



Original Research

Ensilaging in Polyethylene Bags: A Low Cost Technology for Resource Poor Livestock Farmers

Manjunath Patil*, Anant Rao Desai¹ and Raju G Teggelli

ICAR- Krishi Vigyan Kendra, Aland Road, Kalaburagi, University of Agricultural Sciences, Raichur, Karnataka, INDIA

¹Department of Veterinary and Animal Husbandry Extension Education, Veterinary College, KVAFSU, Bidar – 585401, Karnataka, INDIA

*Corresponding author: manjunathpatilvet@gmail.com

Rec. Date:	Jun 28, 2018 05:13
Accept Date:	Oct 12, 2018 13:07
DOI	10.5455/ijlr.20180628051301

Abstract

An action oriented participatory method was used to popularize polythene bag silage (PBS). On-farm demonstrations were conducted on preparation of PBS and also to evaluate it. Dairy cows of control group (T_0) were maintained on regular feeding, while cows in study group (T_1) were fed with PBS. Daily milk yield was recorded for 60 days. Milk samples from individual cows were analyzed for fat, SNF, density, freezing point, protein, lactose and total ash. The increased milk yield in T_1 group on 30th and 60th days were highly significant ($p \leq 0.05$) when compared with T_0 group on corresponding intervals. The freezing point decreased in T_1 group indicating increase in the total solids of milk compared to T_0 . There were minor changes in ash content of milk by feeding with PBS. The increased cost on feeding in treatment group (T_1) due to addition of PBS preparation cost (Rs 13.65) is covered up by significant increase in milk production (2.29 litres/ cow/ day).

Key words: Dairy Cow, Milk Yield, Milk Composition, Maize Silage, Polyethylene Bag

How to cite: Patil, M., Desai, A., & Teggelli, R. (2019). Ensilaging in Polyethylene Bags: A Low Cost Technology for Resource Poor Livestock Farmers. International Journal of Livestock Research, 9(1), 166-173. doi: 10.5455/ijlr.20180628051301

Introduction

Year-round access to good quality forage is a physiological priority for ruminants and an economic priority for farmers. Green fodder is the most important part of ruminant nutrition. In rainfed regions, farmers face acute shortage of green fodder during lean periods. During this period, the farmers feed dry fodder along with the costly concentrates to fulfil the daily dietary requirements of dairy cows. The straws or stovers are less nutritious and are often deficient in vital nutrients resulting in decreased production, whereas the concentrates are economically not viable. Therefore, it is important to produce and conserve good quality



green forage in sufficient quantity. Conserved green forage is needed to maintain the body condition, productive and reproductive performance of the dairy cows during lean season. Silage is the conserved green fodder having moisture content in the range of 65 to 70 per cent. The process of preserving moist thick stemmed crops based on organic acid production by lactic acid bacteria under anaerobic conditions is called ensilaging (Banerjee, 2011). Various methods of ensilaging viz., tower, pit and trench silos etc. are in use, but under average Indian conditions, trench silos will be more practicable and convenient. The trench for the silo can be a simple excavation made in a hard ground and floor and sides hardened by ramming and mud plastering (Chakravarty, 2002). Cement concrete or brick or stone-slab lined trenches, however, are long lasting and seepage-proof.

However, capital investment for construction of silo irrespective of method is high. Also, labour requirement for ensiling process is more. Hence, these methods are felt uneconomical and thus the technology of silage making is less adopted by resource poor farmers. In this context, an alternate option for ensilage is the use of polyethylene bags which is economical and less laborious. The study was undertaken during summer (April and May) when there was scarcity of green fodder. The present study was carried out with an objective of finding the effects of feeding the lactating HF-Deoni crossbred cows with PBS on milk yield and composition. Also, economical benefits, advantages and disadvantages of PBS in comparison with conventional method of silage were studied.

