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The Effect of Waste Watermelon Dry Matter Level on Silage Parameters and *In Vitro* Digestibility

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ABSTRACT: This study was conducted to determine the effect on aerobic microbial changes, aflatoxin content, nutrient level of watermelon silages, in vitro dry matter digestibility, and physical examination quality of sliced leftover watermelons containing different levels of dry matter after dehydration in the open sun. During the experiment, the dry matter (DM) level of leftover watermelon slices with 21-23% was named Group I, 27-29% Group II, and 33-35% Group III. Increasing the dry matter of watermelon slices from 21% to 35% before ensiling caused a non-significant ($p>0.05$) increase in the total aerobic mesophilic bacteria count (TMABc). Yeast and mold counts increased in the low dry matter group and decreased in the high dry matter group. TMABc decreased in silages compared to the pre-ensilage level, but TMABc increased significantly depending on the dry matter level in silages ($p<0.05$). Yeast and mold were not detected in all groups. Almost no aflatoxin was detected in all three groups before and after the silages were opened. No statistically significant difference was observed between the groups in crude ash, ether extract, and nitrogen-free extract ($p>0.05$). Crude protein percentage was found to be statistically insignificant between the Group I and the Group II, but significantly higher in the Group III than in both groups ($p<0.05$). Crude fibre level decreased when the silage dry matter increased ($p<0.001$). The pH value of the silages increased significantly when the dry matter level increased ($p<0.05$). In vitro dry matter digestibility increased significantly with the increase in silage dry matter ($p<0.001$). As a result, this study showed that silage can be made from leftover watermelon slices at all three dry matter levels. However, it was determined that the group with the best nutrient composition and dry matter digestibility was Group III, followed by the groups with Group II and Group I.

Keyword: Watermelon; Wilting; Silage; In Vitro Digestibility.

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INTRODUCTION

The disposal of food waste generated in various processes, such as farms, distribution stations, outlets, product processors, and consumers, constitutes both a significant financial loss and a serious environmental problem (Ghosh, 2018). The Food and Agriculture Organization of the United Nations (FAO) estimates that loss and waste of fruits and vegetables is the highest among all food types and reaches even 60% (Sagar et al., 2018; Gustavsson et al., 2011).

Fruits and vegetables are perishable due to their high water activity and nutritive value. These conditions are more critical in tropical and subtropical countries that favor the growth of spoilage-causing microorganisms (Swain et al., 2014). Due to the high water content and good nutrient content, especially sugar, of watermelons that are out of the market for any reason (Fish et al., 2009; TURKSTAT, 2023), studies have been carried out on canning them without spoilage, and positive results have been obtained (Terlemez and Çerçi, 2019). On the other hand, Swain et al. (2014) reported that lactic acid fermentation of fruits extends the shelf life of fruits and vegetables, improves many beneficial properties, including nutritional value and flavors, and reduces toxicity. These researchers mentioned that fermented fruits and vegetables can be used as a potential source of probiotics because they contain various lactic acid bacteria. In another study (Hartinger et al., 2019), it was reported that in green herbs and fruits and vegetable residues, which have high water activity, wilting was performed to reduce the water content and increase the dry matter content, thus ensuring proper silage fermentation. On the contrary, it has been reported that silage made with corn containing very high moisture content causes leakage and undesirable *clostridia* fermentation, resulting in high dry matter losses, a high pH, and bad odor in the silage (Bagg et al., 2013).

In recent years, advances in baling technology have brought bale silages to the agenda. Based on this, Pinder (2009) made alfalfa grass bale silages containing DM ranging from 22% to 67%. At the end of the study, he reported that when bale silages with high DM were opened after 70 days, there were higher water-soluble carbohydrates in the silages obtained and higher lactic acid producing bacteria counts in low DM silages.

Green grasses from a natural meadow in the Cansiglio Plateau (northern Italy) were ensiled immediately after harvest, after 5 hours of wilting, and after 26 hours of wilting. The dry matter digestibility and nutritive values of wilted silages were found to be higher than those of non wilted silages (Xiccato et al., 1998). It is argued that optimal quality silage is produced from components with a dry matter content between 30% and 35% and that leakage losses increase when the dry matter content of silage material ensiled in bag silos is less than 32%. On the other hand, it is reported that while gaseous or leakage losses occur in the ensiling of very wet forages, different deterioration occurs in the ensiling of very dry forages (FAO, 2022).

