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The Effects of Cutting Time on Herbage Production and Quality of Buckwheat (*Fagopyrum esculentum Meonch.*) Cultivated in Kahramanmaras Conditions

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Abstract
This research was carried out in the trial area of Kahramanmaras Sutcu Imam University, Faculty of Agriculture, Field Crops Department in the summer production period of 2021 to determine the appropriate cutting time of buckwheat varieties to be grown as animal feed in the ecological conditions of Kahramanmaras province. In the study, Aktas and Gunes buckwheat varieties were cut at five different times. The field experiment was conducted in randomized complete block design in a split plot with three replications. The research results showed that dry herbage yield, dry matter ratio, crude protein ratio, raw ash ratio, neutral detergent ratio, acid detergent fiber ratio, digestible dry matter value and digestible dry matter yield were statistically significantly affected. It was determined that green herbage yield was between 657.6-995.1 kg/da, dry herbage yield 136.8-298.5 kg/da, crude protein ratio 7.51-15.02 %, crude protein yield 17.14-29.72 kg/da, crude ash ratio 9.93-12.97 %, NDF ratio 53.95-66.46 %, ADF ratio 37.26-50.52 %, RFV 70.60-103.25 and the digestible dry matter yield 72.76-150.17 kg/da were between. It can be said that the most suitable cutting time for forage quality of buckwheat to be used in animal feeding in Kahramanmaras conditions is the beginning of flowering.

Key words
Buckwheat, NDF and ADF ratio, herbage yield and herbage quality, animal feeds, protein ratio.

Introduction
One of the greatest fears of humankind today and in the near future is the problem of food insufficiency, our basic need. This concern drives us to find fast and effective alternative sources of food. In order to increase production and quality, resources need to be derived in addition to existing products. The main way to meet the need for food is through agricultural production. Agricultural production is the sum of crop and animal production. In order for people to lead a healthy life, it is a necessity for them to include both plant-based and animal-based foods in their nutrition programs. Plant protein sources are more preferred than animal protein because they are cheaper and more easily accessible. The increase in meat prices also limits people's access to animal protein (Aiking, 2011). One of the most important criteria in determining the level of development of countries is the amount of animal products consumed per capita (Gunes, 2013). In order to meet the increasing consumption of animal products, it is necessary to increase the effective use of production areas, increase the yield of products obtained and increase the number of animals and the yield obtained from animals (Balcı, 2022). Accessibility to cheap and high-quality roughage resources is one of the main problems in animal nutrition. In an enterprise where feed costs constitute 70% of total expenses, 78% of feed expenses are roughage and 22% are concentrate feed (Harmansah, 2018). Increasing the production of roughage and making this production by the enterprises themselves will reduce the cost to a great extent. The increase in subsidies to be made by the state will also positively affect production. Roughages are indispensable feed resources in animal husbandry and it is a fact that there is a serious deficit of quality roughage in animal husbandry in our country. In order to meet the feed needs of our animals, it should be aimed to close the quality roughage deficit. In order to achieve this goal, the possibilities of using alternative roughage resources that we can increase the production and quality should be investigated (Gemalmaz and Bilal, 2016). It has been reported in different studies conducted by various researchers that buckwheat, which is rich in leaf number, can be used as roughage (Surmen and Kara, 2017), its short vegetation period, rapid growth and high herbage yield (Kara and Yuksel, 2014), and its adaptability to different soil conditions (Karafaki, 2017). Buckwheat (Debnath et al., 2008), which is annual and has no kinship ties with cereals, is a plant characterized as pseudocereal and has common areas of use with cereals (Yavuz et al., 2016). It is a plant with a height between 60-150 cm, a large number of branches and flower colours such as white, pink, light green, red (Valenzuela and Smith, 2002). Buckwheat is a plant that can reach higher yields in cool weather and is quickly affected by frosts. In regions with high temperatures, plant height is short and yield is low. It is a suitable plant for short summer months in cold ecologies. Although it can be cultivated in every region of our country, the region with the most favourable climatic conditions for buckwheat is Central Anatolia (Balci, 2022). The need for alternative forage crops with high yield and quality and high adaptability is very high both in our country and worldwide. There are very few studies in which buckwheat plant, which has high potential under suitable ecological conditions, is evaluated as feed. Our study and similar studies are of great importance directly in animal nutrition and indirectly in human nutrition. Harvest time is very important for grain and herbage yield (Tan, 2018). This study, which aimed to determine the most suitable harvest time for herbage yield and quality in buckwheat, was conducted in 2021 under Kahramanmaras ecological conditions.

