Effect of pit and plastic bag methods and some additives on chemical composition of grass-legume mixture silages

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Abstract

This study was conducted at the College of Agricultural Engineering Sciences, the experimental field of the University of Sulaimani, during the growing season of 2012 – 2013. The experiment used two methods of making silage (pit method and plastic/ bag method) by making 18 pits with 100×80×100 cm, and 18 plasticbags sized 22 litter. Each silos contained three different forage types: grasses include whole barley and oat; alfalfa as legume and mixture. Those material were treated with two additives of sugar and molasses;solutions at a rate of 1:10; additives were used to improve silage preservation.The factorial design with a complete randomized block design (CRBD) experiment with three replications were used to analysis this study.Themostimportantresults indicatedthat the highest carbohydrates, ash, crude fat, crude fiber and moisture contents of 15.299, 8.580, 2.966, 18.399, and 70.536 % respectively, were achieved by using plastic bags method. The result showed that the highest carbohydrate content of 16.623% was achieved by using plastic methodwith grasses. However, the highest crude protein content of 22.037% was achieved by using pits with plant mixture and sugar. The highest pH value of 5.527 was recorded by the interaction among pits, plant mixture, and molasses. The highest dry matter content of 36.65% of was recorded by the interaction among plastic, grasses and sugar.The maximum carbohydrates content of 15.693% was achieved by using grasses, while legumes gave the highest contents of ash, crude fat, crude protein and dry matter. From the results of this study, it can be concluded that the method of using plastic bags was significant than pits method, the pits method with a mixture of (grasses and legumes) withmolasses produced maximum crude fiber, moisture, crude fat, and dry matter contents.

Key Words: Silage production, additives,chemical composition, grasses-legumes mixtures

Introduction

For dairy animals, silage making is one of the major conservation methods of green forage. It is necessary to adopt this method by silage, which means preserving chopped materials as green fodder in anaerobic conditions (6). Silage can be defined as any plant material undergone fermentation or "pickling" in a silo. In addition, a silo is any storage structure in which green, moist forage is preserved. The main goal of making silage is to enlarge the conservation of initial nutrients in the forage crop to feed livestock later in livestock feeding programs (16). Nevertheless, the accurate nutrient status of the silage will depend on many factors that can only be controlled via management. It is main to recall that silage inclusion will not make bad quality forage into good silage, but it can help make top quality forage into excellent quality silage (10). There will be mold growth if silage while filling pit/tank is not expertly pressed. Smell- good quality silage has a sour taste and is sweet. Color- superior quality silage has a light green or brownish color. A silage extra should be all right to pick up and decrease dry matter losses. Silage additives are added to the forage or crop at ensiling, may improve the ensiling (fermentation) process, reduce losses, shrink aerobic decay at feed out, enhance the hygienic quality of the silage, limit secondary fermentation, improve aerobic stability, increase the nutritive value of the silage, and accordinglyanimal production and give the farmer a greater return than the cost of the additive (15). Large technological and biological factors may affect nutritional value and silage quality (11).The widespread use of barley forage for feeding purposes is relatively new. Barley can be avaluable forage during drought periods or when the barley crop has suffered frost damage that has hindered the grain crop (18). Whole plant silage is now an important feed for ruminants and other species. Winter and summer varieties are used for this silage, sometimes sown in combination with a fast-growing grass variety. Whole plant silage is high in fiber, low in protein, and may be used in extensive cattle production (14). Barley is easy to ensile with a rapid drop of pH, and it provides good quality silage. However, when barley forage is intended for making silage, the most important criterion is its moisture content. The material must be in a 64-72% moisture range. If the forage is allowed to get drier, it may result in difficulties packing it tightly and thus removing air. Excessive heating may occur as well as nutrient losses (9). Barley crop is harvested at the soft dough stage and is suitable for silage. Feeding silage is also a major portion of the process. Silage should be prepared for nourishing three to five weeks after being stored. A silage sample should be collected and analyzed to determine the silage quality (11). Barley silage is comparable to pea or alfalfa silages for intake, and milk yield in dairy cows fed 50% forage diets in early lactation (13).The excellent harvest time is not expository because the quality of the forage reduces steadily with maturity. However, since dry matter intake and apparent digestibility tend to decrease when maturity increases, that impacts milk yield and milk protein and fat (17). It's advised to chop the forage shorter and seal the silo tighter to reduce as much air content as possible of air trapped inside the silage mass.Once properly produced, barley silage should be light green-yellow to green-brown. It should have a lactic acid odor, no butyric acid off-flavor, and a pH ranging from 4.2 to 4.8 (1). The aim of this study was to determine the effect of the type of silo (pit and plastic bag) methods, and additives (sugar and molasses) on the chemical composition of grass-legume mixture silages.