Materials and Methods

Selection of Farmers

An action oriented participatory method was adopted for promoting silage making in polyethylene bags under NICRA (National Innovation in Climate Resilient Agriculture) Project. Melkunda (B) village of Kalaburagi taluk and district of Karnataka state was purposively selected for the study based on two criteria. Firstly, the village had rainfed agriculture with good number of HF-Deoni crossbred cows. The second criterion was a large percent of small and marginal farmers were involved in dairy production. Initially, a focused group discussion was conducted with the dairy farmers of the village, on conservation of green fodder as silage and its importance in lean season. South African Tall (SAT) maize fodder seeds were later distributed among ten farmers rearing HF-Deoni crossbred cows who showed interest in growing green fodder for silage. Technical inputs on fodder production were provided to these selected farmers. Method demonstration on silage making in polyethylene bag was conducted for the dairy farmers, more importantly for the selected farmers.

Preparation of Silage in Polythene Bag

Under the supervision and technical support of ICAR-KVK, Kalaburagi (Karnataka) scientists all the ten selected farmers prepared silage from the green fodder produced. Polythene bags and other inputs were

provided by ICAR-KVK, Kalaburagi. Fodder maize (South African Tall) was harvested when the grains reached the milk stage and was chaffed to a size of 1 inch. Care was taken that the moisture of chaffed maize fodder was around 60-65%. A useful field technique to check the moisture level is the squeeze test. In this method, handful of chaffed fodder is squeezed in the fist for about 30 seconds. Lump formation, with moisture between the fingers, indicates excess moisture (> 65%). Absence of lump formation with chaffed fodder crumbling from the fist and lack of wetting between the fingers indicates correct moisture (60-65 %). This is fit for silage making. Chaffed fodder was poured into the polythene bag; mixture of jaggery and salt in water was sprinkled over each layer of one foot to enrich silage. For 1 ton of chaffed green fodder, 2 kg of jaggery and 1 kg of salt were mixed in 10 litres of water. Filled forage in the bag was pressed as hard as possible to remove oxygen and to create anaerobic condition. These steps were repeated with continued filling and pressing. Once the plastic bag was full with chaffed green fodder, both the lips of the bag were tied tightly to ensure anaerobic condition inside the bag. Silage bag was stored away from direct sunlight and rain and kept it for 21 days. Weights such as stones, stone slabs were placed on the bag to ensure compression on the filled forage. A plastic bag filled with silage can be very heavy. It's therefore advisable to fill it on the position where it will be stored. After 21 days, golden yellow colour and sweet smell with acidic pH of 3.7- 4.5 indicates good quality silage.

Selection of Animals

Data on parity and stage of lactation of HF-Deoni crossbred cows reared by the selected farmers were collected. Those cows which calved in the last month of winter and which were in their second or third lactation were identified and shortlisted. Care was taken that at least two cows were selected from a single farmer. Based on the above criteria, 12 HF-Deoni crossbred cows belonging to six farmers (two each) were selected for this study. Based on the similar average milk yield, parity and stage of lactation the selected cows were grouped into control group (T_0) and study group (T_1), each having six cows. Out of the two cows with each farmer one was grouped in T_0 and another in T_1 .

Experimental Design and Feeding

T_0 acted as control group where no PBS was fed. T_1 cows were fed with PBS @15kg/day. T_1 cows were fed with PBS gradually 15 days before the start of the study so that the cows get adjusted with the diet. The cows in both the groups received a basal diet comprising of roughages and concentrates separately to meet the maintenance and production requirements. All the cows were fed with dry fodder ad libitum and maintenance concentrate ration of 1kg/cow. The production ration consisted of the concentrate mixture @1kg/3L of milk production. The concentrate mixture was prepared at respective farmer's house with the advice of ICAR-KVK, Kalaburagi scientists and composed of maize, cotton seed cake, wheat bran, rice bran, mineral mixture and salt. Concentrates were offered twice daily at the time of milking. The animals

were milked twice daily at 5.30 am and 4.30 pm throughout the study period. The study was carried out for 60 days during summer in March and April months.