Material and Methods
In the summer season of 2021, the experiment was carried out in the experimental field of Kahramanmaras Sutcu Imam University, Faculty of Agriculture, Department of Field Crops. The experimental field located in Kahramanmaras Onikisubat district of the Mediterranean region is located between 37°35'40.86' north latitude and 36°48'47.51' east longitude degrees. The altitude is 487 m and the slope is 3-5%. The temperature, rainfall and relative humidity in 2021, when the experiment was established, are given in Table 1.

Table 1. Climate Data for 2021 and Long Years Measured at Kahramanmaras Meteorological Station

Months	Total Rainfall (mm)		Average Temperature (°C)		Relative Humidity (%)	
	2021	Long Years	2021	Long Years	2021	Long Years
April	16.2	73.0	16.3	15.6	45.3	57.59
May	12.0	38.8	23.2	20.6	47.8	54.95
June	0.0	8.6	26.0	25.7	48.1	49.67
Tot./Avr.	28.2	120.4	21.8	20.6	47.1	54.07

Based on Table 1, when the data of the research period are analysed, the long-term average of total rainfall is 120.4 mm (Anonymous, 2021a). Considering the dates of the experiment, this value was 28.2 mm and 92.2 mm less precipitation than the long-years average. In the season in which the research was conducted, the long-years average temperature was 20.6 ℃. In the dates corresponding to the trial season, the average temperature was 21.8 ℃. When this value is compared with the long-years average, it is seen that it is higher. When the relative humidity values are considered, the long-years average is 54.07% and 47.1% during the growing period. When the whole table is analysed, it can be said that the experimental year was hotter and drier.

Table 2. Physical and Chemical Properties of Soil from the Experimental Area

Parameters Analysed							
Depth (cm)	Water Saturation	pH	Lime (%)	Organic Matter (%)	Salinity (%)	P_2O_5 (kg/da)	K_2O (kg/da)
0-30	69.96	7.71	6.09	1.58	0.05	2.84	55.51

Before the experiment was established, samples were taken from 0-30 cm depth and analysed to determine the physical and chemical properties of the soil. The results of the analyses performed at USKIM are given in Table 2. According to the results of the analysis; water saturation was 69.96% (clay loam), pH value was 7.71 (slightly alkaline), lime content was 6.09% (medium calcareous), organic matter content was 1.58% (low), salinity was 0.05% (saline), phosphorus (P_2O_5) content was 2.84 kg/da (very low) and potassium (K2O) content was 55.51 kg/da (high) (Anonymous, 2021b).

Aktas and Gunes buckwheat varieties obtained from Bahri Dagdas International Agricultural Research Institute were used as the main material in this study. Aktas is a buckwheat variety with white flower colour, grain yield 80-160 kg/da, protein rate 11-14%, thousand grain weight 20-29 g, height range 80-95 cm and hectolitre weight 58-65 kg. It can be grown in every region of our country. Gunes is a variety with white flower colour, grain yield 100-180 kg/da, protein ratio between 11-14%, thousand grain weight 22-30 g, plant height 85-100 cm and hectolitre weight 60-68 kg. As in Aktas variety, it can be cultivated in every region of our country.

The research was established according to the split plots experimental design with 3 replicates. The experimental area was ploughed with plough. Then it was made suitable for sowing by using cultivator and tappet. Sowing was done manually in 6 rows in plots with 20 cm row spacing and 3 m length. The plot size was 1.2 m x 3 m = 3.6 m^2. For both varieties, 350 plants per m^2 was taken as a basis and 1260 plants per 3.6 m^2 were calculated. The thousand grain weight was found to be 25.52 g for Aktas buckwheat variety and 24.99 g for Gunes buckwheat variety. Based on the thousand grain weights, the amount of seeds per 3.6 m^2 was calculated as 32.16 g/parcel for Aktas variety and 31.48 g/parcel for Gunes variety. To determine the green herbage yield, the green herbage harvested from each plot was weighed. Then, based on the value determined for the plot, green herbage yield per decare was calculated. To calculate dry herbage yield, 700 g samples were taken from the mown green herbs and dried at 70 °C in the drying cabinet until the weight was constant. The dried samples were weighed and the dry herbage yield per plot was determined and converted to buckwheat dry herbage yield per decare. For crude ash content, samples of 3 grams each were taken from the plant samples dried at 105 °C and then cooled in a desiccator, placed in porcelain crucibles and burnt at 550 °C for 3 hours. Then crude ash content (%) was calculated by using the formula (Crude ash content (%) = (c-a)/(b-a) x 100 (a: Crucible tare b: Crucible tare + sample c: Crucible tare + ash)). In order to calculate the crude protein ratio, nitrogen analysis was performed on the dried samples by Kjeldahl method and the determined nitrogen values were multiplied by a coefficient of 6.25. In order to determine the crude protein yield, the crude protein ratios determined for each plot were multiplied by the dry herbage yield of each plot and crude protein yield was found. Then, crude protein yield per decare was calculated by making the necessary conversions. NDF and ADF ratios were determined by using Kutlu (2008). In order to determine the relative feed value, NDF and ADF values were calculated using the formulae described by Sheaffer et al. (1995).

