Effects of adding whey and molasses on corn silage quality, growth performance and health of Simmental fattening calves

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Abstract

This study was conducted to evaluate the effects of adding whey and molasses on the physical and chemical quality of corn silage, growth performance and health of Simmental fattening calves. This study was carried out in a completely randomized design with 3 treatments and 5 replications for each treatment, and a total of 15 Simmental male calves. Three treatments were included in the study: Treatment 1: corn silage without any additive (control treatment), Treatment 2: corn silage with addition of 10% whey on a dry matter basis and Treatment 3: corn silage with addition of 10% molasses on a dry matter basis. The results of this study showed that addition of molasses and whey to corn silage, improves physical and chemical quality of corn silage. Adding whey and molasses decreased pH, Ash, ADF, NDF and increased DM, CP, OM and Flieg point of corn silage. There were no significant differences in body weight, feed intake and FCR among control and other treatment groups ($P<0.05$). Further results showed that, addition of molasses and whey to corn silage improved fecal score of Simmental male calves.

Key words: Corn silage; fattening calves; molasses; whey.

Introduction

Silage is a common method for preservation forage with high humidity. In this process, lactic acid bacteria ferment the water-soluble carbohydrates (WSC) in the crop to lactic acid, Due to the production of these acids the pH of the ensiled material decreases and spoilage microorganisms (molds and yeasts) are inhibited (Henderson, 1993). Corn forage is one of the most widely plants that used in dairy farms. Corn forage has a relatively high dry matter content (27-30%), low buffering capacity and high water-soluble carbohydrates (Wilkinson, 1999). The main purpose of ensiling was preserving high moisture crops during periods when drying is not feasible. Unfortunately fermentation in silage is an uncontrollable process that leads to high loss of nutrients. Different feed additives in traditional feeds have been tried to increase the growth in fattening calves and cattle (Maamouri et al., 2019). In order to optimize the fermentation process, various additives are used for the improvement of nutrients and energy recovery in silage, which often leads to improved animal performance (Kung et al., 2000).

Whey and molasses are cheap and available sources of dairy and agricultural waste. The use of these by-products, in livestock nutrition can reduce the cost of animal feeds and environmental pollution from the accumulation of these residues (Awawdeh, 2011). Whey is a good source of digestible carbohydrates (lactose), adding this by-product in silo-forage reduced pH, increasing lactic acid production and improvement of fermentation quality and digestibility of the silage (Siso, 1996). Molasses is one of the additives which is a concentrated brown or black colored sap and is produce after extraction of solidified sugar from concentrated juice of products like sugarcane and sugar beet. Molasses contains high amounts of easily digestible sugar which makes it highly nutritional and is considered as an energy resource in livestock nutrition (Hashemi, 1991). Cajarvill et al. (2011) showed that addition of molasses with 15 g/kg and whey at levels of 20, 50 and 100 g/kg on moderate forage silage, increased lactic acid production and decreases pH of silage. Adding molasses on potato hash silage improved fermentation, increased body weight, feed intake and improved FCR of fattening lambs (Nkosi and Meeske 2010). Therefore, due to cheap and easy to use of these by-products as silage additives in comparison to other expensive commercial additives, this study was performed to evaluate the effects of adding whey and molasses on the physical and chemical quality of corn silage, growth performance and health of Simmental fattening calves.

Material and Methods

Whole-plant corn was cultivated (single cross 704), harvested at the one-half milk line stage and prepared for ensiling. Forage was chopped with a conventional forage harvester to a length of 3 to 5 cm. Then the air was removed between the silage and covered with plastic. A sample of corn forage before and 45 days after ensiling was analyzed to determine the physical and chemical properties. Three treatments were included in the study: Treatment 1: corn silage without any additive (control treatment), Treatment 2: corn silage with addition of 10% whey on a dry matter basis and Treatment 3: corn silage with addition of 10% molasses on a dry matter basis. Molasses were diluted 1 to 4 with water and sprayed uniformly in to silage. Corn silage were kept for 45 days under anaerobic conditions. After 45 days, silos were opened and fed to fattening calves.

Physical properties of silages were evaluated according to a twenty points scoring system. Maximum score for smell, texture and colour of silage were 14, 4 and 2, respectively (Nikpourtehrani et al., 1987). pH of ensiled samples were determined using a digital pH meter. Dry matter (DM) content of fresh whole-crop corn as well as ensiled samples were determined by drying at 60°C for 4 h in a forced air oven. Crude protein**,** Ash and organic matter contents were determined according to AOAC (1995). NDF and ADF were determined using Van Soest method (1991). Flieg point was calculated using the following equation (Kilic, 1986).

$$\text{Flieg point} = 220 + (2 \times \text{DM}-15) - (40 \times \text{pH})$$

This study was conducted at Animals Research farm of Amol city, Mazandaran, Iran. Fifteen Simmental fattening calves (initial body weight= 200 ± 10 kg) were grouped based on body weight. Calves were housed individually with separated pens, each of which was equipped with feeding and watering trough as required for calves. Simmental calves were fed with experimental dietary treatments until 200 days.

