

CONSTRAINTS IN PREPARATION OF SILAGE

K. Deepa*, S. Senthilkumar, T. Suganya, K. Kalpana and M.R. Purushothaman

Department of Animal Nutrition
Veterinary College and Research Institute, Namakkal – 673 002
Tamil Nadu Veterinary and Animal Sciences University
E-mail: kdeepa92@gmail.com (**Corresponding Author*)

Abstract: Silage is a product formed when grass or other material of sufficiently high moisture content (e.g., forage legumes and forage corn) liable to spoilage by aerobic microorganisms is stored anaerobically. However, ensiling forages has its own set of disadvantages. There can be extensive losses in storage if the silage is mismanaged. This loss of nutrients and other problems can be overcome by sufficient guidelines which need to be followed during ensilage.

Keywords: Silage, Constraints, Shrinkage, Seepage, Mycotoxins.

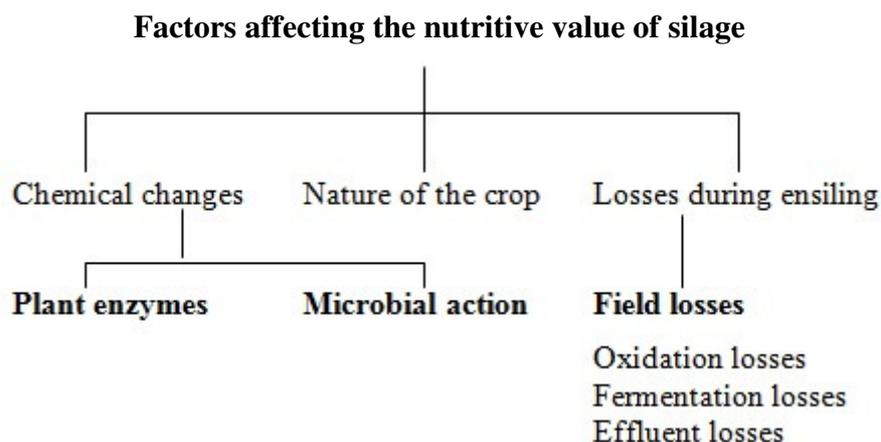
Introduction

Silage is formed by the process referred to as ensilage which takes place in a vessel or structure called a *silo*. The main purpose of silage making is to preserve succulent fodders for usage at the time of scarcity. Silage making involves natural fermentation in anaerobic condition with due care to discourage activities of undesirable bacteria. Voelcker (1884) was probably the first person to draw the distinction between nonfermented and fermented silage which he described as “**sweet silage**” and “**sour silage**” respectively. Various problems involved in silage making and guidelines to overcome it, are explained hereunder.

Problems in preparation of silage

The two major problems of silage making are

- Shrinkage (Dry matter losses)
- Spoilage (Heating due to aerobic organisms)



Chemical changes

Plant enzymes

Plant continues to respire as long as oxygen present or until the plant sugars are used up. Sugars are oxidised to carbondioxide and water, with the production of heat causing rise in temperature of the mass. In addition, proteolysis also occurs immediately after the herbage is cut. Protein is rapidly broken down to simpler substances mainly amino acids. Packing the silo compactly eliminates air pockets and prevents this activity. However, If the herbage is not well consolidated, then air may penetrate into the mass and the temperature will continue to rise. Thus over heated product will be dark brown or black in colour with low feeding value due to excessive loss of soluble carbohydrate and a lowering of the protein digestability.

Microorganisms

In anaerobic condition, the microbes present on the plant surface multiply, using the contents of a cell as medium to produce lactic acid. Thus the acidity of the mass drops to about pH 4.0 – 4.2 and at this pH, organisms other than the aciduric lactic acid bacteria are inhibited as long as conditions remain anaerobic. These aciduric organisms are classified into 2 main groups, the *homofermentative* lactic acid bacteria and the *heterofermentative* lactic acid bacteria. *Homofermentative* lactic acid bacteria are more efficient at converting hexose into the acid than the *heterofermentative* organisms.

