ajava

Asian Journal of Animal and Veterinary Advances

Academic
Journals Inc.

www.academicjournals.com

OPEN ACCESS Asian Journal of Animal and Veterinary Advances

ISSN 1683-9919
DOI: 10.3923/ajava.2018.189.196

Research Article
Effect of Additives on the Forage Quality of Pelleted Hazelnut Husks

[1]Ugur Ozcan and [2]Unal Kilic

[1]Directorate of Provincial Food Agriculture and Livestock Alacam, Samsun, Turkey
[2]Department of Animal Science, Faculty of Agriculture, University of Ondokuz Mayis, Samsun, Turkey

Abstract
Background and Objective: Harvest wastes and some forages are pelleted in order to be used in ruminant nutrition to improve forage quality. This study was conducted to determine nutrient contents and *in vitro* true digestibilities (IVTD) of hazelnut husks (HH) pelleted with the addition of molasses, urea+molasses, corn and sepiolite. **Methodology:** In the study, there were total 8 treatment groups (4 sepiolite added groups and 4 non- sepiolite groups for HH). Daisy incubator^{D220} was used to determine the IVTDs of the feeds. The data obtained from the experiments were analysed in accordance with the completely randomized design. **Results:** The crude protein (CP) contents of HH were 8.79-16.89%. Sepiolite addition did not affect the CP content of HH. The HH had highest IVTD value. The sepiolite addition decreased the IVTD value of HH. All of the feeds were listed in the lowest quality class. But the addition of urea and molasses to the ration was found to have a significant effect on the CP content of HH. The highest IVTD values were found from the addition of corn to rations of HH groups. **Conclusion:** The addition of sepiolite and corn must be given special attention in pelleting process of hazelnut post-harvest wastes.

Key words: *In vitro* true digestibility, hazelnut husk, pellet, sepiolite, molasses

Received: October 09, 2017 Accepted: December 26, 2017 Published: February 15, 2018

Citation: Ugur Ozcan and Unal Kilic, 2018. Effect of additives on the forage quality of pelleted hazelnut husks. Asian J. Anim. Vet. Adv., 13: 189-196.

Corresponding Author: Unal Kilic, Department of Animal Science, Faculty of Agriculture, University of Ondokuz Mayis, Samsun, Turkey Tel: +903623121919*1453 Fax: +903624576034

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Quality forage supply is of utmost importance in ruminant nutrition in terms of rumen physiology and economical stock breeding. In Turkey, the land reserved for fodder crop cultivation is insufficient and pastures and grasslands must be reformed in order to meet the need. Thus, industrial waste, pulp, husks, hull and several others by products, i.e. possible alternative forage sources, are being explored in order to close the gap in the forage supply. Cultivated in great numbers in Turkey, hazelnut produces a by-product, hazelnut husk (HH), at a volume approximately 20% of the harvested product (475.000 t) and it is observed that HH is either not used at all economically or used as fertilizer, alternative fuel and litter, in the case of stockbreeding[1,2].

According to the reports, a number of stock breeders attempted to granulate HH and feed it to their livestock in Turkey which did not lead to desire outcome in terms of feed consumption rate. A literature review on the use of hazelnut meal and hazelnut oil in livestock nutrition reported that these materials do not contain anti-nutritional factors which may have an effect on the livestock performance[3]. Furthermore, hazelnut post-harvest waste has a potential as an alternative forage source. And the process of pelleting itself may offer significant improvement in the nutritional value of such by products[4].

Moreover, sepiolite is a material used especially in combination with pelleted feed as a binding agent. Consequently, sepiolite's water absorption capacity allows for highly durable and firm pellets and prevents fungal development. Sepiolite is commonly used as an additive preferred for its ability to improve feces quality in addition to diarrhea prevention and it stands out as a positive property in terms of environment and animal welfare. Bernal and Lopez-Real[5] reported that sepiolite absorbs gases and reduces the ammonia content of the rumen. The main purpose of this study was to analyse the effect of pelleting and the use of additives on the digestibility of the forages. Having prepared pellets of hazelnut husks, a material which offers a significant forage potential, the additions of urea, molasses, corn and sepiolite to the rations were analysed. The hypothesis of this study was the assumption that liquid and gas absorption capacity of sepiolite reduces the methane discharge from rumen, which in return ensures better use of forage energy and that the use of HH pellets may improve in terms of their forage value with this process.