According to the information obtained from the literature review, we see that fruits and vegetables, including a large amount of watermelon, fall into a waste state worldwide, as in Turkey. It is observed that fruits and vegetables that become waste deteriorate quickly due to their high water content and nutrient levels. In order to prevent this deterioration, they should either be canned or subjected to lactic acid fermentation. On the other hand, making silage by removing the water content and increasing the dry matter level is a good option for making water-rich feeds durable. However, although Turkey ranks second in the world in watermelon production, no study has been conducted in the current literature with regard to adding value to the leftover watermelons as feed and contributing to meeting the feed needs of the livestock sector. Based on this need, leftover watermelons were sliced and wilted under the sun in the natural environment, and leftover watermelon slices containing different levels of dry matter were obtained. This study aimed to determine the effects of different dry matter levels of watermelon slices on their nutrient level, in vitro dry matter digestibility, physical examination quality of the silage, aerobic microbial count, and aflatoxin content by being ensiled in bag silos. In addition, this study aimed to determine the effect of these watermelon slices, which contain different dry matter, on aerobic microbial change and aflatoxin content during the wilting process.

MATERIALS AND METHODS

Feed Material

Leftover watermelons that were out of the market and were taken into the research at the sales points in Hatay (Turkey) in August and September were washed, and the parts that were rotten and could not be used as feed were cut and cleaned with a knife and used in the study. Crude nutrient levels of watermelon slices used in the study are given in Table 1.

Table 1. Crude nutrients of fresh watermelon slices

	Fresh Watermelon (n=5)
Dry Matter %	7.79±0.56
Crude Ash % (DM)	6.46±0.42
Ether Extract % (DM)	3.05±0.51
Crude Protein % (DM)	14.23±1.04
Crude Fibre % (DM)	7.01±1.56
Nitrogen Free Extract % (DM)	69.25±1.38

Preparation of the out-of-market watermelons for silage feed and formation of experiment groups

In order to make quality silage from silage material with a high moisture content, it is necessary to reduce the moisture content, and increase the dry matter ratio. The cheapest and easiest method for this is to fade the material (Gordon, 1967). Watermelons were cleaned under tap water and sliced with a knife into 0.50 - 0.70 cm thick slices. Sliced waste watermelons were placed on tared aluminum trays and placed under the sun on the terrace of HMKU Veterinary Faculty at 9 o'clock in the morning and left to wilt. At 17:00, the watermelon slices in the trays were weighed again and wilting levels were measured. In this process, three different silage materials with 21-23%, 27-29% and 33-35% DM were obtained. Among these silage materials, those containing 21-23% DM are classified as Group I, those containing 27-29% DM are classified as Group II, and those containing 33-35% DM are classified as Group III. In all groups, 1% salt was added to the watermelon slices before they were filled into the silo. Samples were taken for microbiological and mycotoxin analyses before silage was made. Samples taken for microbiological analysis were placed in sterile containers (Andrews and Hammack, 2022). All the samples were stored at -20 °C in a deep freezer until analyzed.

Making of Silage

In this study, the roll bale silage making technique was adapted to laboratory conditions. The silage making and packaging process was done manually, based on the bales that were compressed by the machine in silage production and then wrapped and covered with stretch plastic cover. In this context, the leftover watermelon slices for silage prepared as described above were filled into 1-2 kilo gram bags with wrist strength and compacted. Then, these bags were wrapped well with stretch plastic covers to create an anaerobic environment, and packaging was completed (Savoie and Jofriet, 2003). Silages were made in August and September. The silo containers were kept on the table in the laboratory. The silo containers were observed for 60 days following closure. Leakages in the silo containers were detected and recorded by observation in the first 10 days.

Opening the silage containers

Silage containers were cut to open 60 days after ensiling. While the silages were opened, samples were duly taken for pH measurement, physical evaluation analysis, microbiological analysis, mycotoxin analysis, and nutrient analysis. The pH measurements and evaluation of the samples with the Deutsche Landwirtschafts-Gesellschaft (DLG) silage evaluation key were made immediately. Samples taken for nutrient analysis were placed in normal containers; samples taken for microbiological and mycotoxin analysis were placed in sterile containers and stored at -20°C until analyzed.

Measuring the pH of silages

The pH of silages was measured using the method described by Bolsen et al. (1992). After taking 25 g of silage sample from the packages, 100 ml of pure water was added and mixed with a blender, and the pH of the liquid obtained was measured with a digital pH meter.

