Turk J
Field Crops
2024, 29(1), 46-53
DOI: 10.17557/tjfc.1458251

DETERMINATION OF FEED QUALITY CHARACTERISTICS OF SOME SILAGE MAIZE (*Zea mays* L.) HYBRIDS CULTIVATED IN EASTERN MEDITERRANEAN CONDITIONS

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Received: 25.03.2024

ABSTRACT

The research was carried out in Kahramanmaras Eastern Mediterranean Transition Zone Agricultural Research Institute (DAGTEM) in the main crop growing season of 2019 and 2020 in a Randomized Complete Block Design with three replications to determine the silage quality characteristics of 20 different silage maize hybrids (Macha, Ranger, Simon, AS160, Dracma, DS0224, DKC6442, Colonia, Inove, Antex, Everest, Torro, 73may81, Kilowaatt, Klips, PR31Y43, 30B74, DKC7240, C955, and Gladius) as main crop. The study showed that silage quality varied significantly for maize hybrids and the region's climatic conditions in different years. According to the two-year average results, the dry matter content (T_{60}), dry matter recovery, crude protein content, crude ash content, starch content, NDF content, ADF content, ADL content, pH value, and forage yield were between 28.43-32.59%, 90.11-97.69%, 6.01-7.44%, 4.93-7.52%, 18.88-27.04%, 44.28-54.69%, 23.85-30.30%, 2.00-3.62%, 3.84-3.90, and 51343.5-79920.5 kg ha^{-1}, respectively, and C955, Everest, and PR31Y43 were the hybrids that potential silage nutritional value of them was prominent.

Keywords: Maize varieties, starch, silage quality, *forage yield*.

INTRODUCTION

Maize variety is widely grown as silage feed in the world and in Türkiye due to its high dry matter production per unit area, higher energy content compared to other forages, suitability for mechanization, ability to be easily mixed into rations, and relatively high consumption by dairy cattle (Fernandez et al., 2004). Maize is considered among the easily ensiled plants, mainly thanks to its chemical composition (NRC, 2001). However, commercially available silage maize varieties today are generally considered silage crops only because they yield high green forage. No seed company specializes only in silage maize cultivars. Most of the seed need for silage hybrid maize production is met by non-silage varieties (Ozata et al., 2012). Companies generally produce and market the seeds of grain maize, silage maize, and even other products. In fact, of course, it is unnecessary to find a company that will only produce maize for silage.

However, the resulting seed production genotypes are quickly registered as silage cultivars due to the need for more practical and applicable parameters in silage maize breeding and registration. In order to register any maize variety as silage today in Türkiye, it is sufficient to know the green grass yield, hay yield, and protein ratio. This situation is not favourable in terms of silage feed quality.

Many studies have been conducted on the effect of varieties on silage quality. In these studies, two or three varieties were generally used, and inoculation was examined together with other factors such as silo opening time or chopping size. For example, Sheaffer et al. (2006) used four different varieties to examine the effects of maize varieties and nitrogen fertilization. Two of these varieties were low in lignin content and brown midrib (BMR); one was a variety with abundant leaves, and the other was a standard hybrid. Researchers have determined that BMR varieties have low green forage yield. However, due to their high digestibility properties, animal milk production increased in response to unit feed consumption, and the amount of produced milk per unit area of forage maize was similar. Researchers have reported that BMR hybrids have high neutral detergent fiber (NDF) digestibility. However, dry matter yield is relatively low. Therefore, they have milk production potential similar to that of standard hybrid varieties.

Similarly, Nennich et al. (2003) reported that the variety with abundant leaves, improved for increasing feed quality and animal performance, differed from standard varieties regarding feed quality and milk production of ruminants. In the study conducted with three varieties, the researchers found significant differences between the varieties in terms of NDF digestibility. The fact that there are differences even among a few varieties indicates that the varieties will have different silage properties and feed quality characteristics. On the other hand, maize silage typically contains between 25-35% starch and 40-50% NDF on a dry matter (DM) basis (Ferraretto et al., 2015a). Mertens (2003) reports that maize silages contain 36-54% NDF and 8.3-9.3% protein on a DM basis. As can be seen, there is a wide variation in the chemical structure of maize arising from growing conditions and genotypic characteristics.

This study was conducted to determine the silage quality characteristics of silage maize varieties supplied by different companies in Eastern Mediterranean ecological conditions and to identify a readily determinable and effective silage maize breeding parameter.

MATERIALS AND METHODS

The research was conducted in 2019 and 2020 at the Kahramanmaras ecological conditions under a Randomized Complete Block Design with three replications. Macha, Ranger, Simon, AS160, Dracma, DS0224, DKC6442, Colonia, Inove, Antex, Everest, Torro, 73may81, Kilowaatt, Klips, PR31Y43, 30B74, DKC7240, C955 and Gladius silage maize varieties were used crop materials. The commercial companies from which the varieties were obtained, as well as their maturity periods and FAO maturity groups, are given in Table 1.