MATERIALS AND METHODS

In the experiments, hazelnut husks (HH) were collected after being harvested from 3 different locations in Ondokuz Mayis University, Samsun Province of Turkey in 2016. The samples were dried and ground to a size that can pass through 2mm sieve. Urea, sugarbeet-molasses, corn and sepiolite were used as additives in order to increase the feed values of HH. Hazelnut husk samples are named as follow; HH-Ct: Hazelnut husk control, HH-M: Hazelnut husk+molasses, HH-UM: Hazelnut husk+urea+molasses, HH-C: Hazelnut husk+corn, SHH-Ct: Hazelnut husk control with sepiolite, SHH-M: Hazelnut husk+molasses with sepiolite, SHH-UM: Hazelnut husk+urea+molasses with sepiolite and SHH-C: Hazelnut husk+corn with sepiolite. In this study, 8 groups for HH were created for testing in 2 sepiolite applications (available-not available) and 4 treatments (control, molasses, urea+molasses and corn). The ratios used in this experiment are as follows; molasses 7%, urea+molasses = (2.5+7%) 9.5%, corn 15% and sepiolite 2%. Additives and HH were blended homogeneously. This was followed by each group being pelleted in 6 mm diameter pellets with iterations.

Chemical compositions of samples: The samples were ground in a mill to a size that can pass through 1 mm sieve for chemical composition analyses. Then all the samples were analysed for crude protein (CP), dry matter (DM) and ash content in accordance with AOAC[6]. Crude fibre (CF), acid detergent lignin (ADL), acid detergent fibre (ADF) and neutral detergent fibre (NDF) analysis were performed according to methods suggested by Van Soest *et al.*[7] using Ankom 2000 Fiber Analyzer. Ether extract (EE) content was analysed using Ankom XT[15] Extraction System in accordance with AOCS[8]. Hemicellulose (HCel = NDF-ADF), cellulose (Cel = ADF-ADL) and nitrogen free extracts (NFE = DM-(CP+ash+EE+CF) contents were determined numerically.

Determining *in vitro* true digestibilities of samples: In the experiment, rumen fluid was obtained from Holstein bull (approx. 400 kg live weight and 1.5 years of age) slaughtered very recently at a slaughterhouse. Rumen fluid was then stirred and subjected to carbon dioxide, filtered using two layers of cheese cloths and was put into a thermal container at 39°C with 2 handful (approx. 100 g) rumen solid content. The thermal container was transported to the laboratory within 15-20 min. Determining *in vitro* true digestibilities (IVTD) of samples using Ankom Daisy incubator (filter bag system) according to the procedures reported by Van Soest *et al.*[7] and Ankom[9]. Daisy incubator device contains a 4-cylinder jar which each cylinder jar to be filled with 1600 mL of buffer solution and 400 mL rumen content as inoculums and F57 bag filters. The jars were carbonated using carbon dioxide immediately before sealing them. After 48 h and 96 h incubations, F57 filter bags were cleaned under a stream of water and then they were dried. Then, the bags were analysed for neutral detergent fibre digestibility. *In vitro* true digestibilities of samples were estimated as follows Ankom[9]:

$$\textit{In vitro} \text{ true digestibility (IVTD) (\%)} = 100-\frac{\text{W3-(W1}\times\text{C1)}}{\text{W2}}\times 100$$

Where:
W1 = Weight of filter bag
W2 = Weight of sample
W3 = Final weight after NDF analysis
C1 = Empty bag which was used for correction purposes

Determining relative feed values of samples: The relative feed value (RFV) of hazelnut husk samples were calculated as follows Rohweder *et al.*[10]:

$$\text{DMI = Dry matter intake (Live weight = LW \%) = 120/(NDF \%)}$$

$$\text{DMD = Dry matter digestibility (\%) = 88.9-(0.779}\times\text{ADF \%)}$$

$$\text{RFV = Relative feed value = (DMD}\times\text{DMI)/1.29}$$

According to the Quality Grading Standard issued by the Hay Marketing Task Force of the American Forage and Grassland Council, the RFV assessed as roughage based on the score as follows: (prime)>51, 1 (premium) 151-125, 2 (good) 124-103, 3 (fair) 102-87, 4 (poor) 86-75, 5 (reject)<75.

Statistical analysis: The data obtained from the experiments were analysed in accordance with a completely randomized analysis design. SPSS 20.0 (Ondokuz Mayis University licensed programme, Samsun-Turkey) software package was used in the statistical analyses of the findings. Duncan's multiple range test was used for the comparison of mean values for $p<0.05$ level.

RESULTS AND DISCUSSION

Nutrient content of pelleted hazelnut husks: No previous study focusing on the determination of feed value of hazelnut husks was found, therefore, straws, hay, hulls of some plants which have close nutrient value to hazelnut shell were used in the comparison of the study findings. Table 1 shows the effect of additive use with hazelnut husk pellets on their nutrition content and the nutrients available in the cell wall. According to the results obtained from the experiments, sepiolite does not have an effect on the DM content of HH in SHH-M groups. However, it was found that DM content of SHH-C groups was increased, while it was decreased in SHH-Ct and SHH-UM groups ($p<0.001$). Moreover, among all the treatments used in this study, the highest DM content was found in SHH-C groups, while the lowest DM content was found in SHH-Ct group ($p<0.001$).

