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Effects of Fulvic Acid on Ensiling Properties of Alfalfa (*Medicago Sativa* L.)

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Abstract

Many silage additives have been developed for use in silage fermentation. This research was carried out to determine the effects of organic liquid based fulvic acid which derive from Isparta Keçiborlu district, on the silage characteristics and the effects on the nutrient contents of the alfalfa silage ensiling to laboratory conditions. Fulvic acid based organic liquid was applied at 0 % (control), 0,25 %, 0,50 %, 1 % levels to fresh alfalfa which dry matter content is 21 %. Fresh materials were ensiled as three repeat in 5 kg anaerobic jars. In this research, nutrition value of alfalfa silage with fulvic acid was determined after ensiling. ME and NEL contents were calculated on nutrient contents in alfalfa silages. Adding of fulvic acid based organic liquid was determined there is statistically not significant on chemical composition, energy values and quality properties in silages but pH value was decreasing 5.20 to 4.82 and Flieg point was increasing 36.82 to 52.73 depending on pH. According to our result 1 % fulvic acid is an useful material for silage and can be ensiled successfully with alfalfa.

Key words: Alfalfa, silage, fulvic acid

Fulvik Asitin Yoncanın (*Medicago Sativa* L.) Silolanma Özelliklerine Etkisi

Özet

Silaj fermantasyonunda kullanılmak üzere çok sayıda katkı maddesi geliştirilmiştir. Bu araştırma Isparta Keçiborlu ilçesinden elde edilen fulvik asit içeriğine dayalı organik sıvının, laboratuar koşullarında yapılan yonca (*Medicago sativa*) silajlarının silolanma özelliklerine ve besin madde içeriğine etkisini belirlemek amacıyla yapılmıştır. Fulvik asit temeline dayalı organik sıvı (Bionur FATDOA), % 30-35 kuru madde içeren doğal haldeki silajlık yoncaya yüzde cinsinden % 0 (kontrol grubu), % 0.25, % 0.50, % 1 oranında olacak şekilde katıldıktan sonra üçer paralel şeklinde 5 kg'lık cam kavanozlara hava almayacak şekilde silolanmıştır. Araştırmada, fulvik asitle belli miktarda karıştırılmış olan silajlık yoncanın ham besin madde içerikleri silolama öncesi ve silolama sonrası olarak belirlenmiştir. Silo yemlerinin ME ve NEL içerikleri ham besin maddeleri üzerinden hesaplanmıştır. Fulvik asit temeline dayalı organik bir sıvının yonca silajlarına ilavesinin HP, HY, HS, NÖM içerikleri ve ME, NEL değerleri üzerine istatistiksel olarak etkili olduğu belirlenmiştir ($P < 0.05$). Elde edilen sonuçlara göre % 1 oranında fulvik asitin yonca silajı yapımında başarılı bir şekilde kullanılabileceği sonucuna varılmıştır.

Anahtar Kelimeler: Yonca, silaj, fulvik asit

INTRODUCTION

Turkey has an important potential in terms of the number of cattle and small ruminants. But, insufficient production of quality forages at first, and high feed prices are the basic problems of livestock in Turkey. There are 14.4 cattle and 38.5 million small ruminants correspondingly to 15.4 million animal units [1]. However Turkey has a problem with quality forage production and also feed prices are high. Consequently number of the animals there is currently need 78.7 million tons of quality forage for the healthy and economical production for these animals but quality forage production is 50.6 million tons in Turkey. Therefore, we have 28.10 million tons of deficient amounts [2]. This situation makes the forage production in Turkey is even more important. Because forages play such an important role in providing optimum conditions for ruminal fermentation and production. One of the most problems for the development of animal husbandry is to meet quality, cheap and abundant forage needs. Perennial legumes have important role in providing cheap forages of high nutritive value and digestibility. Alfalfa is one of the most important legume forages of the world due to its nutritional quality, high yields and high adaptability. Especially, alfalfa hay and corn silage are the most widely used forage crops in animal nutrition in developed countries the main livestock countries. Alfalfa is major source of protein for livestock as it is a basic component in rations for dairy cattle, beef cattle, sheep, goats and other classes of domestic animals [3].

Forage crops have high concentrations of water-soluble carbohydrates are widely used as a silage such as maize. Legumes have been known as difficult to ensile because of their low sugar content and high buffering capacity [4]. For these reason legumes are widely used as a forage. Alfalfa is primarily harvested as hay and silage use is limited except the areas where rainfall is abundant and there is no opportunity for drying [5].

Legume's silage use is limited because higher protein and lower carbohydrate content [3]. Since silage quality of legumes is poor additive material is used to control fermentation in silage [6, 7]. Additive materials are classified into two groups according to effect mechanism, structure and uses area [4, 8]. These classification groups are i) suppressing the activity of microorganism, ii) supporting the activity of lactic acid.

