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Effects of Different Fermentation Time, Packaging Color and Bag Sealing Applications on Packaged Corn Silage Quality

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ABSRACT

In this study, effects of two different fermentation times (35 and 70 days), packaging colors (black and white) and sealing (thermal sealing without vacuum in single bag and vacuum binding with clip in first bag + thermal sealing in second bag) were investigated on packaged corn silage quality. According to research results, pH values increased and flieg scores decreased as fermentation time gets longer. The crude protein values obtained from white colored bags were higher than those obtained black bags. When silage quality parameter values are taken into consideration all fermentation time, packaging color and bag sealing applications could be recommend. Packaged corn silage may be advised to be used in small scale livestock farming due to easy transporting and "well" silage quality class.

1. Introduction

The corn plant has the characteristics of silage without using any additives. It is rich in vitamins and minerals, improving the performance of the animals and also important in terms of the prevention of many diet-related metabolic diseases and providing high-quality animal products (Alcicek et al. 2002). Due to its high energy value, corn silage is regarded as a semi-concentrate feed, and this high-energy value is a result of the grain that consists of almost 50% of dry matter of the product. This is a feature that makes corn silage superior to the silage of other plants, and animals fed with corn silage require 33-50% less concentrated feed (Sade and Soylu 2008). Corn is the most preferred plant for silage in Turkey and throughout the world. Corn is grown for its many positive effects such as high energy value, suitability for mechanized harvesting, high rate of dry matter content, high rate of digestion, good quality and delicious silage, higher efficiency per unit area, no need for any additive, and the facilitation of business plans because of a uniform structure (Turgut 2002).

Small scale livestock farmers do not prefer concrete or tower silos because the cost of the silo construction is high and the forage stored in the silo must be consumed immediately, otherwise, it undergoes secondary fermentation outside and spoils. Packaged silage has a consumption advantage because of easy mechanization during transportation and consumption and better forage quality. Making bales or packaged silage adds commercial value to the fodder. Thus, the business, even if it does not have animals itself, may make silage and sell it as fodder to other businesses that own livestock (Bilgen et al. 2005). Particularly in recent years, the popularity of silage motivated commercial enterprises in Turkey, and bales of fresh herbs or fermented silage in bags of 50 kg was offered for sale (Cakmak and Yalcın 2005). As corn silage packing is new to Turkey, the effects of different packaging applications on silage quality should be investigated and those involved in this research should been lightened.

The aim of this study was to determine the effects of different fermentation time, packaging color and bag sealing applications on packaged corn silage quality.

2. Material and Methods

The study was conducted in the laboratory of Karabuk University Eskipazar Vocational School Department of Plant and Animal Production. PR 31Y43 hybrid corn cultivar was used as silage material. The seeds were

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sown in the application field on May 25, 2011 and harvested at the beginning of the period of the early dough stage on October 3, 2011, and pH and dry matter content were determined (6.22 and 29.95%, respectively). Then it was ensiled by machine and packaged. Bags in two different colors (black and white) were used as packaging material. The packages were 57x75 cm in size and 80 micron thick, and produced from a mixture of 20% original and 80% recycled low-density polyethylene.

Black and white colored, low density polyethylene bags were filled with 3 kg of corn silage. The study was carried out in three replications in a "three factor, completely randomized design". Before closing the mouths of the bags to be applied vacuum, with the help of the vacuum bag apparatus mounted on the output of the engine of the milking machine was vacuumed until it reached 300 mmHg. Clips were attached to the mouth of the bags and tied with a knot and placed inside the second bag. The mouth of the outer bag was affixed by a thermal welding machine. The mouths of the bags that were not to be vacuumed were affixed by thermal welding machine immediately after filling. Then, the closed bags were allowed to stand for two different fermentation periods of 35 days and 70 days. Upon completion of fermentation periods, silage packages were opened and physical and chemical properties and quality of silage were determined.

One of the important criteria used to determine the nature of silage is pH value. There is a close relationship between pH value and the dry matter content. In fact, silage quality class can be determined through a regression equation (Equation 1) using the relationship between the pH value and dry matter content of silage (Geren 2001).

Flieg Score: [220 + (2 x silage dry matter (%) - 15)] - 40 x silage pH value (1)

The flieg score obtained from the above equation gives important clues about the quality of silage according to the criteria given in Table 1.

