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Research

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Determination of Nutritional Values of Cattail (*Typha latifolia* L.) and Common Reed (*Phragmites australis* Cav.) Silages

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A B S T R A C T

Cattail (*Typha latifolia* L.) and common reed (*Phragmites australis* Cav.) are species that grow spontaneously in wetlands and produce high biomass. This research was carried out to reveal the potential of these species to be used as an alternative silage plant. These plants were harvested in two different growing stage (boot stage and flowering stage) in 2021 and 2022, and they were ensiled by adding rolled barley at four different rates (0, 5, 10 and 15%). In this study, the dry matter, crude protein, ndf and adf ratios of cattail plant at different harvesting times (boot stage and flowering), which were examined by adding rolled barley at certain ratios, varied between 30.5%-30.3%, 13.35%-12.14%, 57.07%-59.11% and 35.34%-34.21%, respectively, while in common reed plant, the parameters examined varied between 44.8%-48.3%, 17.51%-16.45%, 53.99%-56-28%.

1. Introduction

Global climate change and drought have led agricultural scientists and producers to search for alternative production models. Increasing energy, fertilizer and irrigation costs make agricultural production difficult and increase production costs. Especially the decrease in water resources has made it necessary to use water in agriculture more carefully. Climate change and drought also affect livestock activities, especially causing an increase in the cost of feed, which is the largest input. As direct food production has gained priority in irrigated areas, it has become difficult for forage crops to find a place in crop rotation systems. This situation has further increased the importance of alternative feed sources.

Feeding animals with silage is a technique that is very common and successfully implemented today. The most used plant for silage production around the world is corn. In recent years, less costly alternative silage materials have begun to be emphasized instead of plants with high water consumption, such as corn. In this context, cattail (*Typha latifolia* L.) and common reed (*Phragmites australis* Cav.) are among the plants that attract the most attention, and research on these plants has been concentrated. Cattail and common reed grow on the edges of streams, lakes and wetlands without the need for agricultural practices such as irrigation

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and fertilization. Both species are perennial rhizomatous grasses found in freshwater wetlands. Their use as a bioenergy plant and to reduce environmental pollution in water also attracts attention (Hayta and Erkan, 2019). These plant associations, which cover very large areas in some regions, can produce high amounts of biomass per unit area. Researchers such as Büyükkılıç Beyzi and Sırakaya (2019) and Baran et al. (2002) reported that these species can be used as forage plants. Cattle and horses graze this grass during winter as a protein source, but common reed and cattle is unpalatable after maturity. Due to their coarse structure, these species seem more suitable to be used as silage in animal nutrition (Musa et al., 2019). In order for these plant silages to ferment successfully, harvest periods must be determined correctly.

Büyükkılıç Beyzi and Sırakaya (2019) determined that Phragmites austrialis reached its highest feeding value in mid-June. To increase the chances of success of cattail and common reed silages, it may be necessary to apply some additives containing carbohydrates (Asano et al., 2018). WingChing-Jones and Leal-Rivera (2017) determined that 3% molasses addition was successful in Typha domingensis silage. Cattail and common reed form very large associations in wetlands and stream banks in Erzurum and surrounding provinces. They grow naturally in large areas in many regions of Türkiye. The aim of this research is to determine the silage quality parameters of cattail (*Typha latifolia* L.) and common reed (*Phragmites australis* Cav.) silages that are harvested at different periods and ensiled with barley crushed at different rates.

2. Materials and Methods

2.1. Study Site

The research was conducted in 2021 and 2022 at Atatürk University, Faculty of Agriculture, Department of Field Crops, Erzurum. Erzurum is located in Eastern Anatolia Region of Türkiye. The city is situated 1860 meters above sea level, and It's latitute and longitude coordinates are 39°54'31"N, 41°16'36.98"E. Erzurum is an important center for animal husbandry and is a region with a high need for forage due to the long winter period. Research material; it was obtained from cattail (*Typha latifolia* L.) and common reed (*Phragmites australis* Cav.) associations, which grow naturally in large areas in the Erzurum Plain and on the banks of the Karasu River.