Recently additives based on organic acid have been widely used in order to aerobic stability in silage. They lead to decrease silage pH quickly and prevent to develop microbial population which is causing microbial deterioration such as yeast, fungus, enterobacteria and clostridia [9]. Accordingly, additives have developed aerobic stability in silage [10, 11, 12, 13]. Also it prevent to heating and proteolisis in silage [4, 14]. It was reported by various studies that that dry matter and pH value, as well as physical properties such as; colour, smell and structure are important for determination of the silage evaluation in terms of quality [15, 16, 17, 18].

The aim of this study was to determine the effects of fulvic acid on ensiling characteristics, chemical composition on alfalfa silage which is difficult to ensile.

MATERIAL AND METHODS

In this research, Alfalfa that was grown in Suleyman Demirel University Research Center and harvested with 21 % dry matter content. Fulvic acid is an organic acid naturally occurs in Isparta region. This organic acid has 2.2 pH and it contains 30 % of fulvic acid and rest are; organic and mineral matters, organic acids, amino acids, vitamins, microorganism. It is very complex and electrolyte liquid. It has 1.2*106 bacteria and 98 % dissolved organic carbon in 1 ml.

Alfalfa was harvested at beginning of flowering period at 21 % dry matter content in September 2011. The grass was cut at a length of 2-3 cm using a mechanical forage cutter. Alfalfa and fulvic acids were ensiled in four different groups were; 1) control, 2) 0.25 % fulvic acid, 3) 0.50 % fulvic acid, 4) 1.00 % fulvic acid. Mixed materials were placed in four plastic jars and each group was prepared with three replications. All of jars were closed carefully. The jars opened after a fermentation of 75 days and silages were analyzed for physical and chemical properties. Crude nutrients were determined by Weende method [19], Lepper method [20], The pH value of silages were measured by electronical pH meter were evaluated by silage evaluation scale DLG [17] and Flieg points [21]. ME [22] and NEL [23] content were calculated with regression equation using crude fiber parameter.

Energy values were calculated following formulas;

ME, kcal/kg OM =

3260+(0,455*CP)+(3,517*EE)-(4,037*CF)*

*(CP, EE and CF are g/kg OM)

NEL (Mj/kg KM) = 8.69 – 0.110 * CF

Additionally, Flieg scored were determined with using following formulas [24];

Flieg score = 220 + (2*DM % - 15) – 40 * pH

One-way analysis of variance with Duncan's multiple range test [25] were utilized in the statistical analysis.

RESULTS

Chemical composition of alfalfa silage groups were presented on Table 1.

As can be seen from the Table 1, dry matter contents of silage groups varies between 18.39-20.20 %. Organic matter contents of silage groups varies between 79.92-80.13 % and also crude ash content varies between 12.03-12.51 %. The highest crude protein level was determined in Alfalfa silage+0.50 % fulvic acid as 24.40 %. Ether extract, crude cellulose, nitrogen free extract varies between 1.84-2.57 %, 22.48-23.64 %, 12.03-12.51 % in all silage groups, respectively.

Average in vitro energy values of alfalfa silages were presented on Table 2.

As can be seen from the Table 2, Metabolisable Energy and Net Energy Lactation were found between 9.59-9.74 %, 6.09-6.22 % in all silage groups, respectively. According to Metabolisable Energy and Net Energy Lactation values of alfalfa silage+ 1% fulvic acid group showed relatively increasing values compare to alfalfa silage (control) group but this is statistically not significant. Quality evaluation of alfalfa silages groups were presented on Table 3.

As can be seen from the Table 3 the lowest and highest values of pH were determined in alfalfa silage+1 % fulvic acid as 4.82 and alfalfa silage as 5.20, respectively. The lowest and highest scores of Flieg were determined in alfalfa silage as 36.82 and alfalfa silage+1 % fulvic acid as 52.73, respectively. Alfalfa silage was accepted in 'Moderate' and all other silages groups were accepted in 'Satisfactory' quality classes.

Table 1. Chemical composition of silage groups

	% of DM		Dry matter basis, %				
Silage Groups	**Wet basis**	**Organic matter**	**Crude protein**	**Ether extract**	**Crude cellulose**	**Nitrogen free extract**	**Crude ash**
Alfalfa Silage (control)	19.98^{ab}	80.08^{a}	22.10^{ab}	2.48^{ab}	23.12^{ab}	32.38^{ab}	12.15^{a}
Alfalfa Silage + 0.25 % fulvic acid	19.15^{b}	80.00^{a}	21.50^{ab}	2.57^{a}	23.64^{a}	32.29^{ab}	12.22^{a}
Alfalfa Silage + 0.50 % fulvic acid	18.39^{b}	80.13^{a}	24.40^{a}	1.84^{c}	23.52^{a}	30.36^{b}	12.03^{a}
Alfalfa Silage + 0.1 % fulvic acid	20.20^{ab}	79.92^{a}	20.36^{b}	2.05^{bc}	22.48^{b}	35.03^{a}	12.51^{a}

*a, b, c, d, e, The differences between are significant statistically (P < 0.05).