In terms of crude protein (CP) content, sepiolite addition led to a decrease in SHH-M and SHH-C groups ($p<0.001$) and the highest CP content was found in the group using the addition of urea, as expected. Indeed, although urea is a non-protein nitrogen (NPN), it increases the N content of the mixture improving the CP content. This is a great advantage when it comes to ruminant nutrition. NPN is consumed by rumen microorganisms and it is utilized in stockbreeding. It was reported that silages with fresh sugar beet pulp, molasses (5%), or wheat (4%) increases the CP content[11]; while another study reported that the addition of 5% molasses and 1% and 0.5% urea to corn stalk and cob haylages increases the CP content[12]. Nevertheless, it was observed that HH-Ct and SHH-Ct offer values close to that of corn in terms of their CP content. At this point, it will be fair to say that HH has a great potential in livestock nutrition. Kilic[13] reported that the CP content of HH in its natural form is at 5.46% DM, while the same was found in this study at 9.32% DM. This inconsistency may be accounted for by factors such as the species of hazelnut husk used, composition of the soil, fertilizing practices, harvest time, etc.[13]. Indeed, a number of studies showed that the addition of urea to a number of forage sources significantly increases the CP content of the forage[14-17].

In hazelnut husks, the highest ether extracts (EE) were obtained from HH-UM ($p<0.01$), while the other groups did not show any statistically significant difference. Denek *et al.*[14], Abdi[17], Sehu *et al.*[18] and Gulecyuz[19] reported EE contents ranging between 0.29 and 1.45% for hay; EE content of HH as found in this study was in this range.

In terms of crude fiber (CF) content, the highest values were obtained from HH-Ct and HH-M, while the lowest values were obtained from HH-UM groups ($p<0.05$). CF content, i.e. the fibrous components, was decreased in proportion to the amount of urea added, which led to the consideration of a possible contribution of urea to fiber disintegration. Indeed, it

Table 1: Effects of additives added to hazelnut husk pellets on the nutrient content and cell wall fiber components (Dry matter,%)

Treatments	DM*	Ash	CP	EE	CF	NFE	NDF	ADF	ADL	HCel	Cel
Without sepiolite											
HH-Ct	87.52 ± 0.14^{e}	7.76 ± 0.06	9.32 ± 0.06^{c}	0.84 ± 0.03^{b}	39.58 ± 1.00^{a}	42.51 ± 1.03^{d}	70.98 ± 1.13	56.92 ± 0.75	28.78 ± 2.15	14.07 ± 0.65	28.13 ± 2.31
HH-M	88.53 ± 0.08^{c}	8.30 ± 0.20	10.44 ± 0.09^{b}	1.13 ± 0.13^{b}	36.55 ± 1.67^{ab}	43.58 ± 1.58^{cd}	65.31 ± 0.90	52.72 ± 0.93	24.30 ± 1.24	12.59 ± 0.09	28.42 ± 1.72
HH-UM	88.54 ± 0.05^{c}	8.16 ± 0.10	16.89 ± 0.15^{a}	1.62 ± 0.24^{a}	30.49 ± 0.12^{c}	42.84 ± 0.58^{d}	63.41 ± 1.44	50.97 ± 1.47	27.70 ± 2.04	12.44 ± 0.64	23.27 ± 2.67
HH-C	88.81 ± 0.03^{b}	6.81 ± 0.11	9.36 ± 0.05^{c}	0.99 ± 0.17^{b}	33.03 ± 1.10^{bc}	49.81 ± 1.08^{a}	59.32 ± 0.71	47.42 ± 0.15	23.22 ± 0.88	11.90 ± 0.72	24.20 ± 0.81
With sepiolite											
SHH-Ct	87.08 ± 0.01^{f}	9.13 ± 0.23	9.11 ± 0.07^{cd}	1.05 ± 0.03^{b}	35.50 ± 1.31^{b}	45.22 ± 1.31^{bcd}	69.20 ± 0.49	55.96 ± 0.36	28.09 ± 0.83	13.24 ± 0.13	27.87 ± 0.83
SHH-M	88.65 ± 0.08^{bc}	9.39 ± 0.05	9.27 ± 0.12^{c}	0.78 ± 0.09^{b}	33.15 ± 1.77^{bc}	47.41 ± 1.96^{abc}	65.30 ± 0.54	52.43 ± 0.45	24.11 ± 0.91	12.87 ± 0.11	28.31 ± 0.62
SHH-UM	88.25 ± 0.03^{d}	9.44 ± 0.15	16.80 ± 0.18^{a}	0.84 ± 0.12^{b}	35.17 ± 0.72^{b}	37.75 ± 1.00^{e}	63.63 ± 0.08	50.86 ± 0.33	25.24 ± 0.31	12.76 ± 0.28	25.62 ± 0.42
SHH-C	89.45 ± 0.08^{a}	7.93 ± 0.07	8.79 ± 0.09^{d}	1.10 ± 0.02^{b}	33.71 ± 1.67^{bc}	48.47 ± 1.55^{ab}	59.07 ± 1.15	47.04 ± 0.73	20.75 ± 0.58	12.03 ± 0.42	26.28 ± 0.53
Significant	<0.001	0.716	<0.001	<0.005	<0.012	<0.015	0.69	0.949	0.735	0.559	0.727

