Asian-Aust. J. Anim. Sci.
Vol. 24, No. 9 : 1243 - 1248
September 2011

www.ajas.info
http://dx.doi.org/10.5713/ajas.2011.10460

Evaluation of Mixtures of Certain Market Wastes as Silage

H. Özkul*, A. Kılıç and M. Polat
Ege University, Faculty of Agriculture, Department of Animal Science, Izmir, Turkey

ABSTRACT : The aim of this study was to determine the usefulness of vegetable wastes as silage for ruminants. Varying amounts of wheat straw (WS), wheat bran (WB) and salt (S) were combined with minced vegetable wastes (VW) during ensilage. Seven different ingredient combinations were investigated viz: 100% VW (Group I, control), 90% VW+9% WS+1% S (Group II), 80% VW+15% WS+ 4% WB+1% S (Group III), 70% VW+20% WS+9% WB+1% S (Group IV), 90% VW+9% WB+1% S (Group V), 80% VW+15% WB+ 4% WS+1% S (Group VI) and 70% VW+20% WB+9% WS+1% S (Group VII). The inclusion of straw and bran increased ($p<0.01$) the DM content of silage. The highest contents of the pure silage were CP ($p<0.001$), EE ($p<0.01$) and NFE ($p<0.05$). NDF contents of VW silage and group V were significantly lower and especially the VW silage was found to have the lowest ADL content ($p<0.01$). The *in vitro* ME values of VW silage and bran added silage were higher than other groups ($p<0.01$). pH, lactic acid and acetic acid values of silage groups were changed between 4.09-4.20, 2.43-3.46% and 0.60-0.86%, respectively. In conclusion, different mixtures of VW have a high ensilage capacity and can serve as an alternative roughage source for ruminants. The addition of 9% bran significantly improved the silage in view of both dry matter content and nutritive value. (**Key Words :** Vegetable Wastes, Silage Quality, Ruminants)

INTRODUCTION

Turkey has a large animal production section with approximately 11 million cattle and 30 million sheep (Anonymous, 2008a,b). Despite these large numbers there are significant problems in terms of animal production largely due to the lack of sufficient amount and quality of roughage (Kılıç, 2005). Of the 21.5 million hectares of cultivated land only 5.6% is used for fodder crop production (Anonymous, 2008b). The insufficient fodder crop production and limited availability of pastures due to over grazing has meant that only the basic energy needs of the animals for survival and perhaps limited milk production (4-5 kg/d) are being met (Kılıç, 2000). This lack of roughage has prompted interest is alternative feed sources, including the 7-10 million tones of fruit and vegetable wastes produced each year in Turkey (Vural, 2000). There are several studies suggesting that such plant wastes could be potential feed sources for ruminants (Sarıçiçek et al., 1994; 1997; Bakshi et al., 2006; Khorshed et al., 2006; Wadhwa et al., 2006; Meneses et al., 2007). However, as the majority of these wastes have not been evaluated as animal feed, they instead generally become important environmental pollutants (Erdem, 2005; Khorshed et al., 2006). Utilizing these plant wastes as animal feeds would have benefits both in terms of the environment and animal production. In this way, both the national economy would be positively affected and the risks for human health would be prevented.

Fruit and vegetable wastes generally have a high moisture content and if left untreated will rot in 3-4 days (Hersom, 2006). However, they are rich in soluble carbohydrates and thus could be easily ensiled if the excessive moisture content was addressed. Ensilage is an effective and convenient way to conserve such plant wastes for long periods (Kılıç 1986; Kinh et al., 2010).

Consequently, the aim of the study is to determine the potential of using ensiled vegetable wastes of different market mixtures as alternative feed sources for ruminants.

