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Araştırma Makalesi

Effects of Different Row Spacing on the Nutritional Value of Quinoa Silage

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ABSTRACT

Climate changes in the world cause an increase in arid areas and saline soils, and at the same time, the increase in extreme climate and soil conditions restricts land use efficiency. In these areas, it becomes difficult to provide silage feed for animals. Therefore, the search for alternative forage plants is also increasing. Quinoa (*Chenepodium quinoa* Willd.) plant, which is resistant to arid, cold and salty soils, has an important alternative plant potential for silage production in extreme climate and soil conditions. For this purpose, a research was conducted on the silage nutrition values of 2 quinoa varieties (Cherry Vanilla and Read Head) grown at 4 different row spacing distances (17.5, 35.0, 52.5, 70.0 cm). In the research, it is aimed to determine raw ash content (CA), crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), dry matter digestibility (DMD), dry matter consumption (DMI) and relative feed value (RFV), which have important nutritional values for animals. As a result of the research, it was determined that sowing seeds at different row spacings had a significant effect on CP, NDF, DMI and RFV of quinoa silage. There was no significant difference in the nutritional values of quinoa silage between varieties (except CP). According to the results of the research, it was determined that sowing with wide row spacing increased the nutritional value of quinoa silage.

Key words: Quinoa, crude protein, raw ash, silage, relative feed value

Farklı Sıra Aralığının Kinoa Silajının Besin Değerine Etkisi

ÖZ

Dünyadaki iklim değişiklikleri kurak alanların ve tuzlu toprakların artmasına neden olmakta, aynı zamanda aşırı iklim ve toprak koşullarının artması da arazi kullanım verimliliğini kısıtlamaktadır. Bu alanlarda hayvanlara kaliteli kaba yem sağlamak zorlaşmaktadır. Bu nedenle alternatif yem bitkisi arayışları artmaktadır. Bu araştırma kurak ve soğuk iklim şartları ile tuzlu topraklara toleranslı olan kinoa (*Chenepodium quinoa* Willd.) bitkisi silaj üretimi için önemli bir alternatif potansiyeline olarak görülmüştür. Bu amaçla 4 farklı sıra arası mesafede (17.5, 35.0, 52.5, 70.0 cm) yetiştirilen 2 kinoa çeşidinin (Cherry Vanilya ve Red Head) silaj besin değerlerinin belirlenmesi amacıyla yapılmıştır. Araştırmada hayvanlar için önemli besin değerlerini olan ham kül içeriği (HK), ham protein (HP), asit deterjan lifi (ADF), nötr deterjan lifi (NDF), kuru madde sindirilebilirliği (KMS), kuru madde tüketimi (KMT) ve nispi yem değeri (NYD)'nin belirlenmesi amaçlanmıştır. Araştırma sonucunda tohumların farklı sıra aralıklarına ekilmesinin kinoa silajında HP, NDF, KMT ve NYD üzerine önemli etkisinin olduğu tespit edilmiştir. Kinoa silajının besin değerleri açısından çeşitler arasında (HP hariç) önemli bir farklılık görülmemiştir. Araştırma sonuçlarına göre geniş sıra aralığı ile yapılan ekimlerin kinoa silajının besin değerini arttırdığı tespit edilmiştir.

Anahtar kelimeler: Kinoa, ham protein, ham kül, silaj, nispi yem değeri

INTRODUCTION

The most preferred plant for silage making is corn (*Zea mays* L.). On the other hand, silages of alfalfa, vetch, oats, barley, sudangrass and sorghum are also widely made. In silage making, it is preferred that plants have high carbohydrate and dry matter content. However, high quality silage feed can be obtained by adding silage additives to plants that do not have high carbohydrate and dry matter content. Increasing extreme climate and soil conditions such as climate changes in the world, increase in dry areas, salinization of soils, restrict land use efficiency. In particular, the transformation of lands into marginal areas limits the number of plants that can grow in these areas. In these areas, it becomes difficult to provide silage feed for animals. Therefore, the search for alternative forage crops that can be grown in these areas is increasing.