HH-Ct: Hazelnut husk control, HH-M: Hazelnut husk+molasses, HH-UM: Hazelnut husk+urea+molasses, HH-C: Hazelnut husk+corn, SHH-Ct: Hazelnut husk control with sepiolite, SHH-M: Hazelnut husk+molasses with sepiolite, SHH-UM: Hazelnut husk+urea+molasses with sepiolite, SHH-C: Hazelnut husk+corn with sepiolite. DM: dry matter, CP: Crude protein, EE: Ether extracts, CF: Crude fibre, NFE: Nitrogen free extracts, NDF: Neutral detergent fibre, ADF: Acid detergent fibre, ADL: Acid detergent lignin, HCel: Hemicellulose, Cel: Cellulose, *As natural form, p<0.001, $^{a-e}$Means with different supercripts in the same column are significantly different

was reported that the addition of urea to pomegranate pulp decreases acid detergent fiber (ADF), neutral detergent fiber (NDF), acid detergent lignin (ADL) and water-soluble carbohydrates content (p<0.01)[16]. In addition, it is known that urea addition increases the disintegration of NDF, ADF and HCel[15].

No statistically significant difference was found from the treatments of the hazelnut husks in terms of their ash, NDF, ADF, ADL, HCel and Cel content. However, numerically, the highest number of cell wall fiber components was found in HH-Ct groups subjected to no additives, as expected. This may be resulted from the fact that fibrous content of HH is higher than that of the additives. NDF content of wheat straw was reported in a number of studies[17-22] in a range between 56.0 and 85.1% and that this range was generally consistent with the NDF content found for HH in this study, with some exceptions. These exceptions are believed to be accounted for by many factors such as the species of hazelnut used, the composition of the soil, fertilizing practices, harvest time, etc[23].

The CP content of hazelnut husks was higher than that (2.93-4.63%) reported for wheat straw by Abdi[17], Sehu *et al.*[18] and Gulecyuz[19] and was higher than the CP content (3.65%) reported for corn straw and cob by Avci *et al.*[12]. Nevertheless, it was also found that the CP content findings of this study for HH were higher than the CP content reported for rice straw (4.64%) and barley straw (5.92%) by Sehu *et al.*[18]. Moreover, the CP content found in this study was in agreement with the results that reported for lentil straw (7.81%) and grass hay (10.54%) by Denek *et al.*[14] and that reported for grass hay (7.59%) by Deniz *et al.*[24]. Accordingly, it can be said that HH offers a higher forage value when compared to hay in terms of their CP content. It is observed that HH has the CP content to be used as a replacement of hay in livestock nutrition and it can be used conveniently without the need for additives.

Forage value and *in vitro* true digestibilities of hazelnut husk pellets: Table 2 shows the *in vitro* true digestibilities (DM%) and forage quality categories of the pellets containing hazelnut husks as defined by their RFV content. According to the Table 2, it was observed that the forage quality of HH improves with the addition of corn; while all the groups in question proved to have a generally lower forage quality. No statistically significant difference was found in this study in terms of treatments involving DMD, DMI and RFV (p>0.05). DMD content of wheat straw was reported by Abdi[17], Sehu *et al.*[18], Gulecyuz[19], Stanton and LeValley[20], Fluhart[21] and Hassan *et al.*[22] to be in the range between 22.7 and 51.87%. Accordingly, the DMD value found in this study was also in the range reported for wheat straw[24], however, it was lower than

Table 2: Effects of additive use in HH on forage quality and IVTD (as DM, %)