Calves were fed daily at twice a day (at 8:00 and 16:00) and fed daily with total mix ration (TMR). The ingredients and chemical composition of diet are shown in Table 1. Diets were formulated to meet all of the nutritional requirements for calves based on NRC (2001) recommendations. Diets and water were offered ad libitum throughout the trial period. This study was performed until 200 days, with monthly calves weighing. Body weight, feed intake and FCR were determined at final period of this experiment.

Individual animal health scores were assigned by a single veterinarian. Health scores were assigned using a calf health-scoring system developed by the School of Veterinary Medicine, University of Wisconsin, Madison. Calves were scored on 4 different aspects of health including nasal, eye, ear and cough scores. Fecal scores were determined according to the method described by Meyer et al. (2001). In this method, feces scores were described as (1) normal, (2) soft, (3) fluid and (4) aqueous. Then, the days in which calves suffered diarrhea (scores 3 and 4) were analyzed as total number of disease days.

Statistical analysis

All data were subjected to analysis of variance using the general linear models procedure of SAS software (SAS, 9.1) as completely randomized design. Treatment means were separated by Turkeys test at ($P<0.05$) statistical level. The initial weight of calves was used as covariate for performance data.

Table 1. Composition of experimental diets (as percent of dry matter)

Ingredient	**percentage (%)**
corn silage	15.00
Wheat straw	15.00
corn grain	21.00
barley	24.00
Soybean meal	8.00
Wheat bran	16.00
CaCO3	0.5
salt	0.5
Nutrient composition	
ME (Mcal/kg DM)	2.26
NE (Mcal/kg DM)	1.12
Crude protein (%)	14.3
Crude fiber (%)	22.38
Crude fat (%)	2.56
Calcium (%)	0.84
Phosphorus (%)	0.45
Calcium/ phosphorus	1.86

Results

The results of adding whey and molasses on the physical properties of corn silage are shown in Table 2. Physical properties (smell, touch and colour) of corn silage are same in control and other treatment groups. There were no significant differences in smell, touch and colour among control and other treatment groups ($P>0.05$).

The results of adding whey and molasses on the chemical composition of corn silage are shown in Table 3. The results of this experiment showed that, addition of whey and molasses decreased pH of corn silage. The results of this experiment showed that the lowest pH was observed in whey treatment silage and the highest was in control groups. There were no significant differences in pH of corn silage among control and other treatment groups ($P>0.05$). The lower pH in whey and molasses silages as compared to the control silage was most likely due to higher production of lactic acid which may have inhibited the activity of opportunistic microorganisms. The results of this study showed that addition of whey and molasses increased dry matter of corn silage ($P<0.05$). The highest dry matter was observed in whey treatment silage and the lowest was observed in control groups. Molasses, due to its high dry matter content, increased dry matter and inhibit effluent losses of silage. The results of this study showed that, addition of whey and molasses increased crude protein of corn silage. The higher crude protein in whey and molasses silages was most likely due to higher production of lactic acid which may have inhibited the degradation of protein and decreased pH of silage. The highest crude protein was observed in molasses treatment silage and the lowest was observed in control groups ($P<0.05$).

The results of this experiment showed that, addition of whey and molasses decreased Ash of corn silage. The lowest Ash was observed in molasses treatment silage and the highest was observed in control groups ($P<0.05$). Addition of whey and molasses decreased NDF and ADF of corn silage ($P<0.05$). In this study, addition of whey and molasses increased Flieg point of corn silage ($P>0.05$) that can be attributed to lower pH and higher dry

matter in these silages. The results of adding whey and molasses on growth performance of Simmental fattening calves are shown in Table 4. There were no significant differences in body weight, feed intake and FCR among control and other treatment groups (P>0.05).

The results of this experiment showed that addition of whey and molasses had no significant effects on body weight, feed intake and FCR of Simmental fattening calves (P>0.05). Effects of adding whey and molasses on health status of Simmental fattening calves are shown in Table 5. There were no significant differences in Eye, nasal discharge, ear and cough score among control and other treatment groups (P>0.05). Addition of whey and molasses improved fecal score of Simmental male calves (P<0.05).

Table 2. Effects of adding whey and molasses on physical properties of corn silage

physical properties	control	molasses	whey	SEM
Smell	12.4	12.7	12.8	0.5
Touch	3.3	3.3	3.3	0.2
Colour	1.7	1.7	1.6	0.2
Total score	17.4	17.7	17.7	0.5

SEM, standard error of means; Means in the same row with different superscripts are significantly different ($p < 0.05$).