Quinoa (*Chenepodium quinoa* Willd.) plant, which is resistant to arid, cold and saline regions, has an important alternative potential for silage production (Geerts et al., 2009; Razzaghi, 2011; Pulvento et al., 2012; Zerrouk et al., 2020; Keskin et al., 2023). Plants traditionally used for silage purposes are grown in irrigated and non-saline areas. However, since the quinoa plant is resistant to arid and salty areas, growing quinoa in these areas and making silage of the plant can be seen as an advantage in terms of utilizing salty and arid areas and developing animal husbandry. Quinoa has been used as human food in the South American region for over 5000 years. As a result of understanding the importance of the plant, its cultivation is increasing in many parts of the world (Jacobsen, 2003; Tan and Temel, 2019). The quinoa plant, which is an annual, dicotyledonous plant and prefers the C3 photosynthesis pathway, is generally grown for its seeds. However, recently, as a result of understanding its animal feed value, research has focused on the fact that it can be used as concentrate, roughage and silage feed for animals (Van Schooten and Pinxterhuis, 2003; Tan and Temel, 2017; Podkòwka et al., 2018; Önkür and Keskin, 2019a; Önkür and Keskin, 2019b; Suarez et al., 2019;Temel and Keskin, 2019a; Temel and Keskin, 2019b; Temel and Keskin, 2020; Yacout et al., 2021; Dong et al., 2022; Güner and Temel, 2022).

Studies conducted to determine the nutritional values of quinoa silage to be used in animal nutrition have shown that quinoa silage has high nutritional content, but making silage by adding additives to increase silage quality will be more beneficial in animal nutrition. It has been determined that the raw ash content of quinoa silage is between 1.6-29.1%, crude protein content is between 10.3-18.3%, NDF content is between 37.9-54.8% and ADF content is between 24.4-32.8% (Podkòwka et al., 2018; Salama et al., 2021; Dong et al. al., 2022; Güner and Temel, 2022).

This research was carried out to determine the nutritional values of silage, which is an important resource for animals, in quinoa varieties and to reveal the effects of row spacing on nutritional values.

MATERIALS AND METHODS

Material

In the study, Cherry Vanilla and Read Head varieties, which were found to be highly productive in adaptation studies in Iğdır province, were used (Tan and Temel, 2017). The trial was conducted in 2021 in the trial area of Iğdır University Agricultural Application and Research Center (39^0 55'43.59" K, 45^0 05'42.63'' D). The climate and soil characteristics of the trial area are given in Table 1 and Table 2.

Some climate data of the region during the period when the research was conducted are given in Table 1. When Table 1 is examined, it can be seen that, according to the long-term climate values of the region, the average temperature in the year the research was conducted was high, and precipitation and relative humidity were low. Compared to long years, the year in which the research was conducted was hotter and drier.

Table 1. Some climate data of the research area (MGM, 2021)

MONTHS	Average temperature (°C)		Average relative humidity (%)		Total amount of precipitation (mm)	
	2021	LYA*	2021	LYA*	2021	LYA*
MARCH	7.4	6.8	55.3	52.9	43.4	22.1
APRIL	17.4	13.3	44.0	51.1	15.9	36.2
MAY	21.1	17.6	46.7	53.2	39.5	49.1
JUNE	26.8	22.4	34.4	47.3	0.5	30.3
JULY	27.4	26.1	46.0	45.1	30.6	14.4
Total/Avg.	20.02	17.24	45.28	49.92	129.9	152.1

*Long Year Average (1970-2021)

The properties of the soils taken in the area where the experiment was established are given in Table 2. When Table 2 was examined, it was determined that the texture of the soil of the trial area was "clay-loamy", slightly alkaline and nonsaline. It was determined that the amount of available potassium was "high", the amount of organic matter was "very low", the amount of available phosphorus was "low" and the soil was calcareous (Richards, 1954; Ülgen and Yurtsever, 1974; FAO, 1990).

Table 2. Some physical and chemical properties of the research area soil

Soil Properties	Value	Classification
Soil texture (Saturation %)	54	Clay loam
pH	7.49	Slightly alkaline
EC (dS m^{-1})	3.44	Nonsaline
Salt (%)	0.12	Nonsaline
Calcareous (%)	1.32	Calcareous
Organic matter (%)	0.61	Very little
Phosphorus (kg da^{-1})	3.17	Low
Potassium (kg da^{-1})	166	High

*The analysis of the soil sample of the research area was carried out in the Eastern Anatolia Agricultural Research Institute Soil and Plant Nutrition Laboratory.