Digestible Dry Matter (DDM) (%) = 88.9 - (0.779 x % ADF)

Dry Matter Intake (DMI) (%) = 120 / % NDF (in dry matter)

Relative Feed Value (RFV) = (DDM x DMI) / 1.29

The following formula was used to calculate the digestible dry matter yield (Tassever, 2019).

Digestible Dry Matter Yield (DDMY) (kg/da) = Dry Matter Yield (DMY) (kg/da) x Digestible Dry Matter (%) (DDM)

Based on the results of soil analysis, fertiliser application was made with 20.20.0 compound fertiliser as 6 kg/da N and 6 kg/da pure P. Weed control was carried out manually during the period from germination to harvest. During the vegetation period, drip irrigation was applied 9 times (22 April, 27 April, 5 May, 15 May, 23 May, 27 May, 4 June, 10 June and 14 June). In five different periods (beginning of flowering-22 May 2021, 50% flowering-27 May 2021, 75% flowering-1 June 2021, 100% flowering-7 June 2021, seed ripening-20 June 2021), mowing was done with the help of a sickle from the closest place to the soil.

Results and Discussion

Analysis of variance results of the analysed traits of buckwheat harvested at different times are given in Table 3.

Table 3. Analysis of Variance Results for the Analysed Traits of Buckwheat Harvested at Different Times

	GHY	DH Y	DMR	CPR	CPY	CAR	NDF	ADF	DDM	DMI	RFV	DDMY
	P Value*											
V	0.04	0.02	0.00	0.49	0.35	8.95	0.32	9.98	9.94	0.28	2.90	0.07
CT	0.62	5.53*	88.58*	43.48*	1.81	4.16*	78.26*	18.97*	18.88*	90.49*	71.57*	3.66*
V x CT	1.95	1.62	1.84	2.09	2.09	1.16	7.18*	7.59*	7.60*	6.76*	9.54*	1.89

*Significant at P≤0.05, V: Variety, CT: Cutting Time, GHY: Green Herbage Yield, DHY: Dry Herbage Yield, DMR: Dry Matter Ratio, CPR: Crude Protein Ratio, CPY: Crude Protein Yield, CAR: Crude Ash Ratio, NDF: Neutral Detergent Fiber, ADF: Acid Detergent Fiber, DDM: Digestible Dry Matter, DMI: Dry Matter Intake, RFV: Relative Feed Value, DDMY: Digestible Dry Matter Yield.

Green Herbage Yield (kg/da)

Table 4. Average Green Herbage Yield (kg/da) of Buckwheat Varieties Harvested at Different Maturity Periods and Groups Formed

	Varieties		
Cutting Time	Aktas	Gunes	Average
Beginning of flowering	866.7	657.6	762.1
50% Flowering period	942.3	816.8	879.5
75% Flowering period	893.1	810.1	851.6
100% Flowering period	828.1	944.1	886.1
Seed ripening period	759.4	995.1	877.3
Average	857.9	844.7	851.3

Green herbage yield (kg/da) obtained from buckwheat varieties harvested at different maturity periods was not statistically significant. When Table 4 is analysed, the highest green herbage yield average was 857.9 kg/da for Aktas variety and the lowest green herbage yield average was 844.7 kg/da for Gunes variety. According to the mean values of green herbage yield for harvesting times, the highest green herbage yield was obtained as 886.1 kg/da in 100% flowering period. When Aktas cultivar was evaluated in terms of cultivar x harvest time interaction, it was determined that green herbage yield was between 759.4-942.3 kg/da. In Gunes variety, it was determined that the green herbage yield was between 657.6-995.1 kg/da in terms of variety x harvest time interaction. The highest green herbage yield was 995.1 kg/da in Gunes variety at seed ripening period and the lowest green herbage yield was 657.6 kg/da in Gunes variety at the beginning of flowering. When the results obtained were compared with the results of the researchers who previously studied on the same subject; our findings were higher than the findings obtained by Alkay (2019) in Bingol (269.75-410.00 kg/da), similar to the findings obtained by Polat and Kan (2021) in Konya (114.60- 1520.30 kg/da) and lower than the findings obtained by Acar et al. (2011) in Konya (1783.80 kg/da). It is thought that the difference between our data on green herbage and the values obtained by the researchers is due to climate factor, variety, soil structure and different harvesting times.