MATERIALS AND METHODS

Sampling procedures and analytical methods

The main material of the study was composed of vegetable wastes obtained from three different street markets. Components of the mixture were cauliflower leaves (33%), cabbage leaves (22%), artichoke leaves (17%), carrot (8%), spinach (7%), lettuce (5%), leek (4%)

* Corresponding Author : H. Özkul. Tel: +90-232-3111450, Fax: +90-232-3881867, E-mail: hulya.ozkul@ege.edu.tr
Received December 23, 2010; Accepted April 1, 2011

and celery (4%). Collected vegetable wastes (VW) were cleaned from foreign substance and roughly broken to 5-10 cm pieces, then mixed on a clean plastic bag by hand. Different amounts of wheat straw (WS), wheat bran (WB) and salt (S) with regard to fresh weights were added to the mixture in ensilage due to high water content and low feeding value of individual VW in the mixture. For this purpose, seven different groups were formed in the study: 100% VW (Group I, control), 90% VW+9% WS+1% S (Group II), 80% VW+15% WS+4% WB+1% S (Group III), 70% VW+20% WS+9% WB+1% S (Group IV), 90% VW+ 9% WB+1% S (Group V), 80% VW+15% WB+4% WS+ 1% S (Group VI) and 70% VW+20% WB+9% WS+1% S (Group VII). Obtained mixtures were placed in two liter plastic cans by hand, firmly compressed, closed and strapped to prevent air ingress. Each group was prepared as four replicates and plastic cans were left for fermentation at room temperature for 50 days.

Samples of vegetable wastes silage (VWS) were opened after fermentation and their physical analyses carried out according to DLG standards (DLG, 1987) and their pH values were measured using a digital pH-meter (Hanna, model: HI 8314). After taking suitable samples for chemical analyses, crude nutrient contents (dry matter, crude protein, ether extract, crude ash) of feed samples were determined by Weende analyses method (AOAC, 1995), crude fiber contents by Lepper method (Crampton and Maynard, 1938), and cell wall components were determined by Van Soest analyses method (Goering and Van Soest, 1970). Lactic-, acetic-, butyric acid contents of fresh ensilages were determined by distillation method (Naumann and Bassler, 1993). *In-vitro* metabolizable energy contents of ensilages were estimated by their crude nutrient contents (TS, 2004) and the regression equations with ADF (acid detergent fiber) (Kirchgessner et al., 1977).

Statistical analysis

Variance analysis was used in the statistical analysis of the obtained data and the Duncan's Multiple Range Test was used to determine the difference between groups; for this purpose, SPSS packet software was used (SPSS, 2002).

RESULTS AND DISCUSSION

Chemical compositions of feeds and *in vitro* metabolizable energy values

Crude nutrient and cell wall contents of fresh vegetable wastes in dry matter (DM) basis collected from street markets and prepared ensilages mixed with straw, bran and salt are given in Table 1 and 2. Dry matter content of fresh vegetable wastes determined in the present study (12.16%, Table 1) is compatible with the findings reported by Sarıçiçek et al. (1994 and 1997) and Doğan (2008) for different mixtures of vegetable wastes, however, lower than the finding reported by Meneses et al. (2007) for fresh artichoke leaves (29.7%). It is natural that DM content is changeable depending on the feed types and components of mixture (Kılıç, 1986). Organic matter, crude protein (CP) and nitrogen free extract (NFE) contents in dry matter basis of fresh vegetable wastes were lower than the values reported by Doğan (2008) for the mixture of market vegetable wastes, while the NDF (neutral detergent fiber) content was higher (Table 1). This situation was attributed to the high cell wall contents of cauliflower, lettuce and artichoke leaves used in the mixture (Wadhwa et al., 2006; Meneses et al., 2007).