2.2. Sampling and Experimental design

Sampling was done from the areas covered with cattail and common reed, located on the edge of the Karasu River in Erzurum, during the boot stage and the flowering stage of the plants. In this sampling carried out in July and August, an area of 1 m2 was mowed from 3 different points representing plant associations, leaving a stubble height of 10-15 cm (in the wet habitats associated). The samples taken from the field were chopped into 1-2 cm sized pieces in a laboratory type silage machine and silage was made on the same day. Silages were made by compressing and sealing the material in 2 kg glass jars in an airtight manner. In both plants, samples taken at 2 different stages (booting and flowering) were mixed with 4 different ratios of crushed barley grain (0, 5, 10 and 15%) on a weight basis. The research was arranged in completely randomized experimental design with 3 replications for each species in 2021 and 2022.

2.3. Chemical and statistical analysis

Silages were opened after 60 days and dry matter, crude protein, ADF and NDF ratios and silage pH were determined. Crude protein ratios were determined by the Micro Kjeldahl method (Kacar and İnal 2008). Silage NDF (Neutral Detergent Fiber) and ADF (Acid Detergent Fiber) ratios were calculated by Van Soest et al. (1991) with the help of ANKOM Fiber Analyzer. The methods adopted by Kılıç (2010) were used to determine silage pH.

In the research, each species was evaluated on its own and no comparison was made with another species. Two-year data were subjected to analysis of variance for a complete randomized experimental design. When the ANOVA was significant, means were separated using Duncan's multiple range test at the level of $p \leq 0.05$.

3. Results

3.1. Dry Matter Ratio

While the effect of year, cutting stage and additive rate in cattail on the dry matter ratios of silages was found to be insignificant, the interaction of cutting stage time x additive rate was found to be significant (p <0.05, Table 1). This is due to the different effects of additives depending on the harvest stage. In common reed, the effect of years was found to be insignificant, but the effects of cutting time and additive, and the interaction of cutting time × additive were found to be significant (Table 1). As the harvesting stage was delayed in

common reed silages, the dry matter ratio increased from 44.8% to 48.3%. Addition rates also increased the dry matter ratios, and the dry matter ratio, which was 42.2% in non-additive silages, increased to 49.2% in 15% additive application. Additive rates also had a significant impact depending on the cutting time. While silage dry matter ratios fluctuated according to the increasing additives during the booting stage, a continuous increase occurred during the flowering stage (Table 1).

Table 1. Dry matter content of cattail and common reed silages (%)[1]

Harvest stage	Additive Ratio (%)	Cattail			Common Reed		
		2021	2022	Mean	2021	2022	Mean
Boot stage	0	29.4	28.7	29.1	43.3	42.2	42.8
	5	32.7	30.9	31.9	44.6	45.7	45.2
	10	30.9	30.9	30.9	44.3	45.2	44.8
	15	30.1	30.1	30.1	47.1	46.0	46.6
Mean		**30.8**	**30.2**	**30.5**	**44.8 B**	**44.7 B**	**44.8 B**
Flowering	0	29.0	28.4	28.7	42.1	41.1	41.6
	5	28.5	29.5	29.0	48.7	49.1	48.9
	10	30.6	30.7	30.7	50.4	51.4	50.9
	15	32.8	32.8	32.8	51.0	52.3	51.7
Mean		**30.2**	**30.4**	**30.3**	**48.1 A**	**48.5 A**	**48.3 A**
	0	29.2	28.6	28.9	42.7	41.7	42.2 B
	5	30.7	30.2	30.5	46.7	44.7	47.1 A
	10	30.8	30.8	30.8	47.4	48.3	47.9 A
	15	31.5	31.5	31.5	49.1	49.2	49.2 A
Mean		**30.5**	**30.3**	**30.4**	**46.5**	**46.6**	**46.6**
Additive ratio × Harvest stage			**			*	