Dry Herbage Yield (kg/da)

It was determined that the dry herbage yield (kg/da) obtained from buckwheat varieties harvested at different maturity periods was statistically significant in terms of harvest time.

Table 5. Averages and Groups of Dry Herbage Yield (kg/ha) of Buckwheat Varieties Harvested at Different Maturity Periods

	Varieties		
Cutting Time	Aktas	Gunes	Average
Beginning of flowering	163.3	136.8	150.0 C[1]
50% Flowering period	219.6	183.9	201.7 BC
75% Flowering period	205.4	184.4	194.9 BC
100% Flowering period	214.4	235.6	225.0 AB
Seed ripening period	226.6	298.5	262.6 A
Average	205.9	207.8	206.9

[1]) Averages with similar letters in the same column are statistically indistinguishable from each other within P≤0.01 error limits according to LSD test.

When Table 5 is analysed, the highest average dry herbage yield was obtained in Gunes variety (207.8 kg/da) and the lowest average dry herbage yield was obtained in Aktas variety (205.9 kg/da. According to the mean values of dry herbage yield for harvest times, the highest dry herbage yield was determined as 262.6 kg/da at seed ripening period. In terms of cultivar x harvest time interaction, it was determined that the dry herbage yield of Aktas cultivar was in the range of 163.3-226.6 kg/da and the dry herbage yield of Gunes cultivar was in the range of 136.8-298.5 kg/da. The highest dry herbage yield of Gunes variety was 298.5 kg/da at the seed ripening period and the lowest yield of Gunes variety was 136.8 kg/da at the beginning of flowering. When the results obtained are compared with the results of the previous researchers on the same subject; our findings are higher than the results obtained by Omidbaigi and De Mastro (2004) in Tehran (10.7-25.2 kg/da) and Alkay (2019) in Bingöl (100. 2-142.3 kg/da), similar to the results obtained by Polat and Kan (2021) in Konya (29.5- 413.9 kg/da) and lower than the results obtained by Kara (2014) in Isparta (120.0-853.7 kg/da).

Dry Matter Ratio (%)

Table 6. Averages and Groups of Dry Matter Ratio (%) of Buckwheat Varieties Harvested at Different Ripening Periods

	Varieties		
Cutting Time	Aktas	Gunes	Average
Beginning of flowering	19.0	20.8	19.9 D[1]
50% Flowering period	23.5	22.6	23.0 C
75% Flowering period	23.1	22.9	23.0 C
100% Flowering period	26.1	25.2	25.6 B
Seed ripening period	30.1	30.1	30.1 A
Average	24.3	24.3	24.3

[1]) Averages with similar letters in the same column are statistically indistinguishable from each other within P≤0.01 error limits according to LSD test.

It was determined that the dry matter ratio of buckwheat varieties harvested at different ripening periods was statistically significant in terms of cutting time. Table 6 shows that the average dry matter ratio was 24.3% for Aktas and Gunes varieties. According to the mean values of dry matter ratio of cuttings, the highest dry matter ratio was obtained at the seed ripening period as 30.1% and the lowest dry matter ratio was obtained at the beginning of flowering as 19.9%. When evaluated in terms of cultivar x cutting time interactions, it was determined that the dry matter ratio of Aktas cultivar was between 19.0-30.1% and that of Gunes cultivar was between 20.8-30.1%. The highest dry matter ratio was observed in the seed ripening period (30.1%) for both varieties. The lowest dry matter ratio was reached at the beginning of flowering in Aktas variety with 19%. The findings obtained are higher than the findings of Yavuz and Kara (2018) in Isparta (11.1-21.25%).

Crude Protein Ratio (%)

It has been determined that the crude protein ratio obtained from buckwheat varieties harvested at different ripening periods is statistically significant in terms of mowing time.

Table 7. Crude Protein Ratio (%) Averages of Buckwheat Varieties Harvested at Different Ripening Periods and Groups Formed

	Varieties			Feed
Cutting Time	Aktas	Gunes	Average	Quality
Beginning of flowering	15.02	12.68	13.85 A[1]	2nd grade
50% Flowering period	13.24	12.61	12.93 A	3rd grade
75% Flowering period	11.48	10.98	11.23 B	3rd grade
100% Flowering period	8.50	9.18	8.84 C	4th grade
Seed ripening period	7.51	7.75	7.63 D	5th grade
Average	11.15	10.64	10.89	

[1]) Averages with similar letters in the same column are statistically indistinguishable from each other within P≤0.05 error limits according to LSD test.