So far, there have been different ensilage studies on feeding values of each vegetable and fruit (Khorshed et al., 2006; Wadhwa et al., 2006; Meneses et al., 2007; Doğan, 2008) or combined with different additives (Sarıçiçek et al., 1994; 1997; Kılıç, 2005; Bakshi et al., 2006; Gündüz, 2007; Kinh et al., 2010). However, no information was given in the studies regarding the ratios of feed materials used in the mixtures. Such materials generally have high water contents; therefore, it necessitates the use of raw material with high DM content for ensilage (Kılıç, 1986). In the present study different amounts of straw and bran additions were used to increase the DM content of the initial material. The decrease in the DM content of pure vegetable wastes silage (VWS) compared to initial material was compatible with the finding determined by Sarıçiçek et al. (1994 and 1997) for the mixture of cabbage+marrow and white cabbage silages (10.51 and 12.24%, respectively), but lower than the values found by Sarıçiçek et al. (1997) for black cabbage silage (23.30%), and the values determined by Alçiçek et al. (2000) and Meneses et al. (2007) for artichoke waste silage (25.34 and 25.8%, respectively). Straw and bran additions significantly increased the DM content in all silage groups compared to control group ($p<0.01$). As the feeds with high DM content were added to mixture, DM

Table 1. Chemical composition of fresh vegetable wastes, wheat straw and wheat bran (% DM)

Feeds	DM	OM	CP	EE	CF	NFE	NDF	ADF	ADL
Vegetable wastes	12.16	87.17	19.00	3.29	33.88	32.73	29.61	20.72	3.20
Wheat straw	91.93	91.36	4.62	1.78	33.07	51.89	73.24	48.04	7.70
Wheat bran	90.92	95.05	15.40	4.62	9.24	65.79	36.70	12.10	4.20

DM = Dry matter, OM = Organic matter, CP = Crude protein, EE = Ether extract, CF = Crude fiber,
NFE = Nitrogen free extract, NDF = Neutral detergent fiber, ADF = Acid detergent fiber, ADL = Acid detergent lignin.

contents of mixture silages increased. In addition, CP, EE, CF and NFE levels of VWS were significantly improved. This situation supports the reports that ensilage is the most convenient way to conserve nutritive values of feeds (Kılıç, 1986; Sarıçiçek et al., 1994; 1997; Khorshed et al., 2006).

The highest CP and EE contents (22.59 and 4.25%, respectively) were determined in VWS; in addition, CP and EE contents of silage groups were significantly decreased with the increasing amount of straw and bran additions compared to control group. CP and EE values determined for VWS were compatible with the results reported by Sarıçiçek et al. (1997) for black cabbage silage (22.92 and 4.29%, respectively) and by Bakshi et al. (2006) for cauliflower leave silage (20.4%, for CP). CP and EE contents of especially groups V, VI and VII were higher than those of groups II, III and IV ($p<0.001$, $p<0.01$, Table 2). This could be explained by the fact that protein and fat contents of wheat bran used as additive are higher than those of wheat straw. In addition, EE contents of treatment group changed between 2.69-4.06%, which was compatible with the values determined by Sarıçiçek et al. (1994).

In the study, VWS had the lowest CF content (13.24%, $p<0.01$, Table 2), while its maximum levels were naturally determined in straw added groups II, III and IV. Findings on CF content of VWS were incompatible with the results of Sarıçiçek et al. (1994 and 1997), and Khorshed et al. (2006), while the values of II, III and IV groups were compatible. CF contents of V and VI groups with high bran additions were significantly lower than the values of control and other groups ($p<0.01$). Considering NFE, VWS provided significantly lower results compared to all the treatment groups ($p<0.05$); however, no significant difference was detected between the treatment groups ($p>0.05$, Table 2). Compared to treatment groups, the low NFE content of VWS could be attributed to the loss of easily soluble carbohydrates in silage water. The findings on high NFE contents of treatment groups were highly similar to the results of previous studies (Sarıçiçek et al., 1994; Alçiçek et al., 2000; Gündüz, 2007).

III and IV groups mainly with straw addition had the highest contents of NDF (55.92 and 53.44%, respectively, Table 2), which were followed by II and VII groups ($p<0.01$). This finding was partially compatible with the result (58%) of Bakshi et al. (2006) on cauliflower leaf silage with straw addition. In fact, it was accepted that NDF content increased with straw addition. The lowest NDF content was determined in VWS (28.69%) and group V with only bran addition (30.52%) ($p<0.01$). Results of the NDF content of VWS was partially compatible with the result (31.5%) reported of Bakshi et al. (2006), while it was lower than the results reported by Alçiçek et al. (2000) and Meneses et al. (2007) for artichoke waste silage (49.71 and 50.9%, respectively). NDF content (30.52%) obtained with the addition of 10 % of bran to VWS was similar to the result (30.5%) that Kinh et al. (2010) obtained with the same amount of bran addition. The low NDF content indicates that the consumption potentials of control and group V silages could be higher than other groups.