Evaluation of silages with the DLG silage evaluation key

Samples taken from each opened silage package to represent the mass were evaluated by three subject matter experts with the help of the silage evaluation key (DLG) created by Meyer et al. (1983) for the current color, odor, and structure of the silages, and scores were given.

Determination of Flieg score of silages

Using the dry matter and pH values of the silages, the Fleig score was calculated with the formula below (Kılıç, 1984).

Flieg score = 220+ (2 x % dry matter - 15) - 40 x pH

Determination of energy value of silages

Energy levels of feeds were calculated according to the formulas established by Moran (2005). The total digestible nutrient (TDN) value was also calculated using the formula of Moran (2005).

ME (MJ/kg DM) = (0.185 x TDN) -1.89
TDN = 5.31 + (0.412 x %CP) + (0.249 x %CF) + (1.444 x %EE) + (0.937 x %NFE)

The ME (MJ/kg DM) value found as a result of the calculation was converted into a kcal/kg value with the formula specified below.

1 Mcal / kg = 4.19 MJ/kg and 1 Mcal / kg = 1000 kcal / kg

Nutrient Analysis

In the feed samples taken after the silo was opened, dry matter (DM) was determined in the drying cabinet, ether extract (EE) in the Soxleth extraction device, crude ash in the muffle furnace, crude protein (CP) in the Kjeldahl device by the methods specified in AOAC (1990) and crude fibre (CF) analysis was determined according to the method reported by Crampton and Maynard (1938). Nitrogen free extract (NFE) were determined by calculation. In all silage groups with different dry matters, 5 samples were analyzed in 2 replicates.

Microbiological Analyses

Yeast counts (Tournas et al., 2001), mold counts (Tournas et al., 2001) and total mesophilic aerobic bacteria counts (Maturin and Peeler, 2001) were performed on feed samples taken before silo filling and after silage opening.

Aflatoxin analyses

The method in AOAC (2008) was modified and performed using an HPLC device. Briefly, 50 g of sample was mixed with 300 ml of methanol:water (4:1, v/v) and 5 g of NaCl for 30 min using a shaker (200 rpm). The mixture was filtered with filter paper. 10 ml of the filtered extract was taken and mixed with 60 ml of PBS. Then, the immunoaffinity column clean-up procedure was performed. Aflatoxins were eluted from the column with 3.3 ml of methanol/H_2O (1.375/1.925 ml) into a clean amber vial.

***In-vitro* Dry Matter Digestibility of Silages**

The digestibility of silages was determined by a neutral detergent + enzyme (cellulase) method. Feed samples were first treated with a neutral detergent solution. Then they were incubated with a cellulase enzyme solution. After incubation, the samples were washed with water and acetone, filtered, and dried for weight determination. Thus, *in vitro* dry matter digestibility was determined (Roughan and Holland, 1977; Jones and Hayward, 1973; Carro et al., 1994). The degree of *in vivo* dry matter digestibility was calculated by using in vitro dry matter digestibility with the following formula reported by Roughan and Holland (1977).

In-vivo dry matter digestibility = 0.98 x *In-vitro* dry matter digestibility - 10.12

Statistical Analyses

The IBM SPSS Statistics 23 (IBM SPSS, 2013) program was used for statistical analysis of the data obtained in the study. In the study, a one-way analysis of variance (ONE-WAY ANOVA) was applied to check the importance of the analyzed factors other than the leakage rate. The leakage rate parameter was evaluated by chi-square analysis and its frequencies and percentage rates were stated. The duncan test was used to evaluate the different groups. The data for the study results were given as mean ± standard error. (IBM SPSS, 2013).

RESULTS

In this study, there was no significant difference between groups in terms of mesophilic aerobic bacteria count and yeast population of watermelon slices wilted at different dry matter levels before ensiling ($p>0.05$). A difference was detected in terms of mold population ($p<0.05$). The mold population increased as the dry matter level decreased (Table 2).

In the microorganism analysis performed on the first silage samples taken when opening the silage containers, it was determined that mold and yeast did not grow ($p>0.05$). It was determined that there was a statistically significant ($p<0.05$) increase in the number of mesophilic aerobic bacteria in silages, depending on the dry matter level (Table 3).

When the aflatoxin levels of watermelon slices before ensiling were examined, a very low amount of aflatoxin was detected in all three groups and no difference was seen between the groups ($p>0.05$) (Table 4). A similar situation was found in watermelon slice silages ($p>0.05$) (Table 5).