Materials and Methods

This study wasconducted in the College of Agricultural Engineering Sciences field, the University of Sulaimani during the growing season of 2012–2013. The experiment contained two methods of making silage(pits and plastic bags)by digging18 pitsof100×80×100 cm, and 18 plastic bags sized 22litter. Three ensiled materials were made, grasses including: whole barley (*Hordeum vulgare*) and oat (*Avena sativa*), and alfalfa (*Medicago sativa*) as legumes and mixture. Those materials were treated with the two additives of sugar and molasses, solutions at a rate of 1:10; additives were used to improve silage preservation.

Collection of theexperimentalmaterials

Grasses were harvested at the milk stage, while the legumes were harvested at %25 flowering with higher quality. Both plant groups were harvested at 65-70 % moisture content and werechopped into3-4cm inlength.

Materials processing and preservation

The pits were covered with plastic sheets, and then chopped plants were arranged in the pits as a layer of 12 cm thick. Each layer was compacted completely to ensure that all the air is pushed out of the plant. The solution is added above each layer. In addition, Sawdust was used to cover each layer to balance the moisture. Then, all pits were covered with a plastic sheet tightly covered with a thin layer of soil. The silage was ready for use after 90 days. Samples (100 g) were taken from each replication forchemical analysis. All samples were air-dried and ground using a grinding ofabout1mm screen for chemical analysis. The same procedure was applied regarding making silage in plastic bags.

Chemical composition

The samples obtained in this study were subject to chemical analysis: Carbohydrate was determined using the DNS method (7). The ash was determined using an electric muffle furnace (3). The crude fat was determined by using the Soxhlet extraction apparatus, the crudefiber content was determined by fiber extraction apparatus using diluted H_2SO_4 and NaOH, andthe nitrogen was determined by Kjeldahl method and the nitrogen × 6.25 to obtained crude protein content (4).The samples were dried in the oven at 75°C for 48 hours to determine the dry matter content (5). For the pH determinations, 25g of silage samples were put into a beaker then 100 ml of distilled water was added and mixed well for 5 minutes, then filtered through Whatman filter paper, and pH was measured by a digital pH meter (8).

StatisticalAnalyses

Data of this study were analyzed with a factorial experiment within the completely randomized block design (CRBD) with three replications. All possible comparisons among the means were carried out using the least significant differences (LSD) test at a significant level of 5% (2).

Results and Discussion

Data in table 1 showed that the carbohydrate, ash, crude fat, crude fiber, and moisture contents were significantly (P≤0.05) affected by silo type, while the crude protein content and pH value were not affected significantly. The highest content of carbohydrates, ash, crude fat, crude fiber and moisture in silage samples madeby using the plastic bags were 15.299, 8.580, 2.966, 18.399, 18.399 and70.536%respectively. However, the highest content of crude protein and dry matter introduced by using the pits were 19.573 and 32.757 %, respectively.