Table 3. Effects of adding whey and molasses on chemical properties of corn silage

chemical properties	control	molasses	whey	SEM
pH	4.12	3.9	3.8	0.18
Dry matter	30.4^{b}	32.7^{a}	32.98^{a}	1.5
crude protein	8.5^{b}	10.3^{a}	10.1^{a}	0.4
Ash	7.1^{a}	6.4^{b}	6.5^{b}	0.2
Organic matter	92.9^{b}	93.6^{a}	93.5^{a}	0.2
NDF	55.2^{a}	51.8^{b}	52.6^{b}	0.9
ADF	34.4^{a}	31.5^{b}	32.4^{b}	0.8
Flieg point	101.00	108.00	114.1	9.04

SEM, standard error of means; Means in the same row with different superscripts are significantly different ($p< 0.05$).

Table 4. Effects of adding whey and molasses on growth performance of Simmental fattening calves

Parameters	control	molasses	whey	SEM
Initial BW (kg)	195.400	204.00	200.800	12.85
Final BW (kg)	537.00	559.200	546.400	16.46
Final DM intake (kg)	17.970	18.400	18.00	479.40
Final FCR	9.1	8.7	8.6	0.31

SEM: standard error of means; Means in the same row with different superscripts are significantly different ($p < 0.05$).

Table 5. Effects of adding whey and molasses on health status of Simmental fattening calves

health status	control	molasses	whey	SEM
Eye score	0.32	0.24	0.20	0.08
Nasal discharge score	0.24	0.18	0.16	0.05
Ear score	0.22	0.20	0.18	0.06
Cough score	0.30	0.24	0.22	0.06
Fecal score	1.36^{a}	1.12^{b}	1.14^{b}	0.1

SEM: standard error of means; Means in the same row with different superscripts are significantly different ($p < 0.05$).

Discussion

Results of the present study showed that adding whey and molasses to corn silage improved physical and chemical quality of corn silage. In agreement, Alikhani et al. (2005) reported that adding molasses on sunflower silage improved physical properties of silage. Kavian and Pasandi (2016) showed that there were no significant differences among control and other treatment groups with adding molasses on mustard fodder silage (P>0.05).

Huisden et al. (2009) showed that adding molasses increased water soluble carbohydrate and decreased pH of corn silage in comparison to control groups. The results of research by Aghashahi et al. (2017) showed that, addition of molasses to sugar beet silage, decreased pH and increased dry matter of silage. Pasandi et al. (2012) showed that addition of molasses to corn silage improved fermentation and decreased pH of silage.

Muck and Kung (1997) reported that addition of whey to corn silage, decreased pH and increased lactic acid bacteria population. The results of this study are in agreement with findings of Pasandi et al. (2012); Huisden et al. (2009) and Muck and Kung (1997). The results of study by Khorvash et al. (2005) showed that, addition of 10% and 15% whey powder, increased dry matter and decreased effluent losses of corn silage. Other study showed that addition of molasses increased dry matter of sorghum silage (Gofeen and Khalifa 2007), which is consistent with the results of this study. Khorvash et al. (2005) showed that addition of whey powder with 10% and 15% increased crude protein of corn silage.

Researchers reported that increasing of crude protein in molasses treatment silage, due to decreasing proteolysis activity. Because of in non-additive silage, harmful bacteria are increased and leads to protein breakdown and consequently, decreased protein of silage (Rowghani et al., 2008). Pasandi et al. (2012) showed that addition of molasses in sweet corn silage increased crude protein of silage, Which is consistent with the results of this experiment. In this study, the reason for reducing Ash of silage containing molasses and whey can be attributed to increasing of lactic acid bacteria in this silage. Alikhani et al. (2005) showed that adding molasses to sunflower silage decreased Ash of silage. In agreement with this study, Shabkhan et al. (2016) showed that addition of molasses and whey to sorghum silage decreased Ash of silage.

Addition of whey powder with 10% and 15% decreased ADF and NDF of corn silage (Khorvash et al., 2005). Asadi Alamoti et al. (2004) showed that addition of molasses and bacterial inoculant decreased ADF of millet silage. Pasandi et al. (2012) reported that adding molasses at 30 kg/ton in sweet corn silage, increased Flieg point of silage, Which is consistent with the results of this study.

The results of this experiment showed that addition of whey and molasses had no significant effects on body weight, feed intake and FCR of Simmental fattening calves. Nkosi and Meeske (2010) reported that adding molasses on potato hash silage, improved fermentation and increased feed intake and body weight of growing lambs. Addition urea and molasses on Palm silage increased body weight and improved FCR of fattening goats (salemi et al., 2000). There were no significant effect on body weight and feed intake of calves fed with whey and molasses in this experiment may be attributed to their low dosage in silages.

Perry and Cecava (1995) showed that calves fed with bacterial inoculant silage increased body weight in comparison to control groups. Dayani et al. (2011) reported that adding urea and whey on wheat straw increased body weight and improved FCR of fattening lambs.

Conclusion Addition of whey and molasses improved physical and chemical properties of corn silage. The results of this experiment showed that feed intake, body weight and FCR of calves did not differ significantly between experimental groups. Further results showed that addition of whey and molasses to corn silage improved fecal score of Simmental male calves.

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