Treatments	DMD (%)	DMI (% LW)	RFV	RFV quality	IVTD-48 (%)	IVTD-96 (%)
Without sepiolite						
HH-Ct	44.56±0.58	1.69±0.03	58.45±1.60	5 -Reject	37.90±0.03[e]	41.23±0.42[d]
HH-M	47.83±0.73	1.84±0.02	68.18±1.95	5 -Reject	38.92±0.11[de]	41.36±0.57[cd]
HH-UM	49.19±1.15	1.89±0.04	72.31±3.25	5 -Reject	40.56±0.19[c]	43.68±0.87[b]
HH-C	51.96±0.11	2.02±0.02	81.50±1.00	4 -Poor	44.11±0.11[b]	48.42±0.53[a]
With sepiolite						
SHH-Ct	45.31±0.28	1.73±0.01	60.91±0.80	5 -Reject	34.74±0.76[f]	36.71±0.04[e]
SHH-M	48.06±0.35	1.84±0.02	68.48±1.07	5 -Reject	40.27±0.62[cd]	43.38±0.57[b]
SHH-UM	49.28±0.26	1.89±0.00	72.05±0.44	5 -Reject	41.14±0.21[c]	43.26±1.19[bc]
SHH-C	52.26±0.57	2.03±0.04	82.40±2.50	4 -Poor	46.04±0.81[a]	48.79±0.04[a]
Significant	0.949	0.791	0.888		<0.001	<0.001

HH-Ct: Hazelnut husk control, HH-M: Hazelnut husk+molasses, HH-UM: Hazelnut husk+urea+molasses, HH-C: Hazelnut husk+corn, SHH-Ct: Hazelnut husk control with sepiolite, SHH-M: Hazelnut husk+molasses with sepiolite, SHH-UM: Hazelnut husk+urea+molasses with sepiolite, SHH-C: Hazelnut husk+corn with sepiolite. DMD: Dry matter digestibility, DMI: Dry matter intake, RFV: Relative feed value, IVTD-48: *In vitro* true digestibility for 48 h, IVTD-96: *In vitro* true digestibility for 96 h, p<0.001, [a-c]Means with different supercripts in the same column are significantly different

that of grass hay[24] and sorghum straw[25] (60.18, 53.5, respectively). The results show that the dry matter digestibility of HH is in agreement with that of the wheat straw.

Dry matter intake of HH was found to be 1.69% LW in this study. However, the same was reported in the range between 1.4 and 2.1% LW for wheat straw[17,20-22]. Accordingly, it can be said that HH offers similar DMI values (1.87% LW) when compared to wheat straw and grass hay[24]. Moreover, it should be taken note that forages with high NDF content consistently offer a lower DMI value which reduces the appetite of the animals for such feed.

It was found that HH offers values similar to wheat straw in terms of its relative feed value. Indeed, RFV of wheat straw was reported by Abdi[17], Sehu *et al.*[18], Gulecyuz[19], Stanton and LeValley[20], Fluhart[21] and Hassan *et al.*[22] in the range of 37.7-61.2%. In this study, RFV was found to be 58.45 for HH which is in agreement with the literature. Also, the ADF and NDF contents and RFV of HH were similar to that of wheat straw.

A significant effect was detected for the 48 and 96 h *in vitro* true digestibilities of hazelnut husk pellets when different additives were added (p<0.001). The highest digestibility value was obtained from SHH-C groups after 48 h of incubation process (p<0.001). The lowest IVTD value, on the other hand, was obtained from SHH-Ct group (p<0.001). It was observed that sepiolite addition only increased the IVTD in pellets with the addition of corn for 48 h incubation (p<0.001) and the addition of sepiolite decreased the ITVD in control group (p<0.001). There was no significant effect (p<0.05) of the addition of molasses and molasses+urea on ITVD for 48 h incubation. Corn improves the digestibility of HH, a low quality forage, thanks to its rich starch content; while the addition of sepiolite might be responsible for reduced IVTD as it decreases the OM content being an added mineral in the medium[23]. The highest digestibility value was obtained from SHH-C group pellets after 96 h incubation (p<0.001). The lowest IVTD value was found from SHH-Ct group. It was observed that the addition of sepiolite increased only the IVTD in SHH-M group pellets where the addition of molasses accompanied (p<0.001) and the addition of sepiolite decreased the ITVD in control group (p<0.001). There was no significant effect (p>0.05) on IVTD found in combination with urea+molasses and corn treatments for 96 h incubation.

IVTD reported for 48 h incubation of wheat straw (39.06) by Mohamoud Abdi[17] was in agreement with the IVTD found for HH in this study. The IVTD results of this study were higher than the results reported for soybean straw (46.06) and sorghum straw (49.02) by Abdi[17] and grape seeds (51.35) reported by Kilic and Abdi[26]. This value seems to vary depending on the factors affecting digestibility. Indeed, different cell wall nutrients, fiber contents, mineral matter contents and EE contents may affect digestibility[23].

Mohamoud Abdi[17] reported that the addition of molasses and urea+molasses to wheat, soybean and sorghum straws increases IVTD of hay. Similarly, it was found that the addition of urea+molasses increases IVTD when compared to that of the control group. However, the addition of molasses alone does not affect ITVD in any ways.

Effect of the addition of sepiolite on hazelnut husk pellets: Table 3 shows the effect of the addition of sepiolite to hazelnut husk pellets on their nutrient content; while Table 4 shows its effect on the forage quality (DMD, DMI and RFV) and *in vitro* true digestibilities.