Crude nutrient analysis results of silages made from watermelon slices containing different dry matter are given in Table 6. Naturally, the dry matter level was significantly different in all 3 groups ($p<0.001$). When examined in terms of crude ash, ether extract, nitrogen-free extract, and metabolisable energy, no significant difference was observed between the groups ($p>0.05$). As for the crude protein percentage, the difference between the Group I and the Group II was not found to be statistically significant ($p>0.05$). However, it was determined

Table 2. Microorganism population (log_{10} cfu/g) before ensiling of watermelon slices wilted at different dry matter levels

Microorganisms (log_{10} cfu/g)	Group I (n=5)	Group II (n=5)	Group III (n=5)	SEM	P Value
Total Mesophilic Aerobic Bacteria Count	5.68±0.16	5.89±0.43	6.10±0.45	0.214	NS
Yeast Count	3.51±0.15	2.22±0.92	2.56±0.19	0.318	NS
Mold Count	2.30±0.61[a]	1.12±0.70[ab]	0.00±0.00[b]	0.311	0.034*

[a, b]: the difference between values with different letters in the same row is statistically significant.
*: P<0.05 is statistically significant,
SEM: Standard error of the mean, NS: non-significant

Table 3. Microorganism population (log_{10} cfu/g) of ensiled watermelon slices silages ensiled by wilting at different dry matter levels

Microorganisms (log_{10} cfu/g)	Group I (n=5)	Group II (n=5)	Group III (n=5)	SEM	P Value
Total Mesophilic Aerobic Bacteria Count	4.03±0.48[b]	4.14±0.42[b]	5.58±0.14[a]	0.217	0.022*
Yeast Count	0.00±0.00	0.00±0.00	0.00±0.00	0.00	-
Mold Count	0.00±0.00	0.00±0.00	0.00±0.00	0.00	-

[a, b]: the difference between values with different letters in the same row is statistically significant.
*: P<0.05 is statistically significant,
SEM: Standard error of the mean, NS: non-significant

Table 4. Aflatoxin levels (ppb/g) of watermelon slices wilted at different dry matter levels before ensiling

Aflatoxin (ppb/g)	Group I (n=5)	Group II (n=5)	Group III (n=5)	SEM	P Value
B1	0.02±0.02	0.00±0.00	0.00±0.00	0.008	NS
B2	0.00±0.00	0.00±0.00	0.00±0.00	0.000	-
G1	0.02±0.02	0.00±0.00	0.05±0.05	0.017	NS
G2	0.04±0.02	0.02±0.01	0.02±0.02	0.010	NS

SEM: Standard error of the mean, NS: non-significant

Table 5. Aflatoxin levels (ppb/g) of silages of watermelon slices ensiled by wilting at different dry matter levels

Aflatoxin (ppb/g)	Group I (n=5)	Group II (n=5)	Group III (n=5)	SEM	P Value
B1	0.00±0.00	0.00±0.00	0.04±0.04	0.012	NS
B2	0.00±0.00	0.00±0.00	0.02±0.01	0.004	NS
G1	0.00±0.00	0.00±0.00	0.02±0.02	0.005	NS
G2	0.07±0.05	0.06±0.03	0.01±0.01	0.020	NS

SEM: Standard error of the mean, NS: non-significant

that the crude protein percentage in the Group III was higher than both groups ($p<0.05$). The crude fibre content of silages also decreased due to the increase in the amount of dry matter ($p<0.001$) (Table 6). The pH value of Group I and Group II silages was lower than that of Group III and there was a statistical difference ($p<0.01$). When the evaluation scores made according to the DLG Silage Evaluation key and Fleig Scores were examined, no statistical difference ($p>0.05$) was detected (Table 7).

When the *in vitro* dry matter digestibility levels of the silages are examined, it is observed that the highest value is detected in the group with high dry matter level, and the lowest value is detected in the watermelon slices silage with low dry matter level ($p<0.001$). The same situation is observed in the degree of dry matter digestibility *in vivo*. This difference in digestion trials was found to be statistically significant ($p<0.001$) (Table 8).

The leakage rate in the containers where the watermelon slices that were withered and ensiled at different dry matter levels are given in Table 9. As the dry matter percentage increased, the rate of leaking silo containers decreased ($p<0.001$).