The lowest ADF content was determined in V group with only bran addition (19.73%, $p<0.001$) and this finding was similar to the result (19.8%) of Kinh et al. (2010). The groups with mostly straw addition (groups II, III and IV) naturally had high ADF contents and no difference was detected between the groups. This finding was lower than

Table 2. Chemical compositions of vegetable wastes silages (% DM)

Groups	I	II	III	IV	V	VI	VII	SE	p
Crude nutrient contents									
DM, fresh	11.50^{d}	21.01^{c}	26.59^{b}	28.99^{ab}	19.52^{c}	25.86^{b}	32.64^{a}	0.97	**
OM	82.72^{b}	83.55^{b}	86.79^{a}	86.35^{a}	82.92^{b}	85.77^{a}	87.02^{a}	0.31	**
CP	22.59^{a}	14.23^{d}	12.85^{d}	12.92^{d}	20.06^{b}	19.54^{b}	17.12^{c}	0.49	***
EE	4.25^{a}	2.78^{d}	2.91^{d}	2.69^{d}	4.06^{ab}	3.88^{b}	3.56^{c}	0.08	**
CF	13.24^{d}	19.53^{bc}	23.06^{a}	22.05^{ab}	11.29^{d}	13.55^{d}	17.07^{c}	0.86	**
NEF	42.28^{b}	47.02^{a}	47.88^{a}	48.92^{a}	47.55^{a}	48.59^{a}	49.37^{a}	0.63	*
Cell wall components									
NDF	28.69^{d}	47.51^{b}	55.92^{a}	53.44^{a}	30.52^{d}	36.81^{c}	46.32^{b}	1.43	**
ADF	26.49^{b}	32.60^{a}	34.27^{a}	32.60^{a}	19.73^{d}	23.20^{c}	27.32^{b}	0.69	***
Hemicellulose	2.20^{d}	14.90^{bc}	21.64^{a}	20.83^{a}	10.79^{c}	13.62^{c}	19.00^{ab}	0.98	**
ADL	3.98^{b}	6.77^{ab}	6.09^{ab}	7.47^{a}	6.24^{ab}	5.16^{ab}	6.61^{ab}	0.31	**
Cellulose	23.16^{bc}	25.84^{ab}	28.19^{a}	25.14^{ab}	13.50^{e}	18.04^{d}	20.71^{cd}	0.69	**

I: 100% VW, II: 90% VW+9% WS+1% S, III: 80% VW+15% WS+4% WB+1% S, IV: 70% VW+20% WS+9% WB+1% S, V: 90% VW+9% WB+1% S, VI: 80% VW+15% WB+4% WS+1% S, VII: 70% VW+20% WB+9% WS+1% S.

VW = Vegetable wastes, WS = Wheat straw, WB = Wheat bran, S = Salt, DM = Dry matter, OM = Organic matter, CP = Crude protein, EE = Ether extract, CF = Crude fiber, NFE = Nitrogen free extract, NDF = Neutral detergent fiber, ADF = Acid detergent fiber, ADL = Acid detergent lignin.

SE = Standard error of means. Values with different superscripts within a row differ significantly (* $p<0.05$, ** $p<0.01$, *** $p<0.001$).

the result of Bakshi et al. (2006). On the other hand, ADF contents of VWS and VII group were similar. ADF content of VWS (26.49%) was compatible with the result of Bakshi et al. (2006), however, lower than the results of Alçiçek et al. (2000) and Meneses et al. (2007). A significant increase was observed in the ADF content of VWS compared to initial material. In fact, this value which was 21 % at the beginning increased to 26% following ensilage. This change was related to easily soluble carbohydrates in the initial phase of ensilage (Asbell and Donahaye, 1984).