Table 1. Hybrids used, commercial companies from which they were supplied, and FAO groups

Hybrids	Companies	FAO Groups	Hybrids	Companies	FAO Groups
Macha	Polen	580	Everest	May	680
Ranger	Polen	600	Torro	Polen	680
Simon	Polen	600	73MAY81	May	700
AS160	Agromar	600	Gladius	Sygenta	800
Dracma	Syngenta	630	Kilowatt	KWS	700
DS0224	Agromar	630	Klips	KWS	700
DKC6442	Monsanto	650	PR31Y43	Pioneer	700
Colonia	Agromar	650	30B74	Pioneer	720
Inove	Syngenta	650	DKC7240	Monsanto	750
Antex	Syngenta	650	C955	Monsanto	800

According to the climate data for the period when the research was carried out, it was determined that the average temperatures of the second year of the study were above the long-term average, and the total amount of precipitation in both years was well below the long-term data (Table 2). Silage maize requires a minimum of 6-13 °C for germination (Sanchez et al., 2014) and more than 600 mm of rainfall during the vegetation period (Haarhoff et al., 2019) or needs irrigation when the rainfall is not enough. It can be seen from Table 2 that the average temperature values were at the desired level for maize, but it was not possible to grow maize without irrigation.

Table 2. Some climate data for the research years and long-term

		Months					
Climate data	Year	May	June	July	August	September	Sum/Average
Rainfall (mm)	2019	18.50	0.30	0.10	0.10	1.5	20.50
	2020	8.20	0.00	0.00	0.00	0.00	8.20
	Long Term	41.20	8.40	3.30	2.20	11	66.10
Average Temperature (°C)	2019	15.90	24.50	29.00	29.50	26.3	25.04
	2020	23.45	25.49	30.49	29.65	28.75	27.56
	Long Term	20.30	25.30	25.10	28.40	25.00	24.82
Relative humidity (%)	2019	47.20	46.90	47.20	47.7	41.2	46.04
	2020	43.30	49.00	44.60	40.95	42.86	44.14
	Long Term	54.95	49.67	51.90	48.76	45.42	50.14

Long-term covers the year range of 1930-2021

Some physical and chemical properties of the research area soils are given in Table 3. As seen in Table 3, the trial soils are slightly alkaline and have high $CaCO_3$ content. Soil organic matter is 1.86% in the 0-30 cm depth, where the effective root system is located, 1.91% in the 0-60 cm depth, and can be classified as moderately rich in organic matter. It was determined that the soil of the trial area was sufficient in terms of usable potassium and moderate in terms of phosphorus for maize growth.

Table 3. Some physical and chemical properties of the research soil.

Soil depth(cm)	pH	$CaCO_3$ (%)	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})	Organic matter (%)
0-30 cm	7.53	26.26	46.5	398.7	1.86
30-60 cm	7.52	26.12	42.7	652.4	1.91

This main crop planting was done with a parcel drill in 5 m long parcels, with 70 cm row spacing and 20 cm row spacing for each hybrid in 2019 and 2020. Until the plants reached 40-45 cm tall, weed control was carried out mechanically. During the experiment, irrigation was done using the sprinkler method at needed intervals. Hybrids used in the research reached harvest maturity at different times since each belonged to different maturity groups and vegetation periods were divergent. For this reason, hybrids' dry matter content was considered the essential criterion for harvest, and mowing was done when crops had an average DM content of 32-34%. The harvest stage generally coincides with the period when the grain's milk line decreases to 2/3 of the grain (Loucka et al., 2018). Plants were shredded in a plant shredder machine to a theoretical length of 2-3 cm to make silage. For each parcel, 0.5 kg of material with three parallel was placed in unique plastic bags, automatically sealed after removing 99.9% of the O_2 using a vacuum device (Ferraretto et al., 2015b). Silages were opened after 60 days, and silage quality characteristics were determined.

Approximately 100 g of samples were taken from each silage package after 60 days of fermentation. The samples were dried at 78°C until their weight was constant, then weighed, and the dry matter ratio before (T_0) and 60 days after (T_{60}) ensiling were calculated. Dry matter recovery (DMR), which explains the differences of forage DM mass in the silo day 0 and on the day that the silo opened, was calculated by dividing DM (T60) to DM (T0) and multiplying by 100 as described by da Silva et al., 2020. The dried material obtained here was used for chemical analysis after grinding at a 1 mm sieve. Cell wall components (NDF, ADF, and ADL) contents (%) were determined using the Ankom Fiber Analyzer (Fiber Analyser, ANKOM brand, A220 model) (Van Soest et al., 1991). The samples' nitrogen (N) content was determined using the Kjeldahl method. Crude protein was calculated using N x 6.25 (AOAC, 1990). Starch contents of silages were determined using polarimetry according to Evers' Polarimetric Method (International Organization for Standardization, 1997).

RESULTS AND DISCUSSIONS

The DM content of fresh material of silage maize hybrids varied between 30.30-35.59%, and there was no statistical significance among the DM contents (Table 4). The DM ratio of fresh forage before ensiling is one of the most critical factors affecting the silage's aerobic stability, fermentation, and quality. The DM content for a quality maize silage was determined by Kilic (1986) as between 30-35%, by Basmacioglu and Ergul (2002) as between 25-35%, and by Mohd-Setapar et al. (2012) between 25-40%. In the present study, it can be assumed that the DM contents of maize hybrids were at the desired level, as many researchers reported regarding silage quality. Unlike the DM content of fresh forage before ensiling, differences among DM of resulting silages opened on the 60th day were statistically significant. The highest DM content (32.59%) in resulting silages was determined in the C955 hybrid, followed by the Everest (32.46%). In comparison, Colonia (28.43%) hybrids have the lowest DM content ($P<0.05$), and ten hybrids, which have the highest DM content at T_{60}, were in the same statistical group due to relatively higher LSD value. When the average values were considered, it was determined that the DM content of samples taken before and after ensiling in the first year was higher than that of the second year ($P<0.01$).