Table 6. Crude nutrient and energy levels of watermelon slices ensiled by wilting at different dry matter levels

	Group I (n=5)	Group II (n=5)	Group III (n=5)	SEM	P Value
Dry Matter %	20.96±0.64^{c}	26.19±1.07^{b}	32.00±0.41^{a}	0.438	0.000**
Crude Ash % (DM)	10.16±0.65	9.36±0.39	9.24±0.28	0.271	NS
Ether Extract % (DM)	8.12±1.57	7.39±1.56	6.43±0.37	0.748	NS
Crude Protein % (DM)	16.08±0.96^{b}	16.72±0.95^{b}	19.93±0.73^{a}	0.510	0.021*
Crude Fibre % (DM)	16.99±0.42^{a}	13.36±1.14^{b}	10.51±0.24^{c}	0.412	0.000**
Nitrogen Free Extract % (DM)	48.65±1.75	53.17±3.26	53.89±1.16	1.294	NS
Metabolisable Energy(kcal/kg DM)	2792.20±53.59	2903.60±24.38	2899.80±13.81	20.159	NS

$^{a, b, c}$: the difference between values with different letters in the same row is statistically significant.
*: P<0.05 is statistically significant, **: P<0.001 is highly statistically significant.
SEM: Standard error of the mean, NS: non-significant

Table 7. pH values of watermelon slices silages ensiled by wilting at different dry matter levels, evaluation scores of silages according to DLG Silage Evaluation key and Fleig Scores

	Group I (n=5)	Group II (n=5)	Group III (n=5)	SEM	P Value
pH	3.79±0.01^{b}	3.96±0.14^{b}	4.27±0.05^{a}	0.049	0.006*
Silage Evaluation Score (DLG)	18.00±1.26	18.80±1.20	20.00±0.00	0.581	NS
Fleig score	95.07±1.16	98.98±3.35	98.36±2.77	1.499	NS

$^{a, b}$: the difference between values with different letters in the same row is statistically significant.
*: P<0.01 is highly statistically significant.
SEM: Standard error of the mean, NS: non significant

Table 8. In-vitro Dry Matter Digestibility and In-vivo Dry Matter Digestibility Levels of watermelon slices ensiled by wilting at different dry matter levels

	Group I (n=5)	Group II (n=5)	Group III (n=5)	SEM	P Value
In-vitro Dry Matter Digestibility (%)	93.97±0.67^{c}	96.43±0.17^{b}	98.00±0.49^{a}	0.282	0.000*
In-vivo Dry Matter Digestibility (%)	81.97±0.65^{c}	84.38±0.16^{b}	85.92±0.48^{a}	0.276	0.000*

$^{a, b, c}$: the difference between values with different letters in the same row is statistically significant.
*: P<0.001 is highly statistically significant.
SEM Standard error of the mean

DISCUSSION

There is a significant level of leftover watermelons worldwide and in Turkey, and it is seen that these watermelons are not systematically utilized and become waste and recorded as losses (Fish et al., 2009; TURKSTAT, 2023). In order to prevent these losses, the wilting of leftover watermelons for utilization as silage is different from that of other water-rich plant-based feeds. Due to the fruit structure of watermelon, it is very difficult to wilt without slicing. In the process of slicing watermelon (Terlemez and Çerçi, 2019; Terlemez, 2017), which is rich in nutrients, especially sugar, and leaving it to wilt in the same environment and time, three different silage watermelon slices were obtained in 21-23%, 27-29%, and 33-35% bands. Consequently, we have revealed that the number of aerobic mesophilic bacteria in watermelon slices, which are rich in nutrients, especially sugar (Terlemez and Çerçi, 2019; Terlemez, 2017), increased when the dry matter level increased from 21% to 35% in the watermelon slices in the process of wilting before ensiling, although it was not statistically significant ($p>0.05$). Among the yeasts, the highest level of reproduction was found in Group I among the study groups, but this reproduction intensity did not show a course related to the increase in dry matter level. Mold growth was highest in the groups with low dry matter levels and decreased in the groups with high dry matter levels. No mold was detected in the Group III (Table 2). Another study (Degaga et al., 2022) conducted to evaluate the microbiological quality of other raw vegetables, but not watermelon, found that aerobic mesophilic bacteria counts were 5.7 log cfu/g in tomato, 6.4 log cfu/g in zucchini, 4.7 log cfu/g in green pepper, and 6.2 log cfu/g in carrot. The yeast count was 2.3 log cfu/g in tomato, 2.4 in zucchini, 2.1 in green pepper, and 2.2 in carrot. Mold level was 2.2 in tomato, 2.2 in zucchini, 1.7 in green pepper, and 1.8 log cfu/g in carrot. Similar findings were also obtained by Garg et al. (1990). As seen in Table 2, the microbial quality of watermelon slices with different dry matter contents does not contradict the results of previous studies. In other words, the wilting of watermelon slices does not pose a problem in terms of microbial growth or contamination. When the silages of watermelon slices with different amounts of dry matter were opened, the number of microorganisms in them went down compared to before they were sealed. However, there was a statistically significant ($p<0.05$) rise in the growth of mesophilic aerobic bacteria in the silages, which depended on the amount of dry matter (Table 3). Yeast and mold did not grow in watermelon slice silages at all dry matter levels. This can be attributed to the fact that good anaerobic fermentation is the basis of silage production. Because in this fermentation, aerobic life in the silage feed mass ends in a short time after the silo is compressed and closed to the extent that it is airtight. Aerobic microorganisms (aerobic bacteria, mold and yeast) also die (Jones et al., 2004; Basmacıoğlu and Ergül, 2002; Moran, 2005). Thus, it is self-explanatory that mold and yeast are not detected in silages. The detection of mesophilic aerobic bacteria in silages may be due to the growth of some bacteria in both aerobic and anaerobic environments (Kızılsımsek et al., 2016; Brüning, et al., 2018; Yamamoto et al., 2011).