The highest ADL content was found in IV group (7.47%), while the lowest was in VWS (3.98%); however, it was generally found similar in all groups ($p<0.01$, Table 2). The ADL value of control silage was compatible with the result reported by Alçiçek et al. (2000) for artichoke silage (5.22%), however, lower than the values of Bakshi et al. (2006) and Meneses et al. (2007) (7.6 and 7.5%, respectively). The highest cellulose content was determined in the group III (28.19%), and the lowest was in the group V (13.5%) ($p<0.01$). Considering this parameter, no significant difference was detected between the groups with mostly straw additions; however, the cellulose content increased with high levels of bran additions. Cellulose content (23.16%) determined for VWS was lower than the value (35.57%) of Alçiçek et al. (2000), but close to the value (26%) of Meneses et al. (2007).

The *in vitro* metabolizable energy (ME/kg DM) values of VWS are given in Table 3. Considering the ME values were estimated from crude nutrients of silages, the highest values were determined in VWS (10.12 MJ/kg) and mostly bran added groups (10.39, 10.36, 9.84 MJ/kg) ($p<0.01$). For the estimation of ME values of roughages for ruminants ADF from the cell wall fractions was reported as the most convenient parameter (Kirchgessner et al., 1977, Alçiçek et al., 2000). Accordingly, the highest ME value estimated from ADF contents of silages was determined in the Group V (11.74 MJ/kg), and it was statistically significantly different from the other groups ($P<0.001$). In the study, ME values of VWS and bran added groups were similar. On the other hand, the lowest ME value was detected in straw added groups (groups II, III and IV), it can be seen in Table 3 that additive levels had no significant effect on ME value of silages. The results on ME values of VWS was compatible with the findings of Sarıçiçek et al. (1997); however, it was found lower than the result of Sarıçiçek et al. (1994), and higher than the result of Alçiçek et al. (2000).

Fermentative quality properties of silages

Physical and chemical quality properties of fresh vegetable waste silages are given in Table 4. No significant

Table 3. *In vitro* metabolizable energy values of vegetable wastes silage (MJ/kg DM)

Groups	I	II	III	IV	V	VI	VII	SE	p
ME_{CN}	10.12^a	8.79^b	8.61^b	8.69^b	10.39^a	10.36^a	9.84^a	0.15	**
ME_{ADF}	10.73^c	9.81^d	9.56^d	9.81^d	11.74^a	11.22^b	10.60^c	0.10	***

ME = Metabolizable energy, CN = Crude nutrients, ADF = Acid detergent fiber, SE = Standard error of means.
Values with different superscripts within a row differ significantly (** p< 0.01, *** p<0.001).

Table 4. Physical and chemical quality properties of fresh vegetable waste silages

Groups	I	II	III	IV	V	VI	VII	SE	p
pH values	4.16	4.20	4.13	4.09	4.10	4.15	4.20	0.04	NS
Silage acids (%)									
Lactic acid	2.43	2.52	3.46	3.18	2.64	3.27	2.51	0.14	NS
Acetic acid	0.65	0.65	0.81	0.86	0.60	0.75	0.70	0.03	NS
Butyric acid	0.00	0.00	0.00	0.04	0.00	0.00	0.03	0.00	NS
Total acids	3.08	3.17	4.27	4.08	3.24	4.02	3.24		
Total score	96	96	98	96	98	98	96		
Quality[1]	v. good	v. good	v. good	v. good	v. good	v. good	v. good		
Physical characteristics									
Colour	1.75^c	2.75^a	2.75^a	2.75^a	2.00^b	2.75^a	3.00^a	0.11	**
Smell	6.00^b	7.25^{ab}	7.25^{ab}	7.75^{ab}	7.25^{ab}	8.00^{ab}	9.25^a	0.25	**
Structure	3.00	3.50	3.50	4.25	3.25	4.00	4.25	0.13	NS
Total score	10.75	13.50	13.50	14.75	12.50	14.75	16.50		
Quality[2]	medium	medium	medium	good	medium	good	good		