Table 4. Dry matter content (%) of T_0 and T_{60} silages and dry matter recovery (%) (DMR) values.

	DM (T_0) (%)			**DM (T_{60}) (%)**			**DMR (%)**		
Hybrids	**2019**	**2020**	**Average**	**2019**	**2020**	**Average**	**2019**	**2020**	**Average**
Macha	34.21	30.16	32.19	33.38	28.55	30.97^{A-E}	97.58	94.90	96.24
Ranger	33.44	33.90	33.67	30.76	30.72	30.74^{A-F}	92.33	90.92	91.63
Simon	33.88	35.94	34.91	31.53	31.16	31.35^{A-D}	93.19	87.03	90.11
AS160	33.92	30.46	32.19	30.49	27.67	29.08^{DEF}	89.96	91.37	90.67
Dracma	33.00	33.24	33.12	30.36	28.09	29.23^{C-F}	91.87	85.34	88.61
DS0224	33.69	32.40	33.05	30.51	28.99	29.75^{C-F}	90.54	90.85	90.70
DKC6442	34.34	32.40	33.37	32.36	29.17	30.77^{A-F}	94.24	90.66	92.45
Colonia	32.42	28.18	30.30	30.06	26.80	28.43^{F}	92.80	95.26	94.03
Inove	32.47	32.53	32.50	30.91	29.09	30.00^{C-F}	95.11	89.93	92.52
Antex	34.08	31.56	32.82	31.86	29.18	30.52^{B-F}	93.49	89.65	91.57
Everest	34.62	36.55	35.59	33.37	31.55	32.46^{AB}	96.34	87.47	91.91
Torro	32.95	33.34	33.15	31.03	30.27	30.65^{A-F}	94.15	91.21	92.68
73May81	33.00	32.76	32.88	30.11	31.85	30.98^{A-E}	91.66	97.16	94.41
Kilowaatt	34.63	30.30	32.47	34.02	29.29	31.66^{ABC}	98.23	96.81	97.52
Klips	33.75	29.38	31.57	32.26	27.52	29.89^{C-F}	95.72	93.84	94.78
PR31Y43	33.05	28.29	30.67	30.37	28.53	29.45^{C-F}	91.97	98.74	95.36
30B74	34.36	28.77	31.57	31.24	25.94	28.59^{EF}	91.07	90.48	90.78
DKC7240	34.48	27.88	31.18	32.58	26.12	29.35^{C-F}	94.50	93.83	94.17
C955	34.91	31.56	33.24	34.23	30.94	32.59^{A}	98.05	98.01	98.03
Gladius	33.70	29.27	31.49	32.85	28.65	30.75^{A-F}	97.54	97.84	97.69
Average	33.75^{A}	31.47^{B}		31.71^{A}	28.95^{B}		94.02	92.56	
CV (%)	9.24			7.00			5.87		
LSD	Hybrid: ns Year: 1.10** Year x hybrid: ns ns: not significant			Hybrid: 2.44* Year: 0.77** Year x hybrid: ns			Hybrid: ns Year: ns Year x hybrid: ns		

The DM obtained from the silage of maize hybrids were higher than the values reported by Degirmenci (2000) (25.00-25.90%), compatible with the findings reported by Deniz et al. (2001) (26.49-37.37%) and Basaran et al. (2017) (%28.36-34.58), while lower than the values submitted by Arslan et al. (2016) (44.42%) and Akdemir et al. (1997) (36.13-39.89%). In addition to various characteristics, climatic conditions, and cultural practices are also influential in determining the DM content of maize hybrids. Year, hybrid effect, and year x variety interactions were not statistically significant concerning dry matter recovery (DMR) values. DMR of the hybrids varied between 90.11% for Simon and 98.03% for C955 hybrids (Table 4). Even though there were no significant differences among DMR values of hybrids, considering that silages are prepared with great effort and cost, the approximately 7% difference between the highest and lowest DMR is essential in the business economy.

As can be seen from Table 5, crude protein contents of silage maize varieties varied between 6.01-7.44% depending on the hybrids ($P<0.01$); the PR31Y43 variety had the highest crude protein value, insignificantly followed by Simon with 7.37% and Everest varieties with 7.32%, while the lowest crude protein ratio was acquired from Colonia hybrid with a value of 6.01%. The PR31Y43 silage maize hybrid came to the fore in the study regarding CP content, which is vital for feeding the value of silage. Considering the year effect, CP content ranged from 6.65 to 7.23%, and the average protein value obtained in the second year was significantly higher ($P<0.01$) than in the first year. It was determined that the CP content of Ranger, Simon, Antex, AS160, and some other hybrids increased in the second year, whereas that of Colonia, Klips, and Gladius hybrids decreased in the second year, and this caused a year x hybrid interaction ($P<0.01$) (Figure 1). Oz et al. (2012) reported that the CP contents of 50 different silage maize lines varied between 7.09-9.82%. Similarly, Ozata and Kapar (2017) reported that the silage crude protein ratio of different silage maize varieties ranged from 5.62 to 9.06% in the first year and from 5.22 to 7.81% in the second year, supporting the CP results of the present study.