[1]Means marked with different letters in the same column are different from each other.
*: significant at $p \leq 0.05$, **: significant at $p \leq 0.01$

3.2. Crude Protein Ratio

In the research, crude protein ratios of cattail and common reed silages showed significant changes according to years, additives ratio and cutting times (Table 2). According to the two-year average results, the average crude protein rate is 12.75% in cattail silages and 16.98% in common reed silages. According to the two-year average results, advancing cutting stage significantly reduced the silage crude protein ratio in both species. The effect of additives was insignificant. While there was no difference in common reed, the crude protein content of the first-year silages of cattail was higher (Table 2).

Table 2. Crude protein content of cattail and common reed silages (%)[1]

Harvest stage	Additive Ratio (%)	Cattail			Common Reed		
		2021	2022	Mean	2021	2022	Mean
Boot stage	0	13.88	11.61	12.75	14.90	18.11	16.50
	5	14.39	11.91	13.15	17.00	1786	17.43
	10	14.50	13.48	13.99	17.20	18.57	17.89
	15	14.21	12.83	13.52	17.52	18.90	18.21
Mean		**14.25 A**	**12.45**	**13.35 A**	**16.66 A**	**18.36 a**	**17.51 A**
Flowering	0	12.19	12.31	12.25	14.43	16.69	15.56
	5	12.27	11.58	11.93	14.87	17.50	16.19
	10	11.55	12.38	11.97	15.96	17.86	16.91
	15	12.25	12.59	12.42	15.42	18.84	17.13
Mean		**12.06 B**	**12.22**	**12.14 B**	**15.17 B**	**17.72 b**	**16.45 B**
	0	13.04	11.96bc	12.50	14.67 B	17.40	16.03

	5	13.33	11.74 c	12.54	15.94 A	17.68	16.81
	10	13.02	12.93 a	12.98	16.58 A	18.21	17.40
	15	13.23	12.71ab	12.97	16.47 A	18.87	17.67
Mean		**13.16 A**	**12.34 B**	**12.75**	**15.92**	**18.04**	**16.98**
Additive ratio x Harvest stage			*			ns	

[1]Means marked with different letters in the same column are different from each other.
*: significant at $p \leq 0.05$, ns: non-significant.

3.3. NDF (Neutral Detergent Fiber) Ratio

NDF contents of silages did not change significantly over the years, but varied depending on the additive rate (Table 4). Although delaying in harvest stage generally increased the NDF rate, this increase was found to be significant in the two-year average in common reed. The interaction of additive rate x harvest stage was found to be significant in the two-year average results of both plants. The most significant effect on the NDF content of silages was the additive rates. As the additive rate increased, NDF contents decreased from 64.05 to 53.76% in cattail and from 58.81 to 50.96% in common reed.

Table 4. Neutral detergent fiber (NDF) content of cattail and common reed silages (%)[1]

Harvest stage	Additive Ratio (%)	Cattail			Common Reed		
		2021	**2022**	**Mean**	**2021**	**2022**	**Mean**
Boot stage	0	52.75	68.19	60.47	58.96	58.35	58.66
	5	50.79	60.82	60.31	58.08	55.29	56.69
	10	54.28	52.98	53.63	53.09	55.26	54.17
	15	55.27	52.51	53.89	46.84	46.06	46.45
Mean		**55.52 B**	**58.63**	**57.07**	**54.24**	**53.74**	**53.99 b**
Flowering	0	68.44	66.82	67.63	59.49	58.41	58.95
	5	62.66	54.35	58.51	57.87	57.62	57.74
	10	60.02	53.31	56.67	54.43	51.46	52.95
	15	55.72	51.54	53.63	55.06	55.88	55.47
Mean		**61.71 A**	**56.51**	**59.11**	**56.71**	**55.84**	**56.28 a**
	0	60.59 a	67.51A	64.05 A	59.22 A	58.38 a	58.81A
	5	61.23 a	57.59B	59.41 B	57.98AB	56.46 b	57.22A
	10	57.15ab	53.14BC	55.15 C	53.76BC	53.36ab	53.56B
	15	55.49 b	52.02C	53.76 C	50.95C	50.97 b	50.96B
Mean		**58.62**	**57.57**	**58.10**	**55.48**	**54.79**	**55.14**
Additive ratio × Harvest stage			*			*	