Sampling and Analysis

The milk yield was recorded daily during 60 days of study period. Similarly, milk samples from the individual cows were collected twice a week and were analyzed for fat, SNF, density, freezing point, protein, lactose and total ash using the milk sample (Lactoscan®).

Statistical Analysis

In the present study, mean as a measure of central tendency and the standard error as a measure of random error were employed for the statistical analysis. The students t test ($p= 0.05$) was used to know the significant variation between the groups.

Results and Discussion

The effect of feeding of polyethylene bag silage to HF-Deoni crossbred cows on milk yield and composition are discussed below.

Effect of PBS Feeding on Milk Yield

The effect of feeding PBS on milk yield is presented in Table 1. Average milk yield in control (T_0) cows increased from 8.43, 8.56 and 8.61 L/day on 0, 30th and 60th day which were not significant. However, in treatment (T_1) cows it increased from 8.27, 9.67 and 10.56 L/day which were significant ($p\leq 0.05$). The percentage of increase of milk yield in control group was 2.14% and in T_1 group it was 27.69% which exemplifies the significant increase of milk yield because of feeding PBS. The increase in milk yield in control (T_0) group is the physiological increase in yield in the initial months of lactation. These results are in line with the findings of Lal *et al.* (2017) which revealed that there is a 16% more milk yield from corn silage due to better forage quality.

Effect of PBS feeding on Milk Composition

The effect of supplementing the diet with PBS on milk composition of HF-Deoni crossbred cows is presented in Table 1. In the control (T_0) group, fat percentage was increased from 3.93 on initial day to 4.12 on 60th day whereas in treatment (T_1) group the fat % increased from 3.81 to 4.96 % on 60th day of study period. Compared to control group the fat percentage was increased in the treatment group. (T_1) group, showed significant ($p\leq 0.05$) increase of SNF in milk. Significant increase in the density of the milk from cows that has been fed with PBS could be explained by the increase in the fat and the protein content of the milk. The freezing point of the milk decreased significantly after feeding of PBS for 60 days. The decrease

was due to increase in the fat and protein content of the milk in the treatment group. The increase of protein content of the milk in treatment group was significant on 60th day when compared with 0 day.

The results of milk composition were similar with other researchers. Khan *et al.* (2015) reported harvesting maize silages at a DM content between 300 and 350 g kg(-1) and feeding in combination with grass silage improved the forage DM intake by 2 kg/day, milk yield by 1.9 kg/day and milk protein content by 1.2 g/kg. The increase in milk and protein yields with the maturity of the maize silages were positively related to the increase in the starch/NDF ratio of the maize silages. Also, it is rich in metabolizable energy and supports higher DMI and milk yield.

Table 1: Effect of feeding PBS on Milk yield and Milk composition (Mean \pm SE)