Nature of crop

Legumes have low soluble carbohydrate content with high buffering capacity make them difficult to ensile. In order to obtain nutritious as well as maximum yield of crop, they should be harvested when 50% of the crop are in ear emergence stage as digestibility falls rapidly

with increasing herbage maturity. Chopping or crushing the crop exposes the cell sap which tends to produce more favourable condition for microorganism activity

Dry Matter Loss

- Dry matter (DM) losses occur during the three main stages of silage preservation namely the aerobic respiration stage after cutting, the anaerobic fermentation stage after sealing, and the aerobic feed out stage after the silo is opened. DM losses from silage range from 10% under good management to 40% under poor management. (Adesogan, 2014). Ideally, corn silage should be harvested at the moisture content appropriate for the type of silo used. The recommended moisture contents are 65–70 percent for horizontal silos, 63–68 percent for conventional tower silos, 55–60 percent for limited-oxygen silos, and 65 percent for silo bags.
- Heating and spoilage during feed out is one of the greatest contributors to DM losses. Spoilage occurs when yeasts and moulds that were dormant during the fermentation begin to grow and oxidize nutrients into carbon-di-oxide and heat after they are exposure to oxygen in the air. In addition to increasing DM losses, spoilage reduces silage quality. Undesirable fermentations can produce alcohol or acetic acid, resulting in “*up to a 24% loss of the original sugar*” (Muck, 2000). In uncontrolled silage fermentations, *45% of the protein will be broken down* (Carpintero et al.,1979).

Density and related losses

Richard Muck and Brian Holmes (2006) found that, as silage dry matter increased, both density (lbs. dry matter/ft³) and porosity increased leading to increased air movement and dry matter losses. Densities tended to decrease as particle size increased. Densities varied with the person operating the machine, indicating that correct operation of the bagger is critical to getting a smooth bag of high density. Densities varied dramatically across the face of the silo bag. The density of silage around the top outside half of the bag was only about 40 percent of the densest region on the bottom centre. Hence, any holes occurring in the top half of the bag would allow for the free flow of oxygen causing high amounts of spoilage throughout the top part of the bag.

Low concentration of simple Sugars

One problem with many types of silage is they contain a low concentration of easily fermentable carbohydrates. The bacteria that produce lactic acid are unable to operate well if there isn't a good supply of simple sugars. This is a common problem in silage made out of grasses such as alfalfa that contain large amounts of cellulose, a complex carbohydrate, and

not a lot of simple sugars like the starch in corn or other grain silage. Decreased lactic acid production gives destructive bacteria a chance to breakdown the silage and produce butyric acid, a product that gives poor quality silage a distinctive sour smell and taste.

Compacting silage isolates the lower layers of silage from outside air but the top layer can still spoil due to the *availability of oxygen* for the bacteria contained within. *Rainwater* can also cause problems by neutralizing the acidic conditions created within the silage. To solve these two problems silage is usually covered and sealed from the environment. Molasses can help with this. Spreading a thin layer of molasses over stockpiled silage forms a barrier between the silage and the environment. Compared to leaving silage uncovered just a 1/2” of molasses can reduce spoilage by up to 50%. Using molasses as a cover also doesn't create any waste because it remains as part of the feed when the silage is used.

Seepage

Silage leachate (SL) is the term used to describe liquid runoff from silage piles in upright structures, bags or bunkers. Leachate is an organic liquid that is the result of pressure in the silo or the presence of excess water. Properly ensiled silage results in little or no leachate. SL seeping from silage piles presents a serious environmental problem. On average, leachate is 40 times stronger than dairy parlor wastewater and up to 200 times stronger than raw sewage. The acidity of SL nutrients can harm groundwater or kill vegetation in the area where it drains. It also has a high biochemical oxygen demand (BOD), meaning SL has a high potential for consuming oxygen. When leachate enters a stream or pond, it removes the oxygen necessary for marine life. High ammonia levels in leachate are also toxic to fish. The phytonutrients may also cause algae blooms.

Control and Disposal of Silage Leachate

- Locate silos as far as possible from water resources — surface water, wells, sink holes, and any direct path to groundwater. The minimum recommended distance is 300 feet.
- Divert leachate to a well-ventilated, open-top manure storage facility or filter it through the use of buffer areas or constructed wetlands. Do not add SL to enclosed storage facilities. When mixed with manure, SL produces hydrogen sulfide and other hazardous gases that can kill animals and humans.
- Keep clean water from mixing with the silage with diversion trenches, roofs or covers over the silo. This protects the quality of the silage and decreases the potential for leachate runoff.(Harner, 2006)