Method

The experiment was set up with 3 replications according to the factorial trial design in randomized blocks. The plots were prepared with a length of 4 m and a width of 2 m. Seeds were sown in the plots at row spacings of 17.5 cm, 35.0 cm, 52.5 cm, 70.0 cm. cm.

Before seed planting, pure 9 kg da^{-1} P_2O_5 (42% TSP) and 7.5 kg da^{-1} N (21% Ammonium sulfate) fertilizer were applied to the trial plots. When the plants reached a height of 30-40 cm, an additional 7.5 kg da^{-1} of N (21% Ammonium sulphate) fertilizer was given ((Temel and Şurgun, 2019). The experiment was carried out under irrigated conditions. The moisture in the soil was measured with a soil moisture measuring device and When 50% of the useful water in the soil was consumed, irrigation was carried out with the sprinkler irrigation system until the field capacity was reached again.

When the plants reached the harvest period (beginning of flowering) on June 21, 2021, they were harvested by cutting them with vine shears at a height of 5 cm from the soil surface. After the harvested plants were shredded in the herb shredding machine, approximately 500 g were taken and filled into transparent polyethylene bags. After the air was removed from the polyethylene transparent bags with a vacuum machine, the bags were closed with the same machine. After waiting 60 days for the fermentation of the silages, the bags were opened and the silage nutrition values were determined according to the following methods.

Raw ash ratio: Rae ash ratio was calculated on dry matter. The porcelain crucibles to be used in the determination of raw ash were kept empty in the raw ash furnace at 550 °C for 2 hours. Then, the crucibles were placed in the desiccator and allowed to cool until they reached room temperature. The cooled crucibles were tared (D) and 1 gram of silage material (A) was added into them. The crucibles were placed in the raw ash furnace and kept at 550 °C for 8 hours, then placed in the desiccator and kept for 2 hours, and then weighed together with the crucible (DA). The percent ash content of the feed material was calculated using the raw ash determination formula given below (AOAC 1990).

$$\text{Raw ash ratio (\%)} = \frac{DA - D}{A} \times 100$$

Crude protein ratio: Dried silage samples were ground in a grinding mill with a sieve diameter of 1 mm. Total nitrogen was determined according to the Micro Kjeldahl method, taken by weighing approximately 0.3-0.5 grams of dried and ground samples on a precision scale. By multiplying the obtained % nitrogen ratios with the coefficient of 6.25, crude protein ratios of silages were found according to the principles specified by AOAC (2003).

NDF (neutral detergent fiber) ratio (%): The samples, which were previously ground to pass through a sieve with a diameter of 1 mm, were weighed on a precision scale between 0.950 and 1.050 g along with the Filterbag weight, and were analyzed on the ANKOM fiber analyzer device using the method developed by Van

Soest et al., (1991). Afterwards, the samples removed from the device were washed with acetone and kept on drying papers for 30 minutes. Afterwards, it was dried in an oven at 105 °C for 12 hours and then placed in a desiccator. When the samples reached room temperature in the desiccator, their final weights were weighed with a precision scale and the %NDF ratios were determined.

ADF (acid detergent fiber) ratio (%): The ground samples were weighed on a precision scale between 0.950 and 1.050 g by Filterbag weight. Afterwards, ADF analysis was performed on the ANKOM fiber analyzer device (Van Soest et al., 1991). In the last stage, the feed samples removed from the device were washed with acetone, left on drying paper for approximately 30 minutes, then dried in the drying oven at 105 °C for 4 hours and left to cool in the desiccator for 2 hours. Then, the final weights of the samples were weighed and the %ADF ratios were determined.

Relative feed value, dry matter digestibility and dry matter intake: These parameters were calculated using the equation given below, using ADF and NDF analysis results (Sheaffer et al., 1995).

