fermentation and were well-preserved. Due to efficient fermentation until the end of 90 days fermentation period, this kind of forage mixture can be ensiled in the future without silage additives.

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SAŽETAK

Zanimanje za nova alternativna hraniva u Europi je poraslo zadnjih godina. Hranidbeni sastav i značajke fermentacije u raznim stadijima siliranja istraživani su na talijanskom ljulju (*Lolium multiflorum* Lam) i zimskim smjesama žitarica. Pokus je obavljen na velikoj farmi Galgamenti Agricultural Ltd. u Turnu u Mađarskoj. Proučavane su dvije različite smjese krmiva: smjesa A (tri vrste talijanskog ljulja 40% + dvije sorte tritikala 20% +dvije sorte zobi 20% + pšenica 15%+ ječam 5%) i smjesa B (tri vrste talijanskog ljulja 55% + dvije sorte zimske zobi 45%). Pokusno polje je iznosilo 30.600 m^2 po tretmanu. Dvije različite mješavine krmiva posijane su 11. rujna 2017. godine, (smjesa A:75 kg sjemena/ha; smjesa B: 75 kg sjemena/ha) na dubini od 2-5 cm. Zaštita biljaka nije primijenjena u sezoni rasta. Rezanje je obavljeno rukom za vrijeme stvaranja glavica tritikala na visini stabljike od 10 cm. Svježa smjesa A (suha tvar 189 g/kg; sirova bjelančevina: 161 g/kg DM;NDF: 485 g/kg DM) i svježa smjesa B (suha tvar 195 g/kg; sirova bjelančevina 159 g/kg DM;NDF:519 g/kg DM) je venula do 28-32% DM (24h) bez ikakvog micanja na prozoru.

Povenulo krmivo je rukom brano i sjeckano kombajnom za krmivo (John Deere 7300) na betonskoj površini s teoretskom sjeckalicom duljine 9 mm (težine 800 kg). Povenuli i narezani materijal od 510 g stavljen je rukom u staklenke (volumena 0, 00072 m^3, n=5 ukupni broj minisilosa =15). Otvoreno je pet laboratorijskih silosa po mješavinama 7.,14. i 90. dana nakon siliranja. Određeni su suha tvar DM, sirova bjelančevina CP, sirovo vlakno CF, neutralno deterdžentsko vlakno NDF, kiselo deterdžentsko vlakno ADF, kiseli deterdžentski lignin ADL, ekstrakt etera, pepeo i ukupni šećer u svim tretmanima. Osim toga, u siliranim smjesama izmjereni su pH i koncentracija amonijaka N, hlapive masne kiseline. Nakon 90 dana siliranja u obje mješavine nađene su značajne razlike ($p<0,5$) u svim hranjivim tvarima osim u kiselom deterdžentskom tkivu u mješavini A, sirovim bjelančevinama, pepelu i sirovom vlaknu u mješavini B na što nije djelovalo trajanje fermentacije. Siliranje je prouzročilo značajno smanjenje pH zbog proizvodnje mliječne kiseline ali je uspjelo postići fermentaciju mliječne kiseline. Vrijednosti za amonijak-N, etanol i octenu kiselinu i maslačnu kiselinu bile su niske. Ovi rezultati pokazuju da su talijanski ljulj i silaža zimskih žitarica bili podvrgnuti brzoj fermentaciji te da je kvaliteta dobro očuvana.

Ključne riječi: fermentacija, talijanski ljulj, zimske žitarice, silaža, mliječna kiselina