[1]Means marked with different letters in the same column are different from each other.
*: significant at $p \leq 0.05$.

3.4. ADF (Acid Detergent Fiber) Ratio

ADF contents of silages were affected by the additive rates in both cattail and common reed (Table 3). As the additive rate increased, the ADF rate decreased from 39.79 to 31.55% in cattail and from 31.84 to 27.81% in common reed. Harvesting stage did not have a statistically significant effect on the ADF ratio of the silages (except for the second year in common reed). ADF rates were found to be higher in the second year in both plants, and this difference was statistically significant in cattail.

Table 3. Acid detergent fiber (ADF) content of cattail and common reed silages (%)[1]

Harvest stage	Additive Ratio (%)	Cattail			Common Reed		
		2021	**2022**	**Mean**	**2021**	**2022**	**Mean**
Boot stage	0	39.23	42.56	40.90	33.31	34.92	34.12
	5	33.34	37.80	35.82	30.73	30.78	30.76

	10	27.94	37.41	32.68	27.96	28.21	28.08
	15	31.74	32.18	31.96	25.24	26.95	27.00
Mean		**33.19**	**37.49 A**	**35.34**	**29.31**	**30.22**	**29.76**
Flowering	0	37.46	39.91	38.69	28.09	31.05	29.57
	5	31.92	34.88	33.40	26.08	27.48	26.78
	10	31.23	31.34	31.29	32.09	25.91	29.00
	15	28.48	33.81	31.15	27.51	31.53	29.52
Mean		**32.27**	**34.99 B**	**34.21**	**28.44**	**28.99**	**28.72**
	0	35.85 A	41.23 A	39.79 A	30.70a	32.98 a	31.84 A
	5	32.88 B	36.34B	34.61 B	28.40ab	29.13 b	28.77 B
	10	29.58 C	34.38BC	31.98 C	30.02a	27.06 b	28.54 B
	15	30.11 C	33.00C	31.55 C	26.38b	29.24 b	27.81 B
Mean		**32.73 B**	**36.25 A**	**34.78**	**28.88**	**29.61**	**29.24**
Additive ratio × Harvest stage			ns			**	

[1]Means marked with different letters in the same column are different from each other.

**: significant at $p \leq 0.01$, ns: non-significant.

3.5. Silage pH

The pH values of the silages were statistically affected by both harvest stage and additive rate ($p \leq 0.05$). In general, mowing of the plants at advanced growing stage and integrating additives increased the fermentation of silages and reduced the silage pH (Table 5). The additive ratio of 10% and 15% resulted in lower pH values. In general, common reed silages appear to have higher pH than cattail silages.

Table 5. pH values of cattail and common reed silages (%)[1]