Table 1: Effect of methods on the chemical composition and pH of grass-legume mixture silages

Methods	Carbohydrate %	Ash %	Crude Fat %	Crude Fiber %	Crude Protein %	Moisture %	Dry matter %	pH
a1	13.955	5.583	2.504	15.858	19.573	67.243	32.757	4.544
a2	15.299	8.580	2.966	18.399	18.233	70.536	29.464	4.472
LSD (P≤0.05)	0.597	0.527	0.364	2.163	NS	1.111	1.111	NS

a1: pit method, a2: plastic bag method,NS: not significant

Data in table 2 explain the effect of the plant sources on chemical composition and pHof grass-legume mixture silages. All contents were significantly (P≤0.05) affectedexcept crude fiber content. The maximum carbohydrate content was 15.693% produced by using grasses, while using legumes gave the highest value for ash, crude fat, crude protein, and dry matter content were 8.021, 2.960, 20.468and 34.278%, respectively. Using the mixture of grasses and legumes causes the exhibition of the highest value of moisture content and pH value were 71.315% and 4.956, respectively. Several factors affect silage dry matter and nutritional losses during conservation and feed-out, such as the daily feed-out rate (12).

Table 2: Effect of plants sources on the chemical composition and pH of grass-legume mixture silages

plants sources	Carbohydrate%	Ash %	Crude Fat %	Crude Fiber %	Crude Protein %	Moisture %	Dry Matter %	pH
b1	15.693	6.177	2.296	16.777	16.006	69.631	30.369	4.080
b2	13.592	8.021	2.960	16.325	20.468	65.722	34.278	4.488
b3	14.597	7.047	2.948	18.284	20.236	71.315	28.685	4.956
L.S.D (P≤0.05)	0.732	0.646	0.446	NS	2.659	1.361	1.361	0.300

b1: grasses, b2: legume, b3:mixture of grasses and legumes,NS: not significant

The effect of additives on chemical composition and pHof grass-legume mixture silages are shown in table 3. Using sugar as additives recorded the highest (P≤0.05) content of ash, crude protein, and dry matter were 7.537, 18.928 and 32.103%, respectively, while using molasses as the additives produced the highest (P≤0.05) contents ofcrude fiber and moisture and pHvalue were 18.464, 69.882% and 4.682, respectively. Our results confirm (3) theadditive of molasses improve the silage-making process for tropical forages.

Table 3: Effect of additives on the chemical composition and pH of grass-legume mixture silages

Additives	Carbohydrate %	Ash %	Crude Fat %	Crude Fiber %	Crude Protein %	Moisture %	Dry Matter %	pH
c1	14.466	7.537	2.591	15.793	18.928	67.897	32.103	4.334
c2	14.789	6.626	2.879	18.464	18.879	69.882	30.118	4.682
L.S.D (P≤0.05)	NS	0.527	NS	2.163	NS	1.111	1.111	0.245

c1:Sugar additive; c2:Molasses additive;NS:not significant

Data in table 4 explain the interaction between methods and plant sources onchemical composition and pH of grass-legume mixture silages. This effect was significant (P≤0.05) on moisture and dry matter content. The maximum value for moisture content reached 76.827% by the interaction between using plasticbag method and mixture of grasses with legumes. In which the maximum contentofdry matter was35.795%. By the interaction between using plastic bag method with legumes. At the same time, the minimum value reached 64.205% by the interaction between the plasticbag methodswith legumes. The interaction between plasticbag and mixture of grasses gave a minimum value of 23.173%. Silage additives can be beneficial and economical (19)

Table 4: The interaction effects between methods and plants sources on the chemical composition and pH of grass-legume mixture silages

Methods / plants	Carbohydrate %	Ash %	Crude Fat %	Crude Fiber %	Crude Protein %	Moisture %	Dry Matter %	PH
a1b1	14.897	4.960	2.340	14.872	18.043	68.687	31.313	4.100
a1b2	13.062	6.483	2.677	15.987	19.663	67.238	32.762	4.627
a1b3	13.907	5.305	2.495	16.715	21.013	65.803	34.197	4.907
a2b1	16.490	7.393	2.252	18.682	13.968	70.575	29.425	4.060
a2b2	14.122	9.558	3.243	16.663	21.273	64.205	35.795	4.350
a2b3	15.287	8.788	3.402	19.853	19.458	76.827	23.173	5.005
LSD (P≤0.05)	NS	NS	NS	NS	NS	1.925	1.925	NS

a1b1: pit method ×grasses; a1b2: pit method ×legumes; a1b3 pit method×mixture; a2b1: plastic bag method ×grasses; a2b2: plastic bag method ×legumes; a2b3 plastic bag method ×mixture; NS: not significant