Parameter	T ₀			T ₁		
	0 day	30 th day	60 th day	0 day	30 th day	60 th day
Average Milk Yield (L/day)	8.43 \pm 0.16 ^a	8.56 \pm 0.23 ^a	8.61 \pm 0.28 ^a	8.27 \pm 0.21 ^a	9.67 \pm 0.45 ^b	10.56 \pm 0.34 ^b
% Increase in milk yield on 60 th day over 0 day	2.14%			27.69%		
Fat (%)	3.93 \pm 0.15 ^a	3.95 \pm 0.26 ^a	4.12 \pm 0.10 ^c	3.81 \pm 0.50 ^a	4.43 \pm 0.32 ^b	4.96 \pm 0.51 ^b
SNF (%)	8.09 \pm 0.07 ^a	8.14 \pm 0.10 ^a	8.35 \pm 0.18 ^c	8.01 \pm 0.28 ^a	8.95 \pm 0.40 ^b	9.11 \pm 0.05 ^b
Density (g/cub.cm)	27.63 \pm 0.51 ^a	27.85 \pm 0.39 ^a	27.98 \pm 0.43 ^a	27.65 \pm 0.09 ^a	28.55 \pm 0.23 ^b	29.15 \pm 0.01 ^b
Freezing point (-oC)	-0.52 \pm 0.01 ^a	-0.52 \pm 0.05 ^a	-0.52 \pm 0.09 ^a	-0.50 \pm 0.10 ^b	-0.53 \pm 0.02 ^b	-0.57 \pm 0.04 ^b
Protein (%)	2.90 \pm 0.01 ^a	2.91 \pm 0.25 ^a	2.91 \pm 0.38 ^a	2.80 \pm 0.14 ^a	2.95 \pm 0.02 ^a	3.05 \pm 0.15 ^b
Lactose (%)	5.15 \pm 0.03 ^a	5.16 \pm 0.08 ^a	5.18 \pm 0.05 ^a	5.11 \pm 0.12 ^a	4.63 \pm 0.23 ^b	4.40 \pm 0.04 ^b
Ash (%)	0.59 \pm 0.10 ^a	0.60 \pm 0.10 ^a	0.61 \pm 0.09 ^a	0.60 \pm 0.10 ^a	0.61 \pm 0.05 ^a	0.63 \pm 0.03 ^a

^{a,b,c} Means bearing different superscripts differ significantly ($p \leq 0.05$) between groups at corresponding intervals of T₀ and T₁.

The lactose content of the milk increased by 0.03% in T₀ and it decreased in the treatment group by 0.71%. The decrease in treatment group could be explained by inverse relation between lactose and the protein and fat content of milk. The ash content of the milk in control and treatment group was 0.59, 0.60, 0.61 and 0.60, 0.61, 0.63 on 0, 30th and 60th days respectively. There were very minor changes in the ash content of the milk due to feeding of the polyethylene bag silage. Rezaei *et al.* (2015) obtained results on partial replacement of maize silage by amaranth silage up to 210 g/kg DM was possible in the diet of lactating Holstein cows. However, the maximum values for dry matter intake, milk yield, fat, protein and lactose were observed in the cows that were fed with the diet containing 105 g of amaranth silage/kg DM. Cattani *et al.* (2017) reported feeding sorghum silage, maintained milk composition and did not influence negatively milk coagulation properties, which have a great economic relevance for the dairy industry.

Advantages of PBS over Conventional Methods

Comparative advantages of PBS over conventional methods were also studied. The advantages of PBS were compared with the previous experiences of scientists in silage preparation and usage under conventional methods. The observations are presented in Table 2. Generally higher quality silage is obtained when a bag

is filled and stored properly. The PBS is completely sealed in the bag. This means that all the acid is retained in the silage, unlike that in pit silage where it seeps out through the bottom of the pit as effluent. This compensates for the longer pieces of forage and poorer compaction than that found with silage machinery, so that the quality of the silage is just as good. Bag silage can be closed properly by tying its top so it is not exposed to air after removal and is therefore unspoiled. Much of the silage in pits has been found to be spoiled due to poor sealing and exposure to air every day when the silage is removed for feeding. Ensilaging in bags can be done in low lying areas where pit silage can't be done due to seepage of water. Also, there is less risk of harmful moulds than for upright silos, because of less spoilage and much improved ventilation around bags. Ensilaging in a bag avoids the hard work of having to remove silage, as from a pit where silage must be dug out every day. Upright silos have inherent risks of falls and bunker silos and stacks posed rollover risks when packing, but in ensilaging in polythene bags there is reduced risk to workers. Initial investment and equipment requirement is very minimal. It is suitable for semi intensive, small or medium scale livestock farms.

One of the major disadvantages in PBS is rat bite and loss of silage. Farmers are advised not to use rat poison for control of rats, use rat traps instead. It is advised to store the silo bags in rooms where there is more human movement. Stacking silo bags on slated platforms also reduces the menace of rats.