Rohweder et al. (1978) prepared a table to be used in classifying feed quality according to crude protein ratio. According to this table, if the crude protein ratio is higher than 19%, it is considered as "top quality feed", between 17-19% as "1st class feed", between 14-16% as "2nd class feed", between 11-13% as "3rd class feed", between 8-10% as "4th class feed" and less than 8% as "5th class feed". Feed quality classification is given in Table 7. When Table 7 is analysed, the highest crude protein ratio average was 11.15% in Aktas variety and the lowest crude protein ratio was 10.64% in Gunes variety. According to the average values of crude protein ratio for cutting times, the highest crude protein ratio was determined as 13.85% at the beginning of flowering. In the evaluation made in terms of variety x cutting time interaction, it was determined that the crude protein ratio was between 7.51-15.02% in Aktas variety and between 7.75-12.68% in Gunes variety. The highest crude protein ratio was 15.02% in Aktas variety at the beginning of flowering and the lowest crude protein ratio was 7.51% in Aktas variety at seed ripening period. The crude protein ratio of the plant in the vegetative development period is higher than the plants that have matured and completed their growth. As the plant matures, the ratio of leaves to stems decreases and crude protein ratio decreases with ripening (Buxton, 1996). The results are higher than those obtained by Alkay (2019) in Bingol (8.76-9.88%), similar to those obtained by Köksal (2017) in Yozgat (10.97-15.81%), and lower than those obtained by Arslan (2021) in Bursa (10.57-21.88%).

Crude Protein Yield (kg/da)

Table 8. Averages and Groups of Crude Protein Yield (kg/da) of Buckwheat Varieties Harvested at Different Maturation Periods

	Varieties		
Cutting Time	Aktas	Gunes	Average
Beginning of flowering	24.59	17.27	20.94
50% Flowering period	29.72	23.02	26.37
75% Flowering period	23.31	19.91	21.61
100% Flowering period	18.00	21.37	19.68
Seed ripening period	17.14	22.66	19.90
Average	22.55	20.85	21.70

Crude protein yield obtained from buckwheat varieties harvested at different ripening periods was not statistically significant. When Table 8 is analyzed, it is seen that the highest crude protein yield average was 22.85 kg/da for Gunes variety and the lowest protein yield average was 20.55 kg/da for Aktas variety. According to the average values of crude protein yield for cutting times, the highest crude protein yield was found to be 26.37 kg/da at 50% flowering. According to the evaluation made in terms of variety x cutting time interaction, crude protein yield of Aktas variety was between 17.15-29.72 kg/da and crude protein yield of Gunes variety was between 17.27-23.02 kg/da. The highest crude protein yield of Aktas variety was 29.72 kg/da at 50% flowering period and the lowest crude protein yield of Aktas variety was 17.14 kg/da at seed ripening period. The results were higher than those obtained by Alkay (2019) in Bingol (8.9-12.7 kg/da) and lower than those obtained by Arslan (2021) in Bursa (27.26-62.49 kg/da). It is thought that the difference between our data and the values obtained by the researchers is due to climate factor, variety, soil structure and different harvesting times.

Crude Ash Ratio (%)

It was determined that the crude ash content of buckwheat varieties harvested at different ripening periods was statistically significant in terms of cutting time

Table 9. Crude Ash Ratio (%) Averages of Buckwheat Varieties Harvested at Different Ripening Periods and Groups Formed

	Varieties		
Cutting Time	Aktas	Gunes	Average
Beginning of flowering	12.97	11.39	12.18 A
50% Flowering period	11.10	10.61	10.86 B
75% Flowering period	11.68	10.66	11.17 AB
100% Flowering period	9.99	10.00	9.99 B
Seed ripening period	9.93	10.67	10.30 B
Average	11.13	10.67	10.90

[1]) Averages with similar letters in the same column are statistically indistinguishable from each other within P≤0.05 error limits according to LSD test.

When Table 9 is examined, it is seen that the average crude ash content was 11.13% in Aktas variety and 10.67% in Güneş variety. According to the average values of the crude ash content of the cutting times, the highest crude ash content was 12.18% at the beginning of flowering and the lowest crude ash content was 9.99% at 100% flowering. According to the evaluation made in terms of variety and cutting time interactions, it was determined that the crude ash rate of Aktas variety was between 9.93-12.97% and the crude ash rate of Güneş variety was between 10.00-11.39%. The highest crude ash rate was obtained in Aktas variety (12.97%) at the beginning of flowering and the lowest crude ash rate was obtained in Aktas variety (9.93%) at seed ripening period. The findings were higher than the results obtained by Alkay (2019) in Bingol (2.29-2.60%) and close to the values obtained by Yavuz and Kara (2018) in Isparta (8.19-16.05%). It is thought that the difference between our data and the values obtained by the researchers is due to climate factor, variety, soil structure and different harvesting times.