% Dry matter digestibility (%DMD)= 88.9 – (0.779 * %ADF).
% Dry matter intake (%DMI) = 120 ÷ %NDF
RFV = (DMD x DMI) ÷ 1.29

The results obtained in the study were analyzed by variance analysis in the JMP 5.0.1 statistical package program according to the factorial trial design in randomized blocks. and the comparison of the significant averages were grouped according to the LSD test in the same program.

RESULTS AND DISCUSSION

Raw ash ratio

While variety and row spacing had no effect on the raw ash ratio, the combined effect of variety x row spacing was significant. Raw ash ratios of quinoa varieties varied between 24.1 and 24.4% (Table 3). In a different study conducted under Bingöl conditions, Çağlayan (2021) reported the ash ratios of Cherry Vanilla and Read Head varieties as 15.32% and 16.9%, respectively. Raw ash of quinoa silage in different row spacings varied between 24.1% and 24.5% (Table 3). As a result of the combined effects of variety and row spacing, raw ash ratios varied between 23.3% and 24.9%. Raw ash ratios of the varieties differed depending on row spacing (Figure 1). Studies have found that the raw ash ratios of quinoa silage are between 1.6 and 29.1 (Podkòwka et. al., 2018; Erdoğan and Koca, 2020; Salama et. al., 2021; Güner and Temel, 2022). While the raw ash ratio in the current study was found to be higher in some studies compared to previous studies (Podkòwka et. al., 2018; Erdoğan and Koca, 2020; Salama et. al., 2021), it was found to be low in some studies (Güner and Temel, 2022). Plants grown in regions with different climatic characteristics affect the growth and development of the plant, such as temperature, humidity and precipitation. There may be significant changes in the yield and quality of plants with different growth and development. In addition, the different properties of the soil in which the plant is grown have significant effects on the productivity and quality of the plant. For these reasons, it can be said that the raw ash values obtained in this study are different from plants grown in other regions.

Crude protein ratio

Silage crude protein ratios of the varieties differed significantly. Crude protein ratio was found to be 15.7% in Cherry Vanilla variety and 16.4% in Read Head variety. Genetic, morphological and physiological characteristics of plant species and varieties are different. Plant heights, leaf, stem, cluster ratios and root developments may vary among plant species. At the same time, if the varieties of the species are grown in areas with different climatic characteristics and different cultural practices are applied, plant heights, leaf, stem, cluster ratios and root developments may also differ. Due to these characteristics of the varieties, adaptation studies are carried out to determine the yield and quality of the varieties before recommending the varieties of any species to the regions. For these reasons, there may be differences in the crude protein ratios obtained in quinoa varieties. It is desirable for the crude protein ratio to be high in feed. It is expected that the nutritional value of feed with a high crude protein content will also be high. Depending on the different row spacing, the silage crude protein ratio varied between 14.7% and 17.1%. It was observed that the crude protein content of the silages increased due to the increase in row spacing (Table 3). It is thought that this situation is due to the fact that plants benefit more from the nutrient resources per unit area. The silage crude protein contents of the varieties in different row spacings varied significantly (Figure 2). Varieties showed different responses in different row spacings. Red Head and Cherry Vanilla cultivars showed different responses to different row spacings. While the crude protein ratio of the Red Head variety increased in the 35 cm row spacing compared to the 17.5 cm row spacing, there was no significant change in the crude protein ratio of the Cherry Vanilla variety. On the other hand, compared to the 52.5 cm row spacing, there was no significant change in the crude protein ratio of the Read Head variety in the 70 cm row spacing, while the crude protein ratio of the Cherry Vanilla variety increased (Figure 2). The fact that quinoa varieties responded differently to different row spacing in terms of crude protein content caused the bilateral interaction to be significant. It has been reported that the crude protein content of quinoa silage increases due to the increase in row spacing (Güner and Temel, 2022). Podkòwka et. al. (2018), Dong et. al. (2022), Salama et. al. (2021) and Güner and Temel (2022) reported the crude protein ratio of quinoa silage as 10.31%, 15.1%, 14.59% and 18.3%, respectively. The crude protein ratios obtained in the current study were found to be higher than the values determined by many researchers. It is thought that this situation is due to the different environmental conditions and genotypes used. As a matter of fact, crude protein ratio is affected by many environmental factors (temperature, irrigation, direction, day length, etc.) (Erekul et al., 2016; Koca and Monster, 2014; Koca and Turgut, 2012).