Table 1

Flieg scores and silage quality classes

Flieg Scores	Silage Quality Classes
0-20	Poor
21-40	Low
41-60	Medium
61-80	Good
81-100	Well

To determine pH value, which is an important indicator about the quality of silage, 25 g silage samples were weighed on scales with precision of 0.01 and placed in a blender. One hundred ml of distilled water was added to the sample and homogenized by blending for five minutes. The mixture obtained was filtered and the pH value was measured in 30 ml sample by a Lutron-208 digital pH meter. Upon the completion of fermentation, the silage bags were opened and 150 g samples were taken from each bag. They were weighed on scales with 0.01 precision, dried at 70 °C for 72 hours in the incubator, and re-weighed on the scales with the same sensitivity. The moisture level of the silage was determined. Crude protein analyses of silage were carried out at the laboratory with the Kjeldahl method (Yıldız 2008).

All data were analyzed using an analysis of variance according to the experimental design of three factor, completely randomized (MSTAT-C 1980).

3. Results and Discussion

The dry matter values obtained from the results were not statistically different. The pH values determined in the study shows that there is a statistically significant difference between the fermentation periods (35 days 3.89, 70 days 3.94; $P<0.01$). The pH values obtained from other applications and interactions were not statistically significant (Table2).

The highest crude protein values (10.16%; $P<0.05$) obtained from the white bags (Table 2).

When the flieg score values determined in the study was examined, the difference between the fermentation time × packaging color interaction values was statistically significant ($P<0.05$). The highest flieg score (91.89) was obtained from 35 days × white bag interactions.

Factors such as wrap colour which in the field affects the surface temperature of the bale and consequently the permeability of the wrap can have a significant effect (Snell et al. 2002). Polyethylene film is not completely impermeable to oxygen diffusion and thus will not completely prevent oxygen ingress (McEniry et al. 2011; Bernardes et al. 2012). Although PE sheeting has been the most common method used to protect silage near the surface, the protection provided by PE sheeting is highly variable and often changes during storage (Savoie 1988).

The difference between silage quality classes obtained from other applications and interactions were not considered statistically significant and all the applications were classified as "well" quality classes. In the study, crude protein values were influenced by the color of the packaging and differences between the values obtained were found statistically significant ($P<0.05$).

When earlier studies similar to the current study were examined, it was observed that packaging, color and implementation of vacuum and fermentation did not create statistically different impacts on silage quality classes (Bilgen et al. 2005). The values obtained in the study are consistent with those obtained from research made in this and similar issues previously (Ashbell et al. 2001; Snell et al. 2002).

Table 2
Silage quality parameter values

Fermentation Time (T)	Packaging Color (C)	Bag Sealing (BS)	Dry Matter %	pH	Flieg Score	Crude Protein %	Silage Quality Classes
35 day	Black	TS	27.48	3.92	88.04	9.10	Well
		VTS	28.82	3.92	90.72	8.66	Well
		Mean	28.15	3.92	89.38 ab	8.88	Well
	White	TS	27.97	3.86	91.42	10.36	Well
		VTS	28.38	3.86	92.36	9.50	Well
		Mean	28.17	3.86	91.89 a	9.93	Well
70 day	Black	TS	28.73	3.94	89.86	9.50	Well
		VTS	29.37	3.97	89.67	9.10	Well
		Mean	29.05	3.95	89.77 ab	9.30	Well
	White	TS	26.94	3.92	86.82	10.83	Well
		VTS	27.44	3.95	86.75	9.96	Well
		Mean	27.19	3.93	86.79 b	10.39	Well
		F Values	Ns	Ns	6.02**	Ns	Ns
T mean	35 day		28.16	3.89 b	90.63	9.40	Well
	70 day		28.12	3.94 a	88.28	9.85	Well
	F values		Ns	8.75**	Ns	Ns	Ns
C mean	Black		28.60	3.94	89.57	9.09 b	Well
	White		27.68	3.90	89.37	10.16 a	Well
	F values		Ns	Ns	Ns	5.93*	Ns
BS mean	TS		27.78	3.91	89.03	9.95	Well
	VTS		28.50	3.92	89.87	9.30	Well

*, **: Significant at 0.05 and 0.01 probability level respectively, Ns: Not significant
TS: Thermal sealing without vacuum in single bag
VTS: Vacuum binding with clip in first bag + thermal sealing in second bag

4. Conclusion

When silage quality parameter values are taken into consideration all fermentation time, packaging color and bag sealing applications could be recommend. Packaged corn silage may be advised to be used in small scale livestock farming due to easy transporting and "well" silage quality class.

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