Data in table 5 illustrate the interaction between methods of making silage and additives. This effect was significant (P≤0.05) on carbohydrate, ash, crude fiber, moisture, and dry matter contents. The dry matter content in pit method with sugar gave a maximum value was34.640%. Using pits with molasses produced a maximum value for carbohydrates and ash were 15.790 and 8.697, respectively, while using plasticbags with sugar produced a maximum fiber percent was 19.916%, but using plasticbag with molasses produced a maximum value for moisture content was 70.638%. Regarding contents of carbohydrates, crude fiber, moisture gave a minimum value by using the pit method with sugar were 13.222, 11.800, and 65.360%, respectively. While using plasticbag with sugar gave minimum value for the treatment ash with 4.788%, and the dry matter gave minimum value reached 29.362%by using plasticbag with molasses. To make the best silage, always using an additive is a good recommendation if care should be taken when choosing a silage additive and properly follows the product's direction (19).

Table 5: The interaction effects between methods and additive on the chemical composition and pH of grass-legume mixture silages

Method/ Additive	Carbohydrate %	Ash %	Crude Fat %	Crude Fiber %	Crude Protein %	Moisture %	Dry Matter %	pH
a1c1	13.222	6.378	2.438	11.800	20.551	65.360	34.640	4.351
a1c2	15.709	8.697	2.743	19.786	17.304	70.433	29.567	4.318
a2c1	14.688	4.788	2.570	19.916	18.596	69.126	30.874	4.738
a2c2	14.890	8.463	3.188	17.013	19.162	70.638	29.362	4.626
LSD $_{(P\leq0.05)}$	0.845	0.746	NS	3.059	NS	1.572	1.572	NS

a1c1: pit method ×sugar additive; a1c2: pit method ×Molasse additive; a2c1 plastic bag method ×sugar additive; a2c2: plastic bag method × Molasse additive; NS: not significant

Data in table 6 explain the interaction between the plant sources and additiveson the chemical composition and pH of grass-legume mixture silages. This effect was significant (P≤0.05) on pH value and the content of carbohydrates, moisture and dry matter. The interaction between grasses and molasses additive produced a maximum content of carbohydrate and moisture were 15.862 and 71.895%, respectively, while using a mixture (grasses and legumes) with molasses produced a maximum pH value of 5.425. The dry matter content gave the maximum value of 35.072 %when using legumes with sugar. Additives are natural or industrial products added to the forage or grain mass in rather large quantities. Additives control or prevent certain types of fermentation, thus reducing losses and improving silage stability. In order to assist in the fermentation process, various silage additives have been used to improve the nutrient and energy recovery in silage, often with subsequent improvements in animal performance (19).

Table 6: The interaction effects between plants sources and additive on the chemical composition and pH of grass-legume mixture silages

Plant/ Additions	Carbohydrate %	Ash %	Crude Fat %	Crude Fiber %	Crude Protein %	Moisture %	Dry matter %	pH
b1c1	15.525	6.908	1.922	14.782	17.370	67.367	32.633	3.822
b1c2	15.862	5.445	2.670	18.772	14.642	71.895	28.105	4.338
b2c1	14.077	8.667	2.865	15.602	19.463	64.928	35.072	4.695
b2c2	13.107	7.375	3.055	17.048	21.473	66.515	33.485	4.282
b3c1	13.795	7.037	2.985	16.995	19.950	71.395	28.605	4.487
b3c2	15.398	7.057	2.912	19.573	20.522	71.235	28.765	5.425
LSD $_{(P\leq0.05)}$	1.035	NS	NS	NS	NS	1.925	1.925	0.424

b1c1: grasses×sugar additive; b1c2; grasses ×molasse additive; b2c1: legumes ×sugar additive; b2c2; legumes ×molasse additive; b3c1: mixture ×sugar additive; b3c2; mixture ×molasse additive;NS: not significant