Table 2. Energy values of silage groups

	% of DM	Dry matter basis, %	
Silage Groups	**Wet basis**	**Metabolisable energy MJ/kg**	**Net Energy Lactation, MJ/kg**
Alfalfa Silage (control)	19.98^{ab}	9.7^{a}	6.15^{ab}
Alfalfa Silage + 0.25 % fulvic acid	19.15^{b}	9.62^{a}	6.09^{b}
Alfalfa Silage + 0.50 % fulvic acid	18.39^{b}	9.59^{a}	6.10^{b}
Alfalfa Silage + 0.1 % fulvic acid	20.20^{ab}	9.74^{a}	6.22^{a}

Table 3. Quality evaluation of silage groups

	Physical characteristics								
Silage groups	**Wet basis, % of DM**	**pH**	**Smell (0-14)**	**Structure (0-4)**	**Colour (0-2)**	**DLG point***	**DLG Quality**	**Flieg score**	**Flieg** Quality**
Alfalfa Silage (control)	19.98	5.20	14	4	2	20	Excellent	36.82	Moderate
Alfalfa Silage + 0.25 % fulvic acid	19.15	5.02	14	4	2	20	Excellent	42.51	satisfactory
Alfalfa Silage + 0.50 % fulvic acid	18.39	4.95	14	4	2	20	Excellent	43.65	satisfactory
Alfalfa Silage + 0.1 % fulvic acid	20.20	4.82	14	4	2	20	Excellent	52.73	satisfactory

*DLG scores(20-18:Excellent, 17-14:Satisfactory, 13-10:Modarete, 9-5:Bad, 4-0:Very Bad)
**Fileg scores (20-0:Bad, 21-40:Moderate, 41-60:Satisfactory, 61-80:Good, 81-100:Excellent)

As understood from Table 2 hand evaluation of smell, structure and colour parameters weren't showed differences. It is notified adding of fulvic acid to alfalfa didn't cause to the variation on smell, structure and colour. DLG points were scored with 20 points in all groups.

DISCUSSION

This study was carried out to determine the effects of fulvic acid on ensiling characteristics and feed value of alfalfa as well as physical properties criteria were investigated such as pH value, smell, colour and structure under laboratory conditions.

Alfalfa was harvested at optimum time which was the beginning of flowering at 21.33 % dry matter content. Alfalfa can be difficult to ensile because of low dry matter and sugar content and high buffering capacity, as compared to corn or other grass [26].

Plant maturation period is an effective on dry matter content. Additives should be used in alfalfa silages which dry matter content is below 35-40 % [14]. Although a liquid material of fulvic acid didn't affect the dry matter of alfalfa silages.

Alfalfa silages were evaluated in terms of chemical composition dry matter, organic matter, crude protein, ether extract, crude ash and nitrogen free extract. In respect to these values were observed similar results in all silages groups. It was concluded that fulvic acid can be used for ensiling, smoothly.

The pH values of alfalfa silage decreases by addition of fulvic acid to alfalfa silage at different levels but this is statistically not significant. Adding the fulvic acid increases the acidity of silage. The pH values in a good silage must be between 3.90-4.60 or at least below 5.00 [27]. It was reported that 4.10 – 4.30 pH values for alfalfa-corn mixed silage which is higher than our pH values [28] and 5.22-5.33 pH for *Trifolium Repens*-barley mixed silage which is lower than our values [29]. Also, were reported that 4.76 pH for corn silage and 7.06 pH for alfalfa-corn silage with urea [30]. It was reported that 4.52 pH for alfalfa silage at 21.4 % dry matter content and 4.35 % pH for alfalfa silage at 21.4 % dry matter content [31]. It was reported that pH values were changed from 3.6 to 7.7 for alfalfa silages [32]. Some researchers reported that pH is not decreases easily in silage which contains high legume levels [24, 33]. High protein and low carbohydrate contents of legumes have a great buffer property.

DLG reported that quality of silage classification which can be detected through the senses. Score is determined with smell, structure and colour points. The evaluation of physical properties of silages, all of groups were scored 20 points. Adding fulvic acid was not affected negatively or positively silage parameters. All of silage groups were accepted in excellent class in terms of DLG physical characteristics.

In evaluation of Flieg point of alfalfa silage was scored 38.82 point and was accepted in 'moderate' class. Flieg scores varied between 42.51-52.73 depending on increasing fulvic acid level and were accepted in 'satisfactory' class. Flieg points were not determined the same as DLG evaluation. Because DLG is subjective evaluation compare to Flieg. Alfalfa is legume which can be difficult to ensile because of low dry matter. The reason of the low scores of Flieg is low dry matter content and high pH values. Flieg scores reported by [29] for *Trifolium repens- Hordeum vulgare L*. mixture is similar with our study but Flieg scores reported by [34] for apple pulp-alfalfa mixture is higher than ours.

In this study adding the fulvic acid didn't affect of chemical composition in alfalfa silages but pH value decreased 5.20 to 4.82 and Flieg point was increased 36.82 to 52.73 depending on pH. In this case alfalfa silage without fulvic acid was accepted in 'moderate' class, alfalfa silages with fulvic acid were accepted in 'satisfactory' class.

Keep in view the results of the parent study support that the fulvic acid is an useful material for silage and can be ensiled successfully with alfalfa. Adding 1 % of fulvic acid in the silage on dry matter basis was successful ensiled with alfalfa.

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