Losses of Nutrients during ensilage

- *Field losses*: Harvesting and ensiling on the same day prevents loss of water soluble carbohydrates and protein. ***Wilting beyond 5 days leads to 6 to 10 % dry matter losses.***
- *Oxidation losses and Fermentation losses*: In the presence of oxygen, the action of plant and microbial enzymes on substrates such as sugars, leads to the formation of CO₂ and water. Rapid filling of silo and compression eliminates air pockets leaving anaerobic condition suitable for ensiling and thereby preventing oxidation losses. Even though considerable biochemical changes occur during fermentation, ***the net dry matter loss may not exceed 5%*** and energy loss may be still lower as high energy compounds like ethanol are formed during ensiling.
- *Effluent losses*: Effluent are highly nutritious as they contain sugars, soluble nitrogenous compounds, minerals and fermentation acids. The amount of drainage effluent produced depends largely upon the initial moisture content of the crop. Crops ensiled with moisture of 85% may result in effluent dry matter losses as high as 10%, whereas crops wilted to about 70% moisture produce little effluent.

Aerobic Spoilage

The progression of aerobic instability appears to be as follows:

1. Crops with high natural yeast populations are ensiled.
2. Yeasts grow until oxygen is fully consumed, then become dormant and silage fermentation may continue and produce lactic acid.
3. At feedout, feed is exposed to oxygen.
4. Yeasts begin to grow, usually within a few hours of air exposure.
5. Lactic acid is metabolized by yeasts, resulting in loss of DM and TDN and producing heat.
6. Other silage acids are volatilized.
7. Silage pH rises as the acids in the silage are lost.
8. Molds with low oxygen requirements begin to grow.
9. Digestibility and palatability further decline.

Mycotoxins

The presence of mycotoxins is a significant problem in silages. Mycotoxins are toxins produced by molds and can be found in varying degrees in nearly any corn silage. There are a multitude of different strains such as aflatoxin, vomitoxin, zearalenone, T-2 and fumonisins. At high enough levels, mycotoxins will affect the immune systems, milk production and

reproduction in goats. For those who choose to feed corn silage to goats, it's always good insurance to include a mycotoxin binder in any purchased grain mix—there are a number of different types on the market. If there's one strong argument for avoiding silage as a feed for goats, it's probably the uncertainty of mycotoxins and other moulds.

Guidelines to avoid losses

- **Sufficient moisture** – The bacteria that can create a desirable fermentation need water to live, grow, and produce acid. Having enough moisture also speeds chopping and enables you to expel the air in the silo more effectively. *Sixty-five percent moisture is a good average.*
- **Maturity** – Plants should have sufficient maturity and strength so that the plant cells can resist crushing in the silo that can cause seepage. Plants should also have sufficient maturity to assure an adequate nutrition return from each crop acre. Forage sorghums, for example, contain an adequate level of nutrients at the early dough stage. But harvest is usually delayed until the lower leaves start to turn brown in order to avoid seepage. Recommended stages of harvest for legumes are at its 10% bloom stage while for grasses, it should be harvested just before flowering.
- **Proper Cutting** – Keeping knives sharp and the shear bar properly adjusted will save fuel. This will also damage less plant cells, reducing seepage risks. A reasonably short, uniform cut makes packing easier.
- **Compaction** – Use your heaviest wheel tractor for packing a bunker. It is especially important to have enough plant moisture for a good pack. For upright silos use a distributor.
- **Fill quickly** – Fill your silo fast to minimize exposure to air.
- **Cover with plastic** – Cover bunkers or upright silos with plastic when filling is completed to prevent silage from being exposed to air and rain water. Take care to weight down the outside perimeter of the plastic. In upright silos, weigh down the plastic with several inches of wet forage or dry grain – the latter can be fed out when you open the silo. For bunkers or stacks, plastic is best weighed down with old rubber tires. Put on as many as you can.

References

- [1] Adesogan, T (2014). Avoiding the Two Greatest Silage Problems, Proceedings 50th Florida Dairy Production Conference, Gainesville. pp 9-18.
- [2] Carpintero, C.M., A.R. Henderson and P. McDonald (1979). The effect of some pre-treatment on proteolysis during the ensiling of herbage. J. Br. Grassland. Soc. 34:311.

- [3] Harner, J.P. (2006) Leachate: A Problem with Potential Benefits Technical bulletin pp2-6.
- [4] Muck, R. (2000). Inoculants for corn silage. Focus on forage 2(2). Madison, WI: University of Wisconsin.
- [5] Muck, R. and B. Holmes (2006). Bag Silo Densities and Losses. Transactions of the ASABE. Vol 49(5): pp. 1277-1284.
- [6] Voelcker, A. (1884). On the chemistry of ensilage. Journal of the Royal Agricultural Society of England, 20: 482-504 (Second series).