A year and hybrid effects, as well as year x hybrid interaction, were found to be statistically significant ($P < 0.01$) in terms of the ash content of the silages opened on the 60th day of fermentation (Table 5). The ash rates of different maize hybrids changed between 4.93 and 7.52%; the highest ash content was obtained from the Antex variety with 7.52%, while the lowest values were obtained from Kilowaatt with 4.93% and from 73May81 with 4.99%. It was determined that the average ash content in the second year of the study was higher than in the first year. This difference can be explained by the fact that the plants remained green at harvest due to lower temperatures in the first year. As crop maturing progresses, the leaf/stem ratio decreases, and accordingly, there is a decrease in CP and crude ash values (Akbay et al., 2022). The hybrids used responded differently depending on the years in terms of their ash content, causing a year x variety interaction. For example, the ash content of the DKC7240 hybrid, which was 5.87% in the first year, increased by 34.07% in the second year and reached 7.87%, whereas the raw ash content of the Torro hybrid, which was 6.47% in the first year, decreased by 8% and fell to 5.95% in the second year. In other words, it was determined that the varieties showed different reactions regarding raw ash content depending on the years. The ash values obtained from the current research are compatible with the values of 6.31-8.27% reported by Geren (2000), 4.18-6.91% reported by Erdal et al. (2009), and 5.7-7.1% reported by Seydosoglu and Saruhan (2017).

Table 5. Crude protein (%), crude ash (%), and starch (%) contents and statistical groups.

	CP (%)			Ash (%)			Starch (%)		
Hybrids	**2019**	**2020**	**Average**	**2019**	**2020**	**Average**	**2019**	**2020**	**Average**
Macha	5.99^{kl}	6.68^{c-k}	6.34$^{\mathbf{EF}}$	7.28^{a-d}	7.19^{a-e}	7.24$^{\mathbf{AB}}$	26.51	24.81	25.66$^{\mathbf{AB}}$
Ranger	6.44^{f-k}	7.84^{ab}	7.14$^{\mathbf{A-D}}$	6.51^{b-i}	6.49^{b-i}	6.50$^{\mathbf{B-E}}$	27.37	24.05	25.71$^{\mathbf{AB}}$
Simon	6.83^{b-k}	7.91^{a}	7.37$^{\mathbf{AB}}$	5.16^{j-n}	5.40^{i-n}	5.28$^{\mathbf{HIJ}}$	21.30	21.90	21.60$^{\mathbf{BCD}}$
AS160	6.71^{c-k}	7.57^{a-e}	7.14$^{\mathbf{A-D}}$	6.15^{d-m}	6.45^{c-j}	6.30$^{\mathbf{C-F}}$	18.67	19.26	18.97$^{\mathbf{D}}$
Dracma	6.26^{h-l}	7.14^{a-i}	6.70$^{\mathbf{B-F}}$	5.40^{i-n}	5.93^{e-m}	5.67$^{\mathbf{E-J}}$	24.12	27.25	25.69$^{\mathbf{AB}}$
DS0224	6.68^{c-k}	7.61^{a-d}	7.15$^{\mathbf{A-D}}$	5.41^{i-n}	6.39^{c-k}	5.90$^{\mathbf{D-I}}$	18.78	18.97	18.88$^{\mathbf{D}}$
DKC6442	6.04^{jkl}	7.64^{a-d}	6.84$^{\mathbf{A-E}}$	5.80^{f-m}	6.32^{c-l}	6.06$^{\mathbf{C-H}}$	24.97	24.40	24.69$^{\mathbf{ABC}}$
Colonia	6.69^{c-k}	5.32^{l}	6.01$^{\mathbf{F}}$	5.41^{i-n}	5.43^{i-n}	5.42$^{\mathbf{F-J}}$	21.36	23.36	22.36$^{\mathbf{A-D}}$
Inove	6.53^{e-k}	7.30^{a-g}	6.92$^{\mathbf{A-E}}$	6.42^{c-k}	6.89^{a-h}	6.66$^{\mathbf{A-D}}$	29.69	24.38	27.04$^{\mathbf{A}}$
Antex	6.63^{d-k}	7.93^{a}	7.28$^{\mathbf{ABC}}$	7.39^{a-d}	7.64^{abc}	7.52$^{\mathbf{A}}$	27.97	22.75	25.36$^{\mathbf{AB}}$
Everest	7.06^{a-j}	7.58^{a-d}	7.32$^{\mathbf{AB}}$	6.13^{d-m}	7.36^{a-d}	6.75$^{\mathbf{A-D}}$	22.77	25.58	24.18$^{\mathbf{ABC}}$
Torro	6.15^{i-l}	7.71^{abc}	6.93$^{\mathbf{A-E}}$	6.47^{b-j}	5.95^{e-m}	6.21$^{\mathbf{C-G}}$	18.05	25.24	21.65$^{\mathbf{BCD}}$
73May81	6.90^{a-k}	7.46^{a-f}	7.18$^{\mathbf{ABC}}$	5.11^{k-n}	4.86^{mno}	4.99$^{\mathbf{IJ}}$	20.55	25.94	23.25$^{\mathbf{A-D}}$
Kilowaatt	6.97^{a-k}	7.24^{a-h}	7.11$^{\mathbf{A-D}}$	4.36^{no}	5.50^{i-n}	4.93$^{\mathbf{J}}$	26.36	23.96	25.16$^{\mathbf{ABC}}$
Klips	7.55^{a-e}	7.24^{a-h}	7.40$^{\mathbf{AB}}$	5.58^{h-n}	6.97^{a-g}	6.27$^{\mathbf{C-G}}$	19.65	21.24	20.45$^{\mathbf{CD}}$
PR31Y43	7.50^{a-e}	7.38^{a-g}	7.44$^{\mathbf{A}}$	5.01^{l-o}	5.92^{e-m}	5.46$^{\mathbf{F-J}}$	19.03	23.92	21.48$^{\mathbf{BCD}}$
30B74	6.39^{g-k}	6.76^{c-k}	6.58$^{\mathbf{C-F}}$	5.76^{g-m}	7.77^{ab}	6.76$^{\mathbf{A-D}}$	22.34	24.95	23.65$^{\mathbf{A-D}}$
DKC7240	6.05^{jkl}	7.49^{a-e}	6.77$^{\mathbf{A-E}}$	5.87^{f-m}	7.87^{a}	6.87$^{\mathbf{ABC}}$	23.79	23.03	23.41$^{\mathbf{A-D}}$
C955	6.23^{h-l}	6.61^{d-k}	6.42$^{\mathbf{DEF}}$	3.79^{o}	7.11^{a-f}	5.45$^{\mathbf{F-J}}$	25.84	23.73	24.79$^{\mathbf{ABC}}$
Gladius	7.37^{a-g}	6.23^{h-l}	6.80$^{\mathbf{A-E}}$	4.31^{no}	6.39^{c-k}	5.35$^{\mathbf{G-J}}$	25.74	26.39	26.07$^{\mathbf{AB}}$
Average	6.65$^{\mathbf{B}}$	7.23$^{\mathbf{A}}$		5.67$^{\mathbf{B}}$	6.49$^{\mathbf{A}}$		23.24	23.76	
CV (%)	9.24			13.35			17.72		
LSD	Hybrid: 0.74** Year: 0.24** Year x Hybrid: 1.04** ns: not significant			Hybrid: 0.93** Year: 0.30** Year x Hybrid: 1.32**			Hybrid: 4.79* Year: ns Year x hybrid: ns		