The effect of the addition of sepiolite was insignificant among HH treatments in terms of CF, NFE, NDF, ADF, ADL, HCel and Cel contents (p>0.05) in Table 3. However, significant

Table 3: Effects of addition of sepiolite to HH pellets on their nutrition content

Sepiolite	Ash	CP	EE	CF	NFE	NDF	ADF	ADL	HCel	Cel
Without sepiolite	7.76±0.18	11.50±0.95	1.15±0.11	34.91±1.14	44.68±1.02	64.76±1.35	52.01±1.11	26.00±0.99	12.75±0.35	26.01±1.10
With sepiolite	8.97±0.19	10.99±1.01	0.94±0.05	34.38±0.68	44.71±1.42	64.30±1.13	51.57±0.99	24.55±0.85	12.73±0.18	27.02±0.43
Significant	<0.001	<0.001	<0.038	0.567	0.975	0.483	0.427	0.128	0.945	0.347

DM: Dry matter, CP: Crude protein, EE: Ether extracts, CF: Crude fibre, NFE: Nitrogen free extracts, NDF: Neutral detergent fiber, ADF: Acid detergent fiber, ADL: Acid detergent lignin, HCel: Hemicellulose, Cel: Cellulose, p<0.001

Table 4: Effect of addition of sepiolite to hazelnut husk pellets on their forage quality and IVTD (DM %)

Sepiolite	DMD (%)	DMI (% LW)	RFV	IVTD-48	IVTD-96
Without sepiolite	48.39±0.86	1.86±0.04	70.11±2.66	40.37±0.71	43.67±0.92
With sepiolite	48.73±0.77	1.87±0.03	70.96±2.41	40.55±1.24	43.03±1.32
Significant	0.427	0.569	0.515	0.605	0.175

DMD: Dry matter digestibility, DMI: Dry matter intake, RFV: Relative feed value, IVTD-48: *In vitro* true digestibility for 48 h, IVTD-96: *In vitro* true digestibility for 96 h, p<0.001

Table 5: Effects of treatments conducted on hazelnut husk pellets on their nutrition content (DM %)

Treatments	Ash	CP	EE	CF	NFE	NDF	ADF	ADL	HCel	Cel
Control	8.44±0.32[b]	9.21±0.06[c]	0.95±0.05	37.54±1.17[a]	43.86±0.96[b]	70.09±0.68[a]	56.44±0.43[a]	28.44±1.04[a]	13.66±0.35[a]	28.00±1.10[a]
Molasses	8.84±0.26[a]	9.85±0.27[b]	0.96±0.11	34.85±1.33[ab]	45.50±1.42[b]	65.30±0.47[b]	52.57±0.47[b]	24.21±0.69[bc]	12.73±0.09[ab]	28.37±0.82[a]
Ureae+molasses	8.80±0.30[a]	16.84±0.11[a]	1.23±0.21	32.83±1.10[b]	40.29±1.25[c]	63.52±0.64[b]	50.92±0.67[c]	26.47±1.08[ab]	12.60±0.32[b]	24.44±1.32[b]
Corn	7.37±0.26[c]	9.07±0.14[c]	1.05±0.08	33.37±0.91[b]	49.14±0.90[a]	59.19±0.61[c]	47.23±0.35[d]	21.98±0.73[d]	11.96±0.37[b]	25.24±0,63[ab]
Significant	<0.001	<0.001	0.126	<0.009	<0.001	<0.001	<0.001	<0.001	<0.015	<0.040

DM: Dry matter, CP: Crude protein, EE: Ether extracts, CF: Crude fibre, NFE: Nitrogen free extracts, NDF: Neutral detergent fibre, ADF: Acid detergent fibre, ADL: Acid detergent lignin, HCel: Hemicellulose, Cel: Cellulose, p<0.001, [a-d]Means with different supercripts in the same column are significantly different

Table 6: Effect of treatments conducted on hazelnut husk pellets on their forage quality and *in vitro* true digestibilities (DM %)

Treatments	DMD (%)	DMI (% CA)	RFV	RFV quality	IVTD-48	IVTD-96
Control	44.93±0.33[d]	1.71±0.02[c]	59.68±0.97[d]	5-Reject	36.32±0.78[d]	38.97±1.03[c]
Molasses	47.94±0.36[c]	1.84±0.01[b]	68.33±1.00[c]	5-Reject	39.59±0.41[c]	42.37±0.58[b]
Urea+molasses	49.24±0.53[b]	1.89±0.02[b]	72.18±1.47[b]	5-Reject	40.85±0.18[b]	43.47±0.66[b]
Corn	52.11±0.27[a]	2.03±0.02[a]	81.95±1.22[a]	4-Poor	45.07±0.56[a]	48.61±0.25[a]
Significant	<0.001	<0.001	<0.001		<0.001	<0.001

DMD: Dry matter digestibility, DMI: Dry matter intake, RFV: Relative feed value, IVTD-48: *In vitro* true digestibility for 48 h, IVTD-96: *In vitro* true digestibility for 96 h, p<0.001, [a-d]Means with different supercripts in the same column are significantly different

effects of the addition of sepiolite to HH were found in terms of ash and CP (p<0.001) and EE (p<0.05). The addition of sepiolite decreases the CP and EE content in HH treatments, while at the same time increasing the ash content. This can be explained by the fact that sepiolite is a clay mineral which naturally increases the ash content.