[1] Quality classification: 100-81 = very good, 80-61 = good, 60-41 = pleasing, 40-21 = medium, 20-0: bad (useless).
[2] Quality classification: 20-18 = very good, 17-14 = good, 13-10 = medium, 9-5 = less valuable, 4-0 = bad (useless).
Values with different superscripts within a row differ significantly (** p<0.01), NS = Not significant.

difference was detected in pH values between the groups (p>0.01). The pH values were in the boundaries estimated for good quality silages (Kılıç, 1986; Ensminger et al., 1990). The pH value (4.16) of VWS was higher than the value reported by Alçiçek et al. (2000) for artichoke waste silage (3.42), but similar to the result (4.11) of Meneses et al. (2007). The pH values of groups with additions were compatible with the results of Sarıçiçek et al. (1994), but lower than the value (4.83) reported by Khorshed et al. (2006) for the silages of different fruit and vegetable mixtures.

There was no significant difference between the groups considering lactic-, acetic- and butyric acid contents. The maximum lactic acid (LA) content (3.46%) was determined in Group III, while the lowest LA content (2.43%) was in VWS. Silages with high LA concentrations were reported to have high nutrient density, more delicious and odorous; therefore, they had higher intake potential (Meneses et al., 2007). The LA contents of all groups were higher than the value (2%) estimated for good quality silages (Kılıç 1986). These values were higher than the results of Sarıçiçek et al. (1994; 1997), but similar to the results of Kinh et al. (2010). Acetic acid (AA) contents of silages varied between 0.60-0.86%, which was higher than the value (0.3-0.6%) estimated for good quality silages (Kılıç, 1986). On the other hand very little butyric acid (BA) was detected in any group. Considering the organic acid contents of silages, all silages were found to have "very good" quality. Groups with straw and bran additions had the best values regarding color and odor, while the worst values (1.75 and 6.00, respectively) were determined in VWS (p<0.01, Table 4). There was no significant difference between groups considering structure; however, the lowest value was observed in VWS. Considering the physical quality properties of silages, all the silages except for I, II, III and V groups were found to have "good" quality.

As a result of the study, it was clearly established that the mixtures of different vegetable wastes had high ensilage capacities, the obtained pure silage was concluded as an alternative roughage source especially for ruminants due to its high CP, EE, ME and low NDF, ADL contents; however, 9% of bran addition to this material would result in even better quality silage in view of both dry matter and nutrient contents.

The quality of silages obtained from such materials with continuous production all the year round is highly changeable depending on the types and ratios of components added in it. For this reason, a more comprehensive study including the feeding experiments is needed. Strategies for using such wastes as animal feeds should be immediately established in view of both filling the gap in roughage demand and preventing environmental pollution.

REFERENCES

Alçiçek, A., S. Tümer and H. Özkul. 2000. A preliminary study on nutritive content and feed value of leafed artichoke silage as a roughage. Ege Uni. Agri. Fac. Journal. 37(2-3):27-34.

Anonymous, 2008a. Animal Production Statistics-2008. Prime Ministry of Republic of Turkey, Turkish Statistical Institute.

Anonymous, 2008b. Plant Production Statistics-2008. Prime Ministry of Republic of Turkey, Turkish Statistical Institute.

Asbell, G. and E. Donahaye. 1984. Losses in orange peel silage. Agric. Wastes. 14:73-77.

AOAC. 1995. Official methods of analysis, 16th ed. Association of Official Agricultural Chemists, Washington DC, USA.

Bakshi, M. P. S., M. Wadhwa, S. Kaushal and A. Ameir. 2006. Nutritional value of ensiled fruit and vegetable wastes. Improving Animal Productivity by Supplementary Feeding of Multinutrient Blocks, Controlling Internal Parasites and Enhancing Utilization of Alternate Feed Resources, pp. 191-196.

Crampton, E. W. and L. A. Maynard. 1938. The relation of cellulose and lignin content to the nutritive value of animal feeds. J. Nutr. p. 15:383.