Data in table 7 illustrate the interaction among methods, plant sources, and additives on the chemical composition and pH of grass-legume mixture silages. This effect was significant (P≤0.05) on carbohydrate, ash, crude fiber, moisture, crude protein, dry matter contents and pH value. The highest value of carbohydrates produced by using plastic with grasses and molasses reached 16.623%, but the maximum value of moisture and crude fiber were79.247and 23.030%, respectively, were produced by the interaction among plastic method, plant mixture, and sugar. However, the highest value of crud protein content was 22.037%, produced by using the pits method with plant mixture and sugar. The highest pH value was 5.527%, exhibited by the interaction among pits, plant mixture, and molasses. The highest value of dry matter as recorded by using a plastic method with legume, and sugar additive was 36.560%. While minimum content of crude fiber with 11.863 % was recorded by using the interaction among the pit method with sugar and grasses. The ash content gave a minimum value of 3.980% by using the interaction among the pit method with legumes plants and sugar. Regarding the crude protein content and pH value the minimum value reached 13.083% and 3.510, respectively. While minimum value of moisture content was recorded by using the interaction among plastic bag method with grasses plants and molasses was63.440%. While the carbohydratecontent recorded a minimum value of 11.897%in interaction among pit method with legume plants and sugar. While the minimum content of dry matterwas 20.753% recorded by using the interaction among plastic bag method with plant mixture and molasses.

Table 7: The interaction effects among methods, plants sources and additives on the chemical composition and pH of grass-legume mixture silages

Methods/plants / additions	Carbohydrate %	Ash %	Crude Fat %	Crude Fiber %	Crude Protein %	Moisture %	Dry matter %	pH
a1b1c1	14.693	5.940	2.197	11.863	21.657	66.120	33.880	4.133
a1b1c2	15.100	3.980	2.483	17.880	14.430	71.253	28.747	4.067
a1b2c1	11.897	7.990	2.567	12.577	17.960	66.417	33.583	4.633
a1b2c2	14.227	4.977	2.787	19.397	21.367	68.060	31.940	4.620
a1b3c1	13.077	5.203	2.550	10.960	22.037	63.543	36.457	4.287
a1b3c2	14.737	5.407	2.440	22.470	19.990	68.063	31.937	5.527
a2b1c1	16.357	7.877	1.647	17.700	13.083	68.613	31.387	3.510
a2b1c2	16.623	6.910	2.857	19.663	14.853	72.537	27.463	4.610
a2b2c1	16.257	9.343	3.163	18.627	20.967	63.440	36.560	4.757
a2b2c2	11.987	9.773	3.323	14.700	21.580	64.970	35.030	3.943
a2b3c1	14.513	8.870	3.420	23.030	17.863	79.247	20.753	4.687
a2b3c2	16.060	8.707	3.383	16.677	21.053	74.407	25.593	5.323
LSD ($P \leq 0.05$)	1.463	1.292	NS	5.298	NS	2.723	2.723	0.599

a1b1c1: pit method ×grasses ×sugar additive; a1b1c2; pit method ×grasses ×molasse additive; a1b2c1: pit method ×legumes ×sugar additive; a1b2c2:pit method ×legumes ×molasse additive; a1b3c1: pit method ×mixture ×sugar additive; a1b3c2; pit method ×mixture ×molasse additive; a2b1c1: plastic bag method ×grasses ×sugar additive; a2b1c2; plastic bag method ×grasses ×molasse additive; a2b2c1: plastic bag method ×legumes ×sugar additive; a2b2c2: plastic bag method ×legumes ×molasse additive; a2b3c1: plastic bag method ×mixture ×sugar additive; a2b3c2; plastic bag method ×mixture ×molasse additive; NS: not significant

Conclusion

From the results of this study, we concluded that the method of using plastic bags was significant than pits method on some chemical composition and pH of grass-legume mixture silagesAt the same time, using pits with a mixture of grasses and legumes with molasses produced maximum fiber, moisture, crude fat, and dry matter contents to produce the best silage, always using an extra is a good recommendation if care should be taken when choosing a silage additive and follows the product's direction properly.

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