Neutral Detergent Fiber (NDF) (%)

It was determined that the NDF ratio (%) obtained from buckwheat varieties harvested at different ripening periods was statistically significant in terms of cutting time and variety x cutting time interaction.

Table 10. Averages and Groups of NDF Ratio (%) of Buckwheat Varieties Harvested at Different Ripening Periods

	Varieties			Feed
Cutting Time	Aktas	Gunes	Average	Quality
Beginning of flowering	53.95 e*	54.26 e	54.10 E[1]	3rd grade
50% Flowering period	55.49 de	56.95 cd	56.22 D	3rd grade
75% Flowering period	57.96 cd	57.90 cd	57.93 C	3rd grade
100% Flowering period	61.94 b	59.01 c	60.47 B	3rd grade
Seed ripening period	62.66 b	66.46 a	64.56 A	4th grade
Average	58.39	58.91	58.66	

[1]) Averages with similar letters in the same column are statistically indistinguishable from each other within P≤0.01 error limits according to LSD test. *Averages of cultivar-mowing time interactions indicated with the same letter are statistically indistinguishable from each other within P≤0.01 error limits.

Rohweder et al. (1978) prepared a ruler to be used in classifying feed quality according to NDF values. According to this table, if the NDF value is less than 40%, it is considered as "best quality feed", 40-46% as "1st class feed", 47-53% as "2nd class feed", 54-60% as "3rd class feed", 61-65% as "4th class feed" and more than 65% as "5th class feed". Feed quality classification is given in Table 10. When Table 10 is analyzed, the highest NDF ratio mean value was found in Gunes variety with 58.91% and the lowest NDF ratio mean value was found in Aktas variety with 58.39%. According to the mean values of NDF ratio for cutting times, the highest NDF ratio was 64.56% at seed ripening and the lowest NDF ratio was 54.10% at the beginning of flowering. According to the evaluation made in terms of variety x cutting time interactions, it was determined that the NDF ratio of Aktas variety was between 53.95-62.66% and the NDF ratio of Gunes variety was between 54.26-66.46%. The highest NDF ratio of Gunes variety was 66.46% at the

seed ripening period and the lowest NDF ratio of Aktas variety was 53.95% at the beginning of flowering. The results obtained were higher than the values determined by Surmen and Kara (2017) in Aydın (31.83-40.66%), Yavuz and Kara (2018) in Isparta (31.61 41.63%), and relatively close to the results determined by Köksal (2017) in Yozgat (42.20-52.03%).

Acid Detergent Fiber (ADF) Ratio (%)

It was determined that the ADF ratio (%) obtained from buckwheat varieties harvested at different ripening periods was statistically significant in terms of cutting time and variety x cutting time interaction.

Table 11. Averages of ADF Rate (%) of Buckwheat Varieties Harvested at Different Maturation Periods and Formed Groups

	Varieties			Feed
Cutting Time	Aktas	Gunes	Average	Quality
Beginning of flowering	37.26*c	45.84 b	41.55 D[1]	3rd grade
50% Flowering period	46.28 b	47.52 ab	46.90 BC	5th grade
75% Flowering period	45.50 b	45.78 b	45.64 C	5th grade
100% Flowering period	50.52 a	48.56 ab	49.54 A	5th grade
Seed ripening period	47.81 ab	49.36 ab	48.58 AB	5th grade
Average	45.47	47.41	46.44	

[1]) Averages with similar letters in the same column are statistically indistinguishable from each other within P≤0.01 error limits according to LSD test. *Averages of cultivar-mowing time interactions indicated with the same letter are statistically indistinguishable from each other within P≤0.01 error limits.

Rohweder et al. (1978) prepared a ruler to be used in classifying feed quality according to ADF values. According to this table, if the ADF value is less than 31%, it is considered as "best quality feed", between 31-35% as "1st class feed", between 36-40% as "2nd class feed", between 41-42% as "3rd class feed", between 43-45% as "4th class feed" and more than 45% as "5th class feed". Feed quality classification is given in Table 11. When Table 11 is analyzed, the highest average ADF rate was found in Gunes variety (47.41%) and the lowest in Aktas variety (45.47%). According to the mean values of ADF ratio for cutting times, the highest ADF ratio was found to be 49.54% at 100% flowering. When Table 11 was analyzed in terms of variety x cutting time, it was found that the ADF ratio of Aktaş variety was in the range of 37.26-50.52% and the ADF ratio of Gunes variety was in the range of 45.78-49.36%. The highest ADF content of Aktas variety was 50.52% at 100% flowering and the lowest ADF content of Aktas variety was 37.26% at the beginning of flowering. The findings were higher than the values obtained by Koksal (2017) in Yozgat (29.94-35.82%) and close to the results of Alkay (2019) in Bingöl (40.19-42.04%). It is thought that the difference between our data and the values obtained by the researchers is due to climate factor, variety, soil structure and different harvesting times.