An overall evaluation of all the treatments showed that the addition of sepiolite to the pellets has no statistically significant effect on the DDM, DMI, RFV and IVTD. For this reason the addition of sepiolite had no influence on NDF and ADF contents of the samples. Gulecyuz[19] reported reduced methane production with regards to the addition of sepiolite to wheat straw pellets; additionally, the use of sepioliteis believed to be advantageous for stockbreeding as it improves the pelleting quality.

Table 5 shows the effect of treatments performed on hazelnut husk pellets on their nutrient content. And Table 6 shows their effects on the forage quality and *in vitro* true digestibilities.

Significant differences were found in this study among treatments performed with regards to nutrient contents of ash, CP, NFE, NDF, ADF and ADL (p<0.001) and CF, HCel and CEL (p<0.05). Nevertheless, there was no significant difference between treatments with respect to EE content (p>0.05). As expected, the addition of urea+molasses gave the highest CP values, on the other hand, the lowest CP values were obtained from the addition of corn and from the control groups. Indeed, corn is low on CP content, while urea is an additive rich in nitrogen. Control groups gave the highest values in terms of cell wall nutrients. Accordingly, it is recommended to use HH, a high-fiber feed, in stockbreeding only after enriching it with additive with low fiber content.

In Table 6, an overall evaluation of the results obtained from all treatments showed that groups treated with corn offer the highest forage quality (DMD, DMI and RFV), while control group offers the lowest forage quality (p<0.001). In terms of their digestibilities, a significant difference (p<0.001) was found between treatments with incubation time of 48 and 96 h. Accordingly, the highest IVTD values were observed from groups with the addition of corn, while the lowest IVTD values were found from the control groups (p<0.001). It was observed that all the additives increase digestibility of HH and corn was the additive giving the best results among the others.

The CP content of HH, an alternative forage source, was found in the range of 8.79-16.89% DM and it can be said that HH, in its natural form, offers better nutrition values when compared to hay. According to the forage quality analysis, all the treatments were listed under the lowest quality category. The addition of corn, on the other hand, was found to partially improve the forage quality of HH. Accordingly, it is recommended to focus on the addition of corn during hazelnut husk pelleting. The addition of sepiolite to pellets further increased the IVTD value after 48 h incubation of HH pellets with the addition of corn. In this context, it was concluded that the addition of corn is suitable for HH pelleting in order to increase IVTD.

CONCLUSION

The effects of pelleting of hazelnut husk with different additives on feed quality, digestibility and nutrient content were investigated and the opportunities it offers in terms of closing the gaps in roughage were analysed. It was observed that different treatments had a significant effect on the CP content of pellets and that the addition of urea and molasses significantly increased the CP content. In terms of IVTD, groups prepared with the addition of corn proved to offer the highest values for HH. In conclusion, it is believed that HH pellets must be considered as one of the main forage sources in stockbreeding. It should be noted that the best results are obtained using at least two forage sources in combination. Moreover, it is recommended also to draw attention to tannin and phenolic compounds if HH is used in ruminant feed.

SIGNIFICANCE STATEMENT

This study discovers the forage quality and potential feed value of hazelnut husks pelleted with addition of some additives. The study will help the farmers to meet the forage need in ruminant nutrition and will be benefical for future research on *in vivo* studies.