Table 3. Some silage nutritional values of quinoa varieties in different row spacings

Variety (V)	**Row spacing (R)**				**Variety avg.**
	17.5	**35**	**52.5**	**70**	
			Raw ash ratio		
Cherry Vanilla	24.9	24.7	23.6	24.4	24.4
Red Head	23.3	24.3	24.9	24.0	24.1
Row spacing Avg.	24.1	24.5	24.2	24.2	
F value and significance	R: 0.44 ns	V: 1.16 ns	RxV: 4.24*		
		Crude protein ratio			
Cherry Vanilla	15.6	15.4	14.9	16.9	15.7 b
Red Head	13.7	17.2	17.5	17.3	16.4 a
Row spacing Avg.	14.7 b	16.3 a	16.2 a	17.1 a	
F value and significance	R: 9.90**	V: 4.91*	RxV: 9.61**		
		NDF ratio			
Cherry Vanilla	42.4	44.0	41.5	40.2	42.0
Red Head	42.1	45.2	40.8	40.6	42.2
Row spacing Avg.	42.3 ab	44.6 a	41.2 b	40.4 b	
F value and significance	R: 5.06*	V: 0.03 ns	RxV: 0.27 ns		
		ADF ratio			
Cherry Vanilla	23.6	25.5	21.1	23.3	23.4
Red Head	24.9	21.6	21.7	22.8	22.7
Row spacing Avg.	24.3	23.5	21.4	23.0	
F value and significance	R: 2.38 ns	V: 0.64 ns	RxV: 2.14 ns		
		Dry matter digestibility			
Cherry Vanilla	70.4	69.0	72.4	70.7	70.6
Red Head	69.4	72.0	72.0	71.1	71.1
Row spacing Avg.	69.9	70.5	72.2	70.9	
F value and significance	R: 2.40 ns	V: 0.68 ns	RxV: 2.13 ns		
		Dry matter intake			
Cherry Vanilla	2.83	2.73	2.90	2.96	2.86
Red Head	2.86	2.63	2.93	2.96	2.85
Row spacing Avg.	2.85 ab	2.68 b	2.91 a	2.96 a	
F value and significance	R: 4.48*	V: 0.02 ns	RxV: 0.29 ns		
		Relative feed value			
Cherry Vanilla	154.6	145.8	162.4	163.7	156.6
Red Head	154.2	148.2	164.0	163.3	157.4
Row spacing Avg.	154.4 ab	147.0 b	163.2 a	163.5 a	
F value and significance	R: 5.96**	V: 0.06 ns	RxV: 0.05 ns		

There is no significant difference between the averages shown with similar letters in the same column and row. **p>0.01, *p>0.05.