Maize grains are of great importance as starch sources in silage maize. The starch content of the grain varies depending on the maturity period and reaches its highest value during the dough formation period (Hill, 1993). The starch contents of maize hybrids ensiled during the dough formation period varied between 18.88-27.04%. Approximately half of the energy value of maize silage comes from its starch content. For this reason, it is desired that the starch content of maize silo feed should be high to a certain extent. From the results obtained, the Inove (27.04%) variety stands out with its highest starch content; besides, Gladius, Dracma, Macha, Ranger, and Antex varieties have relatively high rates of starch, respectively. For other results, DS0224 (18.88%) and AS160 (18.97%) varieties were determined to have the lowest starch content (P<0.05). In the study, the average starch content was determined to be 23.24% in the first year and 23.76% in the second year, and there was no significant difference in starch content between the years. The findings from the present study are parallel to the values (22.0-26.2%) reported by Simsek-Soysal et al. (2022).

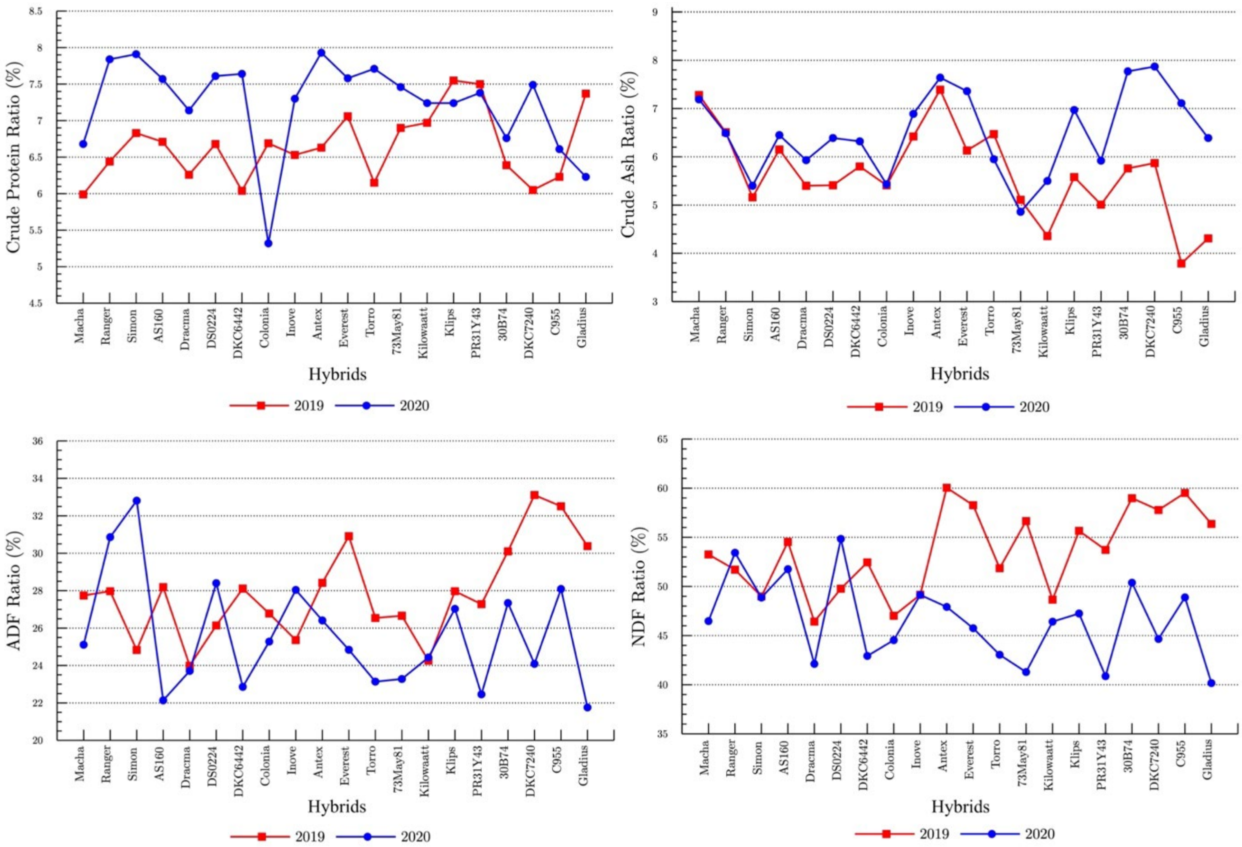

Figure 1. Year x Hybrid interactions for CP, Ash, ADF, and NDF

It was determined that the effects of year and hybrid on the ADF contents of maize silages opened on the 60th day of fermentation were not statistically significant. However, there were differences in the hybrids' responses in both years regarding ADF contents, and the year x hybrid interaction was significant. While the ADF values of the varieties were generally lower in the second year than in the first year, the opposite situation occurred for hybrids such as Ranger and Simon. This interaction can be associated with the year x variety interaction occurring in the plants' crude protein and ash content values. The ADF content of feeds containing high protein is known to be low (Arzani et al., 2006), and there is a negative correlation between them (Mcdonald et al., 1995; Prajapati et al., 2019). Loucka et al. (2018) reported that the ADF ratio of maize varieties should be 30% for a quality silage. Oz et al. (2012) reported that the ADF contents of 50 selected maize lines varied between 26.70-30.76%. Ozata and Kapar (2017) reported that the ADF contents of silo feeds of different maize varieties varied between 24.1-35.9%. The findings obtained from the current study agree with the reports mentioned above.

Table 6. Average ADF (%), NDF (%), and ADL (%) values and statistical groups.

	ADF (%)			NDF (%)			ADL (%)		
Hybrids	**2019**	**2020**	**Average**	**2019**	**2020**	**Average**	**2019**	**2020**	**Average.**