REFERENCES

1. Ozenc, N., 2004. Effects on product quality and soil traits at hazelnut-grown soils of hazelnut husks and other organic materials. Ph.D. Thesis, Ankara University, Science Institute, Ankara, Turkey.
2. Karadeniz, T., S.Z. Bostan, C. Tuncer and C. Tarakcioglu, 2008. Hazelnut cultivation. Scientific Publication Series No. 1, Ordu, Turkey, pp: 154.
3. Ozen, N. and N. Ocak, 2009. Usage of hazelnut by-products in animal nutrition. Proceedings of the 5th National Animal Nutrition Congress, September 30-October 3, 2009, Corlu, Tekirdag, Turkey.
4. Kilic, U. and E. Gulecyuz, 2017. Effects of some additives on *in vitro* true digestibility of wheat and soybean straw pellets. Open Life Sci., 12: 206-213.
5. Bernal, M.P. and J.M. Lopez-Real, 1993. Natural zeolites and sepiolite as ammonium and ammonia adsorbent materials. Bioresour. Technol., 43: 27-33.
6. AOAC., 1998. Officinal Methods of Analysis. 16th Edn., Association of Official Analytical Chemists International, Gaithersburg, MD., USA.
7. Van Soest, P.J., J.B. Robertson and B.A. Lewis, 1991. Methods for dietary fiber, neutral detergent fiber and nonstarch polysaccharides in relation to animal nutrition. J. Dairy Sci., 74: 3583-3597.
8. AOCS., 2005. Approved procedure Am 5-04, rapid determinationof oil/Fat utilizing high temperature solvent extraction. American Oil Chemists Society, Urbana, IL.
9. Ankom, 2002. Operator's manual Ankom 200/220 fiber analyzer. Ankom Technology Corporation, Fairport.
10. Rohweder, D.A., R.F. Barnes and N. Jorgensen, 1978. Proposed hay grading standards based on laboratory analyses for evaluating quality. J. Anim. Sci., 47: 747-759.
11. Avci, M., S. Deniz and H. Akdeniz, 2005. Evaluation of silage quality of wet sugar beet pulp prepared with different additives. Selcuk Univ. J. Vet. Sci., 21: 39-45.
12. Avci, M., O. Kaplan and N. Denek, 2013. Determination of corn stover haylage quality prepared by various additives. J. Vet. Fac. Harran Univ., 2: 32-35.
13. Kilic, U., 2005. Determination of some fermentation products and energy contents of some feedstuffs using *in vitro* gas production technique. Ph.D. Thesis, Ondokuz Mayıs University, Science Institute, Samsun, Turkey.
14. Denek, N., A. Can and S. Tufenk, 2004. Effects of addition of different additives on *in vitro* dry matter digestibilities and silage quality to maize, sorghum and sunflower stalks. J. Agric. Fac. Harran Univ., 8: 1-10.
15. Filya, I., E. Sucu and H. Hanoglu, 2004. Effects of urea application on the silage fermentation, aerobic stability ruminal degradability and fattening performance of lambs. J. Agric. Sci., 10: 258-262.
16. Canbolat, O., A. Kamalak and H. Kara, 2014. The effects of urea supplementation on pomegranate pulp (*Punica granatum* L.) silage fermentation, aerobic stability and *in vitro* gas production. Ankara Univ. J. Vet. Fac., 61: 217-223.
17. Abdi, A.M., 2016. Effect of lignin peroxidase enzyme on feed values of different straws. M.Sc. Thesis, Ondokuz Mayis University, Science Enstitute, Samsun, Turkey.

18. Sehu, A., S. Yalcin, A.G. Onol and D. Kocak, 1998. Prediction of dry matter intake and live weight gain in lambs by some characteristics of roughages. Turk. J. Vet. Anim. Sci., 22: 475-483.
19. Gulecyuz, E., 2016. Determining *in vitro* digestibility and methane production of wheat straw and soybean straw pelleted with different additives. M.Sc. Thesis, Ondokuz Mayis University, Science Enstitute, Samsun, Turkey.
20. Stanton, T.L. and S. LeValley, 2006. Feed composition for cattle and sheep. Colorado State University Cooperative Extension, USA.
21. Fluharty, F.L., 2009. Protein and energy supplementation of crop residues for breeding cattle. Ohio Beef Cattle Letter, OSU Extension Services, Ohio.
22. Hassan, Z., M. Nisa, M.A. Shahzad and M. Sarwar, 2011. Replacing concentrate with wheat straw treated with urea molasses and ensiled with manure: Effects on ruminal characteristics, *in situ* digestion kinetics and nitrogen metabolism of Nili-Ravi buffalo bulls. Asian-Aust. J. Anim. Sci., 24: 1092-1099.
23. Kutlu, H.R. and L. Celik, 2014. Feeds knowledge and feed technology. Cukurova University, Agricultural Faculty, General Publish Number: 266, Lesson Books. Adana,Turkey.
24. Deniz, S., N. Denek, M.A. Karsli, H. Yumak and H. Nursoy, 2000. Effects of grinding forages with different type grinder on chemical composition, intake and digestibilities of forage. J. Yuzuncu Yil Univ. Vet. Fac., 11: 82-86.
25. Jonathan, S.G., A.N. Okorie, E.O. Garuba and O.J. Babayemi, 2012. Bioconversion of sorghum stalk and rice straw into value added ruminant feed using *Pleurotus pulmonarius*. Nat. Sci., 10: 10-16.
26. Kilic, U. and A.M. Abdi, 2016. Determination of *in vitro* true digestibilities and relative feed values of wine industry grape residues as alternative feed source. J. Fac. Vet. Med. Kafkas Univ., 22: 895-901.