When aflatoxin levels were examined during the wilting process to increase the dry matter level in watermelon slices to be silaged, almost no aflatoxin was detected in all three groups (Table 4). A similar representation was observed in watermelon slice silages after the silos were opened (Table 5). This may be attributed to the fact that mold contamination was low because the watermelons were washed before slicing and molds were not detected at all in the silages (Table 3) (Ogunade et al., 2018; Oğuz et al., 2011).

The proximate analysis of nutrients of the silages made from watermelon slices with different dry matter content was presented (Table 6), the dry matter level was significantly different in the groups ($p<0.001$) (Kızılsımsek et al., 2020). No significant difference was observed between the groups in crude

Table 9. Leakage rate of watermelon slices ensiled by wilting at different dry matter levels in the silage containers

	Group I	Group II	Group III	P Value
Frequency	n (%)	n (%)	n (%)	
Leakage Rate of Silages	100.00[a]	60.00[b]	40.00[c]	0.000*

n: 5
[a, b, c]: the difference between values with different letters in the same row is statistically significant.
*: P<0.001 is highly statistically significant.

ash level (p>0.05). Although the ether extract percentage showed a decrease in the groups due to the increase in dry matter, this decrease was not statistically significant (p>0.05). Although there was a mathematical difference between the Group I and Group II in the crude protein percentage, this difference was not statistically significant. However, it was observed that the crude protein percentage was higher in the Group III than in both groups (p<0.05). We have observed that the crude fibre percentage of silage watermelon slices decreased when the dry matter of the silage was increased and the level of nitrogen-free extract increased slightly (Table 6). This can be explained by the increase in fermentation intensity due to the low dry matter level of watermelon slices, and the proportional increase in the insoluble crude fibre percentage as a result of excessive degradation of easily soluble carbohydrates, and the decrease in the nitrogen-free extract percentage in which easily soluble carbohydrates are present Çerçi et. al., 1996; Gürdoğan and Çerçi 2003; Filya et al., 2000). The differences in the breakdown of nutrients were reflected in the energy levels calculated over nutrients, and the lowest metabolisable energy level was found in the Group I (Table 6). When the pH values of the silages were examined as another parameter indicating the fermentation intensity, the lowest pH was found in group I, which had the lowest dry matter level. It was observed that the pH value of the silage increased when the dry matter level increased. When the evaluation scores according to the DLG Silage Evaluation Key and Fleig Scores were examined, the lowest value was found in the Group I, although not at a statistical level (Table 7). It was also observed that these two silage evaluation scores increased as the dry matter level of the silage material increased. In order to understand the changes in nutrients in these research groups and the arguments brought by us regarding these changes, the results of previous related studies were examined. Beaulieu et al. (1993) reported that silage pH and water-soluble carbohydrate levels decreased, while ammonia-N and lactate levels increased in relation to the decrease in DM of silages. Again, in the study on the determination of fermentation characteristics of wilting in silage materials, Xiccato et al. (1998) emphasized that the pH of the silage increased from 3.82 to 4.33 with wilting of the silage material, and at the same time, there was a decrease in the fermentation activity of the silage, so all fermentation end products decreased significantly. In a study conducted on silages made with materials with different dry matter levels, it was found that the pH and water-soluble carbohydrate levels of silages with higher dry matter levels were higher (Pinder, 2009). As can be seen, previous research data support the findings on nutrient levels obtained in this study and the arguments put forward by us.