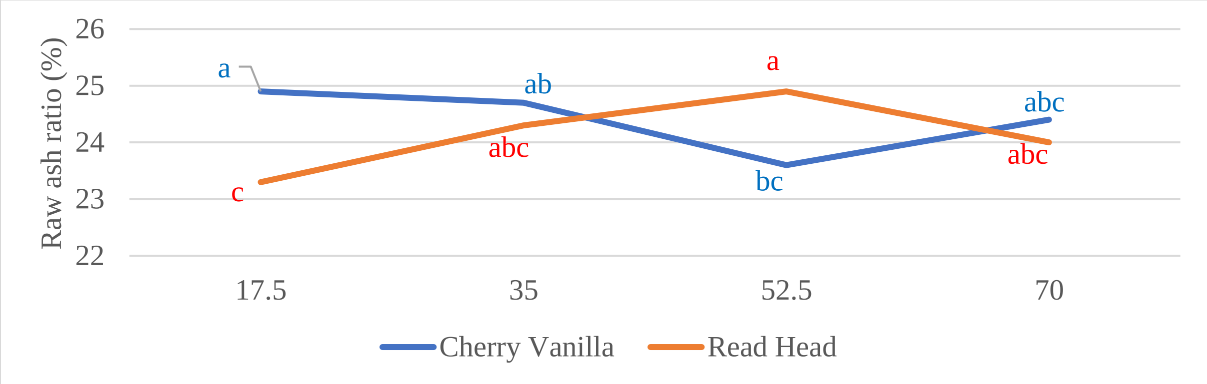

Figure 1. Effects of variety and row spacing on raw ash ratio

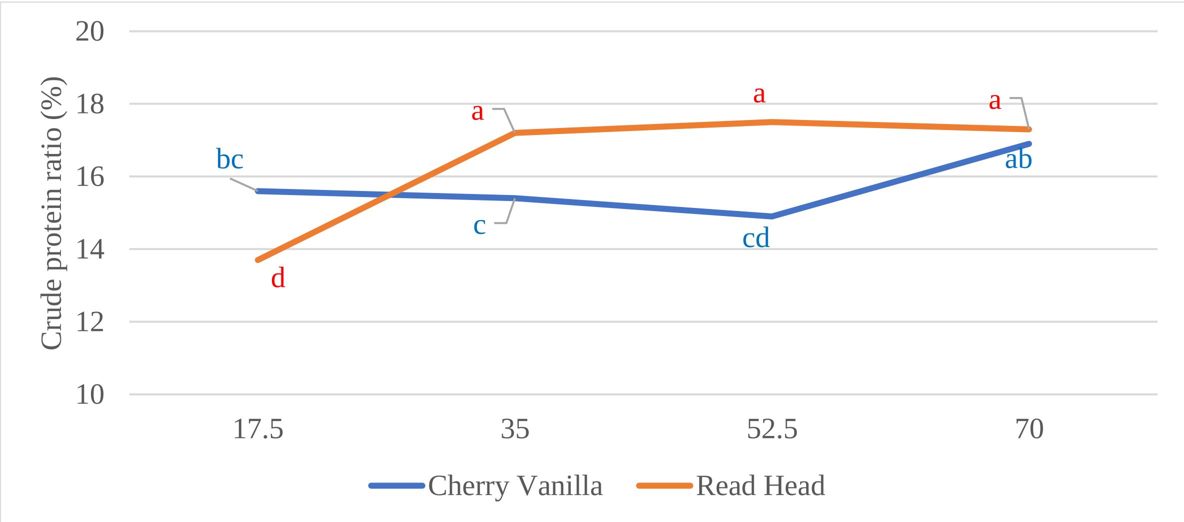

Figure 2. Effects of variety and row spacing on crude protein ratio

NDF ratio

While different row spacings had a significant effect on the NDF ratio of quinoa silage, the effect of quinoa varieties was insignificant (Table 3). NDF ratios were calculated as 42.0% and 42.2% in two quinoa varieties. Tan and Temel (2020), in their study examining the forage quality characteristics of quinoa grass under dry conditions, reported the NDF ratio of the Cherry Vanilla variety as 36.39% and the NDF ratio of the Read Head variety as 39.24%. NDF ratios varied between 40.4% and 44.6% depending on row spacing (Table 3). As a result of the research, it was seen that NDF ratios were higher in row spacing distances of 17.5 and 35 cm, where plant density was dense. As a result of the combined effects of variety and row spacing, the highest NDF ratio was found to be 45.2% in the Read Head variety planted in 35 cm row spacing. The lowest NDF ratio was found to be 40.2% in the Cherry Vanilla variety in the 70 cm row spacing (Table 3). NDF ratio is one of the important feed quality parameters that indicates the fiber ratio insoluble in natural solvents in feed plants. Rivera and Parish (2010) reported that the NDF ratio should be below 40% for the best forage quality. However, the data obtained in the current study were found to be above this value. In previous studies, Podkòwka et. al. (2021), Salama et. al. (2022), Dong et. al. (2022) and Güner and Temel (2022) reported the NDF ratios of quinoa silage as 46.65%, 54.85%, 48.8% and 37.9%, respectively. The NDF ratio obtained in the current study was generally found to be lower than previous studies. It can be said that the different varieties used in the research, the different row spacing and the different climatic factors affecting yield and quality such as temperature, humidity and precipitation cause the NDF contents obtained to be different.