Table 2: Comparison of PBS over conventional (Pit) method

Particulars	Polyethylene Bag Silage (PBS)	Conventional (Pit Method)
Dimensions and cost of silo (1 ton capacity)	3.28 ft x 3.28 ft x 3.94 ft @ Rs. 700/-	4 ft x 4 ft x 5.20 ft @ Rs. 45/cubic ft
Capital investment (Rs.)	700/-	3744/-
Annual maintenance cost (Rs.)	804/-	957/-
Advantages	Less labour requirement	Suitable for large livestock unit
	Less spoilage	More quantity can be stored
	Can be used 2 to 3 times	Can store for a longer duration
	Can have bags of different sizes	
Disadvantages	Rat bite, disposal	Laborious process, moisture seepage
Economics	Cheaper	Costlier

Economics of Plastic Bag Silage

Economics of PBS was calculated and is presented in Table 3. Every day, dairy cows in control group (T₀) were fed with concentrate feed (@1Kg/ 3Kgs of milk produced + 1Kg maintenance ration) and dry fodder (ad libitum). Dairy cows in treatment group (T₁) received PBS (@15Kg/cow) in addition with the daily diet provided to the control (T₀) group. The average cost of concentrate feed prepared was 21 Rs/ kg. Cost

of preparation of PBS including purchase of silo bag was 1.25 Rs/ kg. The market price of raw milk in the study area during the study period was Rs 40/ltr.

Table 3: Economics of feeding PBS to HF-Deoni crossbred cows during hot summer

Parameters	T ₀	T ₁
Total cost of concentrate feed (Rs/cow/day)	81.27	94.92
Cost of silage (Rs/cow/day)	0	18.75
Total expenses on feeding (Rs/cow/day)	81.27	113.67
Average Milk yield on 60 th day (Kg/cow)	8.61	10.56
Cost of feed on milk production (Rs/kg)	9.44	10.76
Daily income on milk sale (Rs/cow/day)	344.4	422.4
Profit (Rs/cow/day)	263.13	308.73

Total expenses on feeding (Rs/cow/day) for control (T₀) group and treatment group (T₁) was Rs 81.27 and Rs 113.67 respectively. Profit earned per day per cow in control (T₀) group and treatment group (T₁) was Rs 263.13 and Rs 308.73 respectively. By feeding PBS in lean season the farmers earned Rs 45.60 more per animal per day against not feeding greens or silage to dairy cows. Increased cost on feeding in treatment group (T₁) due to addition of PBS preparation cost (Rs 13.65) is covered up by significant increase in milk production (2.29 litres) due to feeding of PBS. Hence increasing the profits, Fadul-Pacheco *et al.* (2013) opined improved profitability made farms sustainable. These results are in line with the findings of Jaimez-García *et al.* (2017).

Conclusion

Ensilaging in polythene bags is the economical alternative for the farmers of rainfed region. Feeding Polythene Bag Silage (PBS) resulted in significant increase in milk yield of HF-Deoni cross bred cows. Lactose content, protein, fat and SNF increased significantly. The freezing point decreased in T₁ group indicating increase in the total solids of milk compared to T₀. There were minor changes in ash content of milk by feeding with PBS. The increased cost on feeding in treatment group (T₁) due to addition of PBS preparation cost (Rs 13.65) is covered up by significant increase in milk production (2.29 litres/ cow/ day). Based on the above results feeding PBS during lean season improved production and also economics of dairying. Improved profitability also improved farm performance and made dairy farming in rainfed areas a sustainable enterprise. It is advantageous over the conventional methods as low investment, better quality, ease in preparation, different sizes of polythene bags, low labour requirement, less space consumption and can be prepared in small quantities.

Acknowledgements

The authors gratefully acknowledge the funds granted for NICRA (National Innovation in Climate Resilient Agriculture) project by ICAR-CRIDA (Central Research Institute for Dry Land Agriculture) Hyderabad,

through ICAR-ATARI (Agriculture Technology Application Research Institute) Bengaluru to ICAR-KVK Kalaburagi.

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