Looking at the *in vitro* dry matter digestibility of watermelon slices ensiled with different dry matter levels, the highest value was found in the group with a high dry matter level, and the lowest value was found in the watermelon slice silage with a low dry matter level (Table 8). The same pattern was observed in the *in vivo* dry matter digestibility calculated from the *in vitro* values. This difference in digestion trials was statistically significant (p<0.001). The reason for the difference between the groups is clearly understood when the nutrient levels of the silages in the groups are examined. The crude fibre percentage, which has a negative effect (Çerçi and Sarı, 1995), decreased in the group with a high silage dry matter percentage, while crude protein percentage, which has a positive effect (Kang et al., 2015; Zhu et al., 2020) increased (Table 6 and Table 8). The results of the research will be better understood when we look at the studies in which this effect was examined. Chanthakhoun et al. (2012) tested different dietary crude protein levels in buffaloes and reported that dry matter digestibility increased from 53.6% to 64.7% when the dietary crude protein level was increased from 9.2% to 12.4%. Short (1966) tested different rations with different crude cellulose levels in deer and found a negative relationship between dietary crude cellulose level and dry matter digestibility. Arroyo-Aguilu and Evans (1972) also reported that cellulose, acid-detergent lignin, and cell wall fractions were inversely related to digestible dry matter. Jahn et al. (1970) stated that dry matter and crude protein digestibility decreased linearly with the fibre content of the diet. Akbay et al. (2020) found that the degree of organic matter digestibility increased as the amount of crude protein increased, while organic matter digestibility decreased as the amount of dietary fibre increased. In a study on the effect of wilting on silage forages with high moisture content, it was found that the dry matter digestibility and nutritive values of silages made with wilted forages were higher than those of silages without wilting (Xiccato et al., 1998). When the studies on the crude protein level of the ration, which is one of the nutrients that affect the degree of dry matter digestibility, were examined, it was found that lambs fed concentrate feeds containing low, medium, and high crude protein had higher DM, nitrogen-free extract, and hemicellu-

lose, organic matter, crude protein, crude fibre, and cellulose digestibility in lambs fed concentrate feeds containing medium crude protein (Hassan and Saeed, 2012). Again, goat kids were fed isoenergetic diets containing 14.8% (control), 13.4%, and 12.0% crude protein and it was found that a low crude protein diet decreased average daily body weight gain, feed efficiency, dry matter, organic matter, crude protein, and fibre digestibility (Zhu et al., 2020). As can be seen, the data from previous studies also supports that the findings on the degree of digestibility of dry matter obtained in these research groups are not coincidental and reflect reality.

When the silages of wilted watermelon slices at different dry matter levels were examined, it was seen that the rate of leaking silo containers decreased as the amount of dry matter increased (Table 9). While Group I leaked the most, Group III leaked the least ($p<0.001$) (Table 9). A similar picture emerged in the study conducted by Savoie et al. (2002). In order to reduce the effluent in silages, reducing the moisture content of the feed before ensiling is effective (Gebrehanna et al., 2014). It has been reported that wilting before ensiling is one of the best methods to reduce leakage (Woolford, 1978). In another study, the leakage and effluent amounts of 50 silages were examined and it was reported that increasing the dry matter content of grasses from 15% to 30% reduced the amount of leakage significantly (Bastiman, 1976).

CONCLUSIONS

As a result in the study, we demonstrated that leftover watermelons can be sliced and aerobically and microbially safely wilted under the sun at three different dry matter levels. We also observed that silage can be made from watermelon slices with three different dry matter levels. We have revealed that the nutrient levels of these silages varied depending on the dry matter levels, and the best nutrient composition and dry matter digestibility were in the Group III, followed by the Group II and the Group I. We have also reported that especially small livestock farms, can use watermelons that are left over for any reason as a durable alternative feed by making silage in their farms. However, based on the promising results obtained in this study, researches should continue to increase alternative feed resources by silaging all kinds of fruit and vegetable leftovers.

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