Macha	27.74^{a-h}	25.11$^{d-ı}$	26.43	53.26^{c-j}	46.48^{k-r}	49.87$^{\mathbf{B-G}}$	2.01	2.01	2.01$^{\mathbf{DE}}$
Ranger	27.97^{a-h}	30.86^{a-d}	29.42	51.71^{e-l}	53.43^{b-j}	52.57$^{\mathbf{A-D}}$	2.95	2.28	2.62$^{\mathbf{B-E}}$
Simon	24.83$^{e-ı}$	32.81^{ab}	28.82	48.98^{h-o}	48.87^{h-o}	48.93$^{\mathbf{C-G}}$	3.05	2.37	2.71$^{\mathbf{B-E}}$
AS160	28.19^{a-g}	22.14^{hı}	25.17	54.53^{a-h}	51.76^{e-l}	53.15$^{\mathbf{ABC}}$	4.03	3.20	3.62$^{\mathbf{A}}$
Dracma	23.99^{ghı}	23.71^{ghı}	23.85	46.43^{k-r}	42.12^{p-s}	44.28$^{\mathbf{H}}$	2.48	2.40	2.44$^{\mathbf{B-E}}$
DS0224	26.14$^{d-ı}$	28.40^{a-g}	27.27	49.77^{g-m}	54.84^{a-h}	52.31$^{\mathbf{A-D}}$	2.98	2.23	2.61$^{\mathbf{B-E}}$
DKC6442	28.11^{a-g}	22.86^{ghı}	25.49	52.45^{d-k}	42.93^{o-s}	47.69$^{\mathbf{E-H}}$	2.57	2.63	2.60$^{\mathbf{B-E}}$
Colonia	26.78$^{c-ı}$	25.28$^{d-ı}$	26.03	47.02^{k-r}	44.54^{m-s}	45.78$^{\mathbf{GH}}$	2.73	2.73	2.73$^{\mathbf{BCD}}$
Inove	25.36$^{d-ı}$	28.04^{a-h}	26.70	49.16^{h-n}	49.14^{h-n}	49.15$^{\mathbf{C-G}}$	2.76	2.76	2.76$^{\mathbf{BC}}$
Antex	28.42^{a-g}	26.41$^{d-ı}$	27.42	60.05^{a}	47.92$^{ı-p}$	53.99$^{\mathbf{AB}}$	3.24	2.18	2.71$^{\mathbf{B-E}}$
Everest	30.91^{a-d}	24.84$^{e-ı}$	27.88	58.27^{a-d}	45.75^{l-s}	52.01$^{\mathbf{A-E}}$	2.38	2.36	2.37$^{\mathbf{B-E}}$
Torro	26.54$^{d-ı}$	23.14^{ghı}	24.84	51.86^{e-l}	43.05^{n-s}	47.46$^{\mathbf{FGH}}$	2.19	2.19	2.19$^{\mathbf{B-E}}$
73May81	26.66$^{c-ı}$	23.28^{ghı}	24.97	56.66^{a-e}	41.29^{qrs}	48.98$^{\mathbf{C-G}}$	2.00	1.99	2.00$^{\mathbf{E}}$
Kilowaatt	24.26$^{f-ı}$	24.43$^{e-ı}$	24.35	48.66^{h-o}	46.42^{k-r}	47.54$^{\mathbf{FGH}}$	2.60	1.99	2.30$^{\mathbf{B-E}}$
Klips	27.97^{a-h}	27.03$^{b-ı}$	27.50	55.66^{a-g}	47.25^{j-q}	51.46$^{\mathbf{A-F}}$	2.49	2.55	2.52$^{\mathbf{B-E}}$
PR31Y43	27.28$^{a-ı}$	22.46^{ghı}	24.87	53.72$^{b-ı}$	40.87^{rs}	47.30$^{\mathbf{FGH}}$	2.09	2.15	2.12$^{\mathbf{C-E}}$
30B74	30.10^{a-f}	27.34$^{a-ı}$	28.72	58.99^{abc}	50.38^{f-m}	54.69$^{\mathbf{A}}$	2.65	2.67	2.66$^{\mathbf{B-E}}$
DKC7240	33.11^{a}	24.09^{ghı}	28.60	57.78^{a-e}	44.66^{m-s}	51.22$^{\mathbf{A-F}}$	2.12	2.11	2.12$^{\mathbf{CDE}}$
C955	32.51^{abc}	28.09^{a-h}	30.30	59.52^{ab}	48.89^{h-o}	54.21$^{\mathbf{AB}}$	2.90	2.87	2.89$^{\mathbf{B}}$
Gladius	30.38^{a-e}	21.76^{ı}	26.07	56.37^{a-f}	40.17^{s}	48.27$^{\mathbf{D-H}}$	2.22	2.22	2.22$^{\mathbf{B-E}}$
Average	27.86$^{\mathbf{A}}$	25.60$^{\mathbf{B}}$		53.54$^{\mathbf{A}}$	46.54$^{\mathbf{B}}$		2.62	2.39	
CV (%)	13.71			7.59			25.21		
LSD	Hybrid: ns Year: 1.33** Year x Hybrid: 5.96* ns: not significant			Hybrid: 4.37** Year: 1.38** Year x Hybrid:6.19**			Hybrid: 0.73** Year: ns Year x hybrid: ns		