Digestible Dry Matter (%)

Table 12. Averages and Groups of Digestible Dry Matter Value of Buckwheat Varieties Harvested at Different Ripening Periods

	Varieties		
Cutting Time	Aktas	Gunes	Average
Beginning of flowering	59.88*a	53.19 b	56.54 A[1]
50% Flowering period	52.85 b	51.89 bc	52.37 BC
75% Flowering period	53.46 b	53.24 b	53.35 B
100% Flowering period	49.55 c	51.08 bc	50.32 D
Seed ripening period	51.66 bc	50.45 bc	51.06 CD
Average	53.48	51.97	52.72

[1]) Averages with similar letters in the same column are statistically indistinguishable from each other within P≤0.01 error limits according to LSD test. *Averages of cultivar-mowing time interactions indicated with the same letter are statistically indistinguishable from each other within P≤0.01 error limits.

It was determined that the digestible dry matter value obtained from buckwheat varieties harvested at different ripening periods was statistically significant in terms of cutting time and variety x cutting time interaction. When Table 12 is examined, the highest average digestible dry matter value was obtained as 53.48% in Aktas variety and the lowest value was obtained as 51.97% in Gunes variety. When the mean values of digestible dry matter value of cutting times were analyzed, the highest value of 56.54% was obtained at the beginning of flowering. According to the evaluation made in terms of variety x cutting time interaction, it was determined that the digestible dry matter value of Aktas variety was between 49.55-59.88% and the digestible dry matter value of Gunes variety was between 50.45-53.24%. The highest digestible dry matter value was 59.88% in Aktaş variety at the beginning of flowering and the lowest value was 49.55% in Aktaş variety at 100% flowering. The values determined as a result of the research were similar to the values obtained by Alkay (2019) in Bingol (56.15-57.59%) and lower than the values obtained by Surmen and Kara (2017) in Aydin (60.99-67.05%).

Dry Matter Intake (%)

It was found that the digestible dry matter intake value obtained from buckwheat varieties harvested at different ripening periods was statistically significant in terms of harvest time and variety x harvest time interaction.

Table 13. Averages and Groups of Dry Matter Intake Value of Buckwheat Varieties Harvested at Different Ripening Periods

	Varieties		
Cutting Time	Aktas	Gunes	Average
Beginning of flowering	2.22*a	2.21 a	2.22 A[1]
50% Flowering period	2.16 ab	2.11 bc	2.13 B
75% Flowering period	2.07 cd	2.07 cd	2.07 C
100% Flowering period	1.94 e	2.03 d	1.99 D
Seed ripening period	1.92 e	1.81 f	1.87 E
Average	2.06	2.05	2.06

[1]) Averages with similar letters in the same column are statistically indistinguishable from each other within P≤0.01 error limits according to LSD test. *Averages of cultivar-mowing time interactions indicated with the same letter are statistically indistinguishable from each other within P≤0.01 error limits.

Table 13 shows that the average dry matter uptake value (%) was 2.06% for Aktas variety and 2.05% for Gunes variety. The highest value was 2.22% at the beginning of flowering and the lowest value was 1.87% at seed ripening. When the values in terms of variety x cutting time were analyzed, it was found that the dry matter uptake value of Aktas variety was in the range of 1.92-2.22% and Gunes variety was in the range of 1.81-2.21%. The highest dry matter uptake value was 2.22% for Aktas variety at the beginning of flowering and the lowest dry matter uptake value was 1.81% for Gunes variety at the seed ripening period. The values obtained were lower than the values obtained by Alkay (2019) in Bingol (2.61-2.92%).

Relative Feed Value

It was found the relative forage value obtained from buckwheat varieties harvested at different maturity periods was statistically significant in terms of harvest time and variety x harvest time interaction.

Table 14. Relative Feed Value Averages and Groups of Buckwheat Varieties Harvested at Different Ripening Periods

	Varieties			Feed
Cutting Time	Aktaş	Gunes	Average	Quality
Beginning of flowering	103.25*a	91.21 b	97.23 A[1]	3rd grade
%50 Flowering period	88.62 bc	84.80 cd	86.71 B	3rd grade
%75 Flowering period	85.86 bcd	85.56 bcd	85.71 B	4th grade
%100 Flowering period	74.68 ef	80.52 de	77.60 C	4th grade
Seed ripening period	76.75 e	70.60 f	73.68 D	5th grade
Average	85.83	82.54	84.19	

[1])Averages with similar letters in the same column are statistically indistinguishable from each other within P≤0.01 error limits according to LSD test. *The Averages of variety-cropping time interaction indicated with the same letter are statistically indistinguishable from each other within P≤0.01 error limits.