DLG, 1987. Bewertung von grünfutter, silage und heu. Merkblatt, no: 224, DLG-Verlag. Frankfurt am Main. 112 p.

Doğan, B. 2008. Potential of vegetable-fruit wastes of markets in Bornova district of Izmir province as animal feed. Ege Uni. Division of Environmental Sciences, (MS thesis, unpublished). p. 34.

Erdem, A. 2005. Solid waste management congress. 25-27 May, Izmir. pp. 1-9.

Ensminger, M. E., J. E. Oldfield and W. W. Heineman. 1990. Feed and Nutrition (Second Ed.) The Ensminger Publishing Company, Clavis, California.

Goering, H. K. and P. J. Van Soest. 1970. Forage fiber analyses. Agriculture Handbook, no: 379, Washington DC. USA. p. 829.

Gündüz, E. 2007. The study on the ensiling of the mixture of vegetables and fruits taken from the residues of market and market hall and the level's of goat's consumption. Ege Uni. Institute of Science and Technology, Izmir. (MS thesis, unpublished). p. 48.

Hersom, M. J. 2006. By-product feed utilization for forage diets. Florida Beef Cattle Short Course. p. 10.

Khorshed, M. M., S. A. H. Abo El-Nor and S. M. Kholif. 2006. Effects of supplementing some chemical agents to ensiled vegetable and fruit market wastes on silage quality and digestibility coefficients (*in vitro* and *in vivo*). JKAU: Med. Env. Arid Land Agric. Sci. 17(2):53-64.

Kılıç, A. 1986. Silage. Bilgehan Publishing, Izmir. p. 327.

Kılıç, A. 2000. Forage production and its problems. Turkey Agriculture Engineering V. Technique Congress, 17-21 January, Ankara. I.skin. p. 845-858.

Kılıç, A. 2005. Determination of roughages quality. Hasad Publishing, Izmir. pp. 11-18.

Kinh, L. V., V. N. Trung, P. H. Ninh, P. V. Sy, N. V. Phu and L. H. Chau. 2010. Rice bran as ingredient for ensiling fresh cashew apple in laboratory. (http://www.iasvn.org/uploads/files/rice_bran_ 0521144646.pdf).

Kirchgessner, M., R. J. Kellner, F. X. Roth and K. Ranfft. 1977. Zur schatzung des futterwertes mittels rohfaser und der zellwandfraktionen der detergentien-analyse. Landwirtsch. Forsch. 30:245-250.

Meneses, M., M. D. Meg´ıas, J. Madrid, A. Mart´ınez-Teruel, F. Hern´andez and J. Oliva. 2007. Evaluation of the phytosanitary, fermentative and nutritive characteristics of the silage made from crude artichoke (*Cynara scolymus* L.) by-product feeding for ruminants. Small Rumin. Res. 70:292-296.

Naumann, C. and R. Bassler. 1993. Die chemische untersuchung von futtermitteln, Methodenbuch, Band III, VDLUFA-Verlag, Frankfurt.

Sarıçiçek, B. Z., M. Zincirlioğlu and A. Yılmaz. 1994. Grown in the Black Sea region as a silage evaluation of some plants and plant residues. Nineteen May Uni. Agric. Fac. Journal, 9(3): 129-141.

Sarıçiçek, B. Z., G. Erener and C. Sarıcan. 1997. Ensiling possibilities of some plant residues. Tr. J. Agric. Forestry. 21:135-140.

SPSS. 2002. SPSS for Windows Advanced Statistics Release 11.5, SPSS Inc. Chicago-Illinois.

TS. 2004. Turkish Standard Institute. Animal feeds-metabolizable energy analyses (chemical method). TS 9610. Ankara, Turkey.

Vural, H., D. Eşiyok and İ. Duman. 2000. Crops. Ege Uni. Publishing, Izmir. p. 45.

Wadhwa, M., S. Kaushal and M. P. S. Bakshi. 2006. Nutritive evaluation of vegetable wastes as complete feed for goat bucks. Small Rumin. Res. 64:279-284.