It was determined that year, hybrid, and year x hybrid interactions were statistically significant regarding NDF contents of resulting silages (Table 6). It was determined that NDF rates varied between 44.28-54.69% depending on the varieties; the highest NDF rate was obtained from the 30B74 variety with 54.69%, followed by the C955 variety, with 54.21%, and the lowest NDF content was obtained from the Dracma with 44.28%. NDF content in any forage refers to all fiber in the plant cell, including hemicellulose, cellulose, and lignin. NDF is a critical quality criterion that gives information about how much feed consumption by ruminants. NDF content of the feed in the ration is desired to be between 27-30%. The study shows that the average NDF rate in the first year (53.54%) was higher than the average NDF rate in the second year (46.54%), and both were above the desired level. This situation can also be associated with the dry matter content. As the plant matures, its dry matter content increases, but digestion becomes difficult (Akbay et al., 2020). Oz et al. (2012) reported that the NDF values of 50 selected maize lines varied between 43.07-57.66%, and similarly, Ozata and Kapar (2017) reported that the NDF rates of silo feeds of different maize varieties varied between 40.8-58.6%. Considering both the current research results and the results of previous studies, the ADF contents in maize silages are higher than the desired level.

Table 7. Average pH and forage yield (kg ha^{-1}) values and statistical groups.

	pH			Forage Yield (kg ha^{-1})		
Hybrids	**2019**	**2020**	**Average**	**2019**	**2020**	**Average**
Macha	4.02	3.83	3.93$^{\mathbf{ABC}}$	51171.1	83564.3	67367.7$^{\mathbf{A-E}}$
Ranger	3.83	3.85	3.84$^{\mathbf{C-F}}$	49905.6	72219.0	61062.3$^{\mathbf{B-E}}$
Simon	3.83	3.74	3.79$^{\mathbf{EF}}$	56227.8	77421.4	66824.6$^{\mathbf{A-E}}$
AS160	3.96	3.85	3.91$^{\mathbf{A-D}}$	58105.6	92100.0	75102.8$^{\mathbf{A}}$
Dracma	3.79	3.71	3.75$^{\mathbf{F}}$	66896.7	84054.8	75475.8$^{\mathbf{A}}$
DS0224	3.92	3.85	3.89$^{\mathbf{A-D}}$	48174.4	79052.4	63613.4$^{\mathbf{B-E}}$
DKC6442	3.90	3.86	3.88$^{\mathbf{A-E}}$	49052.2	84454.8	66753.5$^{\mathbf{A-E}}$
Colonia	3.73	3.84	3.79$^{\mathbf{EF}}$	53427.8	85695.2	69561.5$^{\mathbf{ABC}}$
Inove	3.85	3.78	3.82$^{\mathbf{DEF}}$	57505.6	82842.9	70174.3$^{\mathbf{AB}}$
Antex	3.87	3.86	3.87$^{\mathbf{B-E}}$	63278.9	80292.9	71785.9$^{\mathbf{AB}}$
Everest	3.90	3.94	3.92$^{\mathbf{ABC}}$	51045.6	70723.8	60884.7$^{\mathbf{B-E}}$
Torro	3.93	3.81	3.87$^{\mathbf{B-E}}$	49681.1	67823.8	58752.5$^{\mathbf{CDE}}$
73May81	3.92	3.82	3.87$^{\mathbf{B-E}}$	57826.7	82341.7	70084.2$^{\mathbf{AB}}$
Kilowaatt	3.92	3.87	3.90$^{\mathbf{A-D}}$	53722.2	69709.5	61715.9$^{\mathbf{B-E}}$
Klips	3.91	3.87	3.89$^{\mathbf{A-D}}$	43242.2	82636.9	62939.6$^{\mathbf{B-E}}$
PR31Y43	3.92	3.81	3.87$^{\mathbf{B-E}}$	53846.7	81583.3	67715.0$^{\mathbf{A-D}}$
30B74	3.99	3.72	3.86$^{\mathbf{B-E}}$	43968.9	83802.4	63885.7$^{\mathbf{B-E}}$
DKC7240	3.99	3.90	3.95$^{\mathbf{AB}}$	39111.1	76270.2	57690.7$^{\mathbf{DE}}$
C955	3.96	3.94	3.95$^{\mathbf{AB}}$	34790.0	78226.2	56508.1$^{\mathbf{E}}$
Gladius	3.93	4.02	3.98$^{\mathbf{A}}$	45890.0	78595.2	62242.6$^{\mathbf{B-E}}$
Average	3.90^{A}	3.84^{B}		51343.5^{B}	79920.5^{A}	
CV (%)	2,19			14.84		
LSD	Hybrid: 0.03** Year: 0.1** Year x hybrid: ns ns: not significant			Hybrid:11203.2** Year: 3542.8** Year x hybrid: ns		