Harvest stage	Additive Ratio (%)	Cattail			Common Reed		
		2021	2022	Mean	2021	2022	Mean
Boot stage	0	4.98	5.70	5.34	5.81	6.23	6.02
	5	4.93	5.46	5.20	5.58	5.56	5.57
	10	4.45	5.21	4.83	5.19	5.35	5.27
	15	4.44	5.08	4.76	5.17	5.42	5.30
Mean		**4.70 B**	**5.36**	**5.03 B**	**5.44 A**	**5.64**	**5.54 a**
Flowering	0	5.77	5.63	5.70	5.17	6.40	5.79
	5	5.38	5.22	5.30	5.18	5.76	5.47
	10	4.76	5.05	4.91	5.34	5.22	5.28
	15	4.92	4.91	4.92	5.32	5.25	5.29
Mean		**5.21 A**	**5.20**	**5.21 A**	**5.25 B**	**5.66**	**5.46 b**
	0	5.38 a	5.67 a	5.52 a	5.49 a	6.32 a	5.91 a
	5	5.16 a	5.34 a	5.25 a	5.38 ab	5.66 b	5.52 b
	10	4.61 b	5.13 b	4.87 b	5.27 b	5.29 c	5.28 c
	15	4.68 b	5.00 b	4.84 b	5.25 b	5.34 c	5.30 c
Mean		**4.96 c**	**5.29b**	**5.12bc**	**5.35 b**	**5.65a**	**5.50**
Additive ratio × Harvest stage			*			*	

[1]Means marked with different letters in the same column are different from each other. *: significant at $p \leq 0.05$.

4. Discussion

As a result of the study, it was determined that different harvesting times and rolled barley added at different rates significantly affected some quality characteristics of cattail and common reed plants. However, this situation showed some differences depending on years and species. While the effect of harvest time and additive ratio on the silage dry matter ratio was found to be insignificant in cattail silages, delaying in the harvesting stage and adding rolled barley in common reed silages increased the silage dry matter ratio. Because the accumulation of structural substances in plants will increase with the progression of plant growth, it is expected that there will be an increase in the dry matter ratio

(Buxton and Mertens, 1995). It is thought that rolled barley increases the silage dry matter content because it contains husk. Dumlu and Tan (2009) and Dumlu Gül et al. (2015) pointed out similar results. Crude protein content was found to be higher in both plants in the early development stage. As the growth stage of forage plants progresses, the crude protein rate decreases as the structural substances in the plant increase (Bakoglu et al., 1999). ADF and NDF ratios, which express the crude protein ratio and the fibrous fraction, change inversely proportional to each other (Tan et al., 2019; Güllap et al., 2021). In this study, additive rates did not have a significant effect on crude protein ratio. Dumlu and Tan (2009) stated that the increasing effect of rolled barley on crude protein ratio occurs in material silages with low crude protein content.

The ADF ratio decreased with the advancement of the development stage in both plants, while this change was found to be statistically significant in cattail, it was insignificant in common reed. In general, the ADF ratio, which represents the fibrous fraction in plants, is expected to increase as the growing stage advanced (Tan et al., 2012). The increases in the generative parts during the flowering stage in cattail may have reduced the ADF rate in the silage. The addition of rolled barley and the increase in the additive ratio reduced the ADF content in both plants. It is estimated that this situation is due to the lower ADF content in rolled barley. Similarly, increasing additive rates resulted in significant decreases in NDF content. As a matter of fact, the results obtained by adding barley to silage in Dumlu Gül et al. (2015) support our study.

In this research, different results of harvest stage on silage pH were revealed depending on the species. As the cutting stage progressed, silage pH increased in cattail and decreased in common reed. It was determined that additives reduced pH in both species. Additives like rolled barley make ease fermentation and decrease the pH value of silages, because they have high soluble carbohydrate content (Umana et al., 1991). It is desirable that the silage pH be low, which is an indicator of successful fermentation. In this study, it is generally seen that gun pH is high in both plants. Harvesting stage and the addition of rolled barley did not cause decreases in the pH sufficiently. Similarly, Musa et al. (2020) determined the pH value of cattail silages as 5.39 and stated that the addition of urea and molasses was not sufficient to reduce the pH. For this reason, although it is considered more appropriate to harvest cattail and common reed in the boot stage for silage making, different additive applications should be tried to reduce the silage pH.

4. Conclusion

In the silage study in which the effects of harvesting at different periods and addition of rolled barley at different rates on different plant species were examined, we can suggest that the addition of rolled barley at a rate of 10-15% in addition to harvesting at early growth periods will positively affect the quality of silage.

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