A table showing feed quality standards was prepared by Rivera and Parish to be used in classifying relative feed values. According to this table, if the relative feed value is greater than 151, it is considered as “the best quality feed”, 151-125 as “1st class feed”, 124-103 as “2nd class feed”, 102-87 as “3rd class feed”, 86-75 as “4th class feed” and less than 75 as “5th class feed”. Forage quality grades are given in Table 14. When Table 14 is analysed, the highest mean relative feed value was 85.83 in Aktas variety and the lowest mean relative feed value was 82.54 in Gunes variety. According to the mean values of the relative feed value of the harvesting times, the highest value was obtained as 97.23 at the beginning of flowering. The relative feed value of Aktas variety was found to be in the range of 74.68-103,25 and Gunes variety was found to be in the range of 70.60-91.21 in terms of variety x harvest time interaction. The highest relative feed value was found 103.25 in Aktas variety at the beginning of flowering an the lowest was found 70.60 in Gunes variety at seed ripening period. Our findings were lower than those obtained by Yavuz an Kara (2018) in Isparta (145.69-213.53), Sürmen and Kara (2017) in Aydin (139.75-196.22) and Alkay (2019) in Bingol (118.84-123.12). It is thought that the difference between our data and the values obtained by the researchers is due to climate factor, variety, soil structure and different harvesting times.

Digestible Dry Matter Yield (kg/da)

İt was determined that the digestible dry matter yield values obtained from buckwheat varieties harvested at different ripening periods were statistically significant in terms of harvest time and variety x harvest time interaction.

Table 15. Averages and Groups of Digestible Dry Matter Yield of Buckwheat Varieties Harvested at Different Maturity Periods

	Varieties		
Cutting Time	Aktas	Gunes	Average
Beginning of flowering	97.64	72.76	85.20 C[1]
%50 Flowering period	116.30	95.03	105.67 BC
%75 Flowering period	110.33	98.20	104.27 BC
%100 Flowering period	106.87	120.40	113.64 AB
Seed ripening period	116.92	150.17	133.54 A
Average	109.6	107.3	108.46

[1]) Averages with similar letters in the same column are statistically indistinguishable from each other within P≤0.01 error limits according to LSD test

When Table 15 is analysed, it is seen that the highest average digestible dry matter yield was 109.6 kg/da in Aktas variety and the lowest was 107.3 kg/da in Gunes variety. The highest digestible dry matter yield was 133.54 kg/da at seed ripening and the lowest was 85.20 kg/da at the beginning of flowering. The digestible dry matter yield of Aktas variety was 97.64-116.92 kg/da and that of Gunes variety was 72.76-150.17 kg/da. The highest digestible dry matter yield was 150.17 kg/da at seed ripening period in Gunes variety and the lowest digestible dry matter yield was 72.76 kg/da at the beginning of flowering in Gunes variety. The findings of the study were lower than the values determined by Arslan (2021) in Bursa (145.96-431.97 kg/da).

Conclusion

In this study, green herbage yield, dry herbage yield, dry matter rate, crude protein rate, crude ash rate, NFD, ADF, digestible dry matter value, dry matter intake value, relative feed value and digestible dry matter yield were investigated in buckwheat plant under the ecological conditions of Kahramanmaras. In general, it has been reported that feeds containing less than 8% crude protein enough ammonia for rumen microorganisms to maintain their normal activities (Norton, 2003). El-Shatnawi and Mohawesh (2000) reported the protein requirement of lactating ewes as 7-9% crude protein for survival and 10-12% crude protein for lactation period. Therefore, when the crude protein values of buckwheat hay to be used as an alternative feed source for feeding purposes are examined, it can be said that grasses containing less than 8% protein and mown during the seed ripening period will not be sufficient for the activity of rumen microorganisms in the animal. Therefore, when low protein buckwheat hay is used by animal breeders, a protein source must be added to the feed. In summary, buckwheat hay with a protein content above 8% is suitable for direct use in animal feeding, while buckwheat hay with a lower protein content is suitable for use as an additive in compound feeds. It can be said that the most suitable harvesting time in terms of dry herbage yield of buckwheat for animal feeding in Kahramanmaras conditions is 100% flowering or seed setting period, and the most suitable harvesting time in terms of forage quality (crude protein ratio, ash ratio, NDF, ADF and NYD) is the beginning of flowering.

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Conflict of Interest

The authors declare that they have no conflict of interest.

Author's Contributions

The contribution of the authors to the present study is equal. All the authors read and approved the final manuscript. All the authors verify that the Text, Figures, and Tables are original and that they have not been published before results.

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