One of the most essential criteria used to determine silo feed quality is pH measurement. Whether the wet forage is sufficiently fermented or not may be understood by measuring the pH value of the silo feed. Table 7 shows that year and variety affect the pH value of results from silages belonging to corn varieties (T_{60}) statistically significant (P<0.01). In contrast, the variety x year interaction has no meaningful effect on pH values. It is known that the pH value of a good silo feed should be around 3.8-4.0, and the pH values of the silages vary between 3.75-3.98, which is in the range of desired values. Gladius variety has the highest pH value with 3.98, followed by DKC7240 and C955 varieties with insignificant differences, and the lowest pH value is obtained from the Dracma variety with 3.75. It is seen that the pH (T_{60}) values vary between 3.84 and 3.90 according to year, and the highest pH value is obtained from the plantings in the first year. The pH value remained stable over the years in the study due to no significant difference between the values according to the variety x year interaction. The findings related to silage pH from the present study are in agreement with some other studies, such as Alcicek et al. (1997), Geren (2000), and Geren (2001), who reported that it varied between 3.75-4.10, 3.87-4.24 and 4.03-4.15, respectively.

The forage yield of corn hybrids was changed between 56508.1 and 75475.8 kg ha^{-1}, depending on the varieties. The highest forage yield was obtained from Dracma and AS160 hybrids with the values of 75475.8 and 75102.8 kg ha^{-1}, respectively (Table 7), followed by Antex with 71785.9 kg ha^{-1}, Inove with 70174.3 kg ha^{-1} and 73May81 variety with 70084.2 kg ha^{-1}, with no statistical differences. The lowest forage yield was obtained from the C955 variety with 56508.1 kg ha^{-1}, significantly different from the abovementioned ones. There are some other studies on corn varieties, but the variety differed from those used in the present study. For instance, Ozata et al. (2012) reported that forage yields varied between 33405.0-62970.0 kg ha^{-1} and the highest grass yield was obtained from the TTM.2007-145 genotype in the study conducted with corn genotypes under Samsun ecological conditions. Olgun et al. (2012) reported that when the green grass yields of 23 different corn genotypes were compared, the yield varied between 66990-134870 kg ha^{-1} in a study conducted in Eskisehir ecological conditions. In parallel, Seydosoglu and Saruhan (2017) reported that the highest green grass yield in Diyarbakır conditions was obtained from the Burak variety with 103728 kg ha^{-1}, while the lowest green grass yield was obtained from the 31Y43 variety with 60005.0 kg ha^{-1}. It was determined that in the first year of the study, the average forage yield was 51343.5 kg ha^{-1}, while it was 79920.5 kg ha^{-1} in the second year. The yield difference between years may be due to the differences in average temperatures between years because the average temperature of the growing period 2020 was almost 2.5 ºC higher than that of the 2019 year.

CONCLUSION

For a successful silage fermentation, it is desired that the dry matter content during harvest is sufficient and the dry matter loss at resulting silage is low. The study determined that C955 and Everest varieties stood out with their high dry matter content. For a quality silage feed, starch, protein, ash rates, and digestibility are required to be high, while fiber concentration is expected to be relatively low. In the study, PR31Y43, Simon, and Everest hybrids stood out regarding crude protein content, Antex and Macha regarding crude ash content, and Inove, Gladius, and Dracma regarding starch content. However, 73May81 and Macha hybrids' fiber content was lower than other hybrids. The pH values of all hybrids were in the range of desired values, although the forage yield showed further variability. This two-year study conducted with 20 different silage hybrid maize showed remarkable differences in silage feed quality characteristics, the highest potential nutritional value of silage feeds, and the forage yield acquired from PR31Y43 and Antex hybrids under Eastern Mediterranean conditions.

ACKNOWLEDGMENTS

The Turkish Council of Scientific and Technological Research (TUBITAK), project number 1180200, supported this study.

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