ADF ratio

Variety and row spacing did not cause a significant change in the ADF ratio of quinoa silage. ADF ratio is one of the important parameters that determine silage quality and expresses the amount of cellulose, lignin and insoluble protein in the cell wall. In the current study, the ADF ratios of the varieties were found to be 23.4% in the Cherry Vanilla variety and 22.7% in the Read Head variety, respectively (Table 3). As a matter of fact, in a quality forage, this ratio is desired to be below 31% (Rivera and Parish, 2010). Van Soest et al. (1991) reported in their study that when the ADF ratio of roughage increased, the digestion ratio decreased. In plants, structural carbohydratios such as lignin are concentratiod in leaves, stems, and veins (Moore and Jung, 2012; Temel and Yolcu, 2020; Temel and Keskin, 2022). Podkòwka et. al. (2018), Salama et. al. (2021) and Dong et. al. (2022) determined the ADF ratios of quinoa silage as 32.8%, 29.78% and 24.4%, respectively. In the current study, ADF ratios were found below these values. It can be said that the different varieties used in the research, the different row spacing and the different climatic factors affecting yield and quality such as temperature, humidity and precipitation cause the ADF contents obtained to be different.

Dry matter digestibility

Dry matter digestion ratios did not differ between varieties and row spacing. Dry matter digestibility of the varieties was 70.6% in Cherry Vanilla variety and 71.1% in Read Head variety. Depending on row spacing, dry matter digestibility varied between 69.9% and 72.2% (Table 3). Considering the dry matter digestion ratios of the determined quinoa silage, it can be said that quinoa silage is a good quality silage (Rohwender et al., 1978). As a result of the combined effect of variety and row spacing, the dry matter digestion ratio varied between 69.0 and 72.4% (Table 3).

Dry matter intake

There was no significant difference between the dry matter intake ratios of the varieties. The dry matter intake of the Cherry Vanilla variety was calculated as 2.86%, and the dry matter intake of the Read Head variety was calculated as 2.85%. There were differences in dry matter intake depending on the row spacing of quinoa silage. Depending on the increase in row spacing, the dry matter intake ratio also increased. As a result of the combined effects of variety and row spacing, dry matter intake ratios of quinoa silage varied between 2.63% and 2.96% (Table 3). It is in the highest quality class according to the quality classification of Rohwender et al., (1978).

Relative feed value

Relative feed value is a quality parameter that serves as a guide in marketing and determining the quality of forage. Although this parameter, calculated using ADF and NDF values, is a method developed for quality control in alfalfa (Medicago sativa L.) in the United States, it is used for all forage crops. There was no significant difference between the relative feed values of Cherry Vanilla (156.6) and Red Head (157.4) varieties. In this research, the relative feed value of quinoa silage changed significantly in different row spacings. It can be seen that the relative feed value varies between 147.0 and 163.5 depending on the row spacing. There was a significant change in the NDF and ADF ratio depending on row spacing (Table 3). NYD value is calculated using NDF and ADF ratios. The responses of NDF and ADF ratios to row spacing were also seen in the NYD value. Changes in the leaf, stem and cluster ratios of the plant depending on row spacing also cause significant differences in the nutritional content of the plant (Temel and Keskin, 2019a; Temel and Keskin, 2019b; Temel and Keskin; 2020; Güner and Temel, 2022). For these reasons, it can be said that there are significant changes in the NYD values of the plant depending on the row spacing. In the study, it was concluded that the relative feed value increased as the row spacing increased. When variety x row spacing is evaluated together, the relative feed values of quinoa silage ranged between 145.8 and 164.0 (Table 3). Considering the relative feed values of quinoa silage, it can be said that it is a good quality silage (Rohwender et al. 1978; Moore and Undersander, 2002).

CONCLUSION

In this research, the nutritional values of Quinoa silage were determined without adding any additives. In the study where silage nutritional values were determined, there were differences in silage crude protein ratios of Cherry Vanilla and Red Head quinoa varieties. On the other hand, sowing quinoa plants in different row spacings had significant effects on the crude protein, NDF ratio, dry matter consumption ratio and relative feed values of quinoa silage. According to the results of the research, it was determined that planting with wide row spacing increased the nutritional value of quinoa silage. There were no significant differences between the nutritional contents (except crude protein) of Read head and Cherry Vanilla varieties. Therefore, it has been seen that both varieties can be grown for silage purposes.

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