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Conservation of Fodders–Silage and Hay Making

SILAGE MAKING

When green fodders are in plenty, they are conserved as either silage or hay to meet the demand of good quality fodder during lean season. The awns (spear grass) and thorns in some species may be rendered quite innocuous through ensiling. Weed seeds die off in the silo. Silage can be defined as a green material produced by controlled anaerobic fermentation of green fodder crop retaining its moisture content. Silage is the green succulent roughage preserved more or less in its original condition, with a minimum deterioration and minimum loss in respect of various nutritive constituents of fodders. The process of conserving green fodder is called ensilage. Silo is the receptacle in which silage is made. The best silages are moist to the touch, soft but not slimy and fragrant in their own characteristic way.

Green, fruity silage is the most palatable and nutritious type. This can be produced only under careful management from crops that are cut at the right stage with a dry matter of 35%. A dark-brown colour indicates excessive heating.

Crops Suitable for Silage Making

1. *Kind of crop*

a. Crops rich in soluble sugars/carbohydrates are most suitable for ensiling, e.g., maize, sorghum, bajra.

b. Cultivated and natural grasses can be ensiled with addition of molasses at 3 to 3.5%.

c. Mixture of grasses/cereal fodders and legumes such as berseem, lucerne, etc., in a ratio of 3:1.

d. Unwilted leguminous leafy fodders and dry forage in the ratio of 4:1.

2. *Stage of harvesting*

Crop should be harvested between flowering and milk stage. In general, crops with thick stems are conserved in the form of silage while thin stemmed crops are conserved as hay.

Preparation of Silage

Silo

A silo is an air tight structure designed for the storage and preservation of high moisture feed as silage. Pit silos are more common in India. The pits are dug 2.4 to 3.0 m deep, with variable sizes. One cubic metre of space is required for 400 kg fodder.

Requisites of a Silo

1. The walls should be impermeable so that water can't gain entry into the silo pit. Walls may be made of cement or brick and mortar.
2. Silo should be sufficiently deep. It should not be shallow. The depth depends on the water table in the locality.
3. Silo must be located on an elevated ground.
4. The size of the silo should be calculated on the basis of the number of animals to be fed, the length of feeding period.

Method of Preparing Silage

1. Select the crop that is to be ensiled when it has 30-35% dry matter. In case the crop has less than 30% dry matter, allow it to dry for 3-4 hours so that the dry matter content would increase to 30-35%.
2. Generally, the crops are harvested and ensiled when the ears start coming.
3. Select the days of the week when the weather is fair and not rainy.
4. Silo can be filled with long fodder as well as with chopped fodder. It is always better to chop the fodder first since packing is better. Thus, loss of nutrients is minimized with chaffed fodder. Further, filling and removal of silage is easier.

5. After chaffing and ensuring that dry matter is around 35% the silo is filled with fodder.
6. The fodder should be evenly distributed throughout the pit. Trampling should be done properly either with men or tractor or bullocks depending upon the size of the pit. At the top of the silo the fodder should be packed 3-4 feet above the ground level.
7. From all the sides it should be covered with long paddy straw or poor quality grasses and then covered with wet mud and dung to seal the material preventing the entry of air and water. The layer of straw/grasses (over the green fodder) may be about 4 to 5". The silage would be ready in two months after covering.
8. Salt at 0.5% and urea at 1% are added to cereals and grasses to improve the palatability and nitrogen content. In grass silages, molasses is added at 3 to 3.5% to improve the sugar content and thus quality of silage. In a more mature crop higher level of molasses (5%) may be added.

Changes During Fermentation

Carbohydrates

When green crops are cut up and packed in air-tight silo pits or towers, fermentation occurs to convert it into silage. Plant respiration continues for a short time after the material is packed in the silo pit. Enzymes, aerobic bacteria, yeast and moulds become active until all the oxygen in the packed material is used up. The respiration also uses up some of the carbohydrates in the plant material, giving off CO_2 and water. There is also a production of energy which contributes to the heat, with a rise of temperature to about 27 to 38°C, particularly in the early stages of the fermentation process (aerobic phase).

The remaining carbohydrates are then broken down to their monomers glucose and fructose, which are water soluble and are the major carbohydrate sources for microbial purposes.

Proteins

Proteases are important enzymes responsible for undesirable changes in plant proteins during the first 5-7 days of ensilage. A proportion of the protein is degraded to nonprotein nitrogen compounds, mainly free amino acids, ammonia, amides and amines. The free amino acids may be metabolized further. Aspartate is thus degraded to α-alanine and glutamate

Aspartate → α alanine
glutamate → α amino Butyrate

to α-amino butyrate. These two reactions are particularly important, since the two amino acids are limiting factors for the growth and development of lactic acid bacteria. The activity of plant proteases is influenced by factors such as the pH and dry matter content. The optimum pH for proteolysis is around 6 for most silage crops, with activity declining linearly between pH 6 and 4 because proteases are acid labile and cease to function 5-7 days after ensilage when the acidic condition is established.

Other plant enzymes such as polyphenol oxidases may contribute to changes in the protein value of silage. Under improper ensilage conditions and in the presence of oxygen, the enzyme causes formation of quinones which combine with proteins and eventually leads to the formation of brown colour by the Maillard reaction process. While proteases convert proteins to soluble compounds of some value, the polyphenol oxidases and the Maillard reaction sequence make proteins biologically unavailable to the animal.

Types of Fermentation

Two main types of fermentations occur: Lactic acid type and Butyric acid type. When the fodder contains 65 to 75% moisture and sufficient sugar in the plant juices, anaerobic lactic acid bacteria become active, to produce eventually a good, clean-smelling silage of high quality. If the acidity rises to about 1% at the start itself, the silage will be of good quality, as the lactic acid checks the activity of undesirable organisms (pH around 4.0). Harmful bacteria, for example, those producing butyric acid are inhibited. It is thus essential that the forage used should contain a high percentage of carbohydrates.

Two fermentation types of lactic acid bacteria are involved: homofermentative type and heterofermentative type. In case of homofermentative type, 2 moles of lactic acid are formed per mole of glucose or fructose under anaerobic conditions; heterofermentative type forms anaerobically 1 mole of lactic acid, 1 mole of ethanol, and 1 mole of carbon dioxide per mole of glucose and mannitol, acetic acid and less lactic acid per mole of fructose. Heterofermentative type is less efficient than the homofermentative one in terms of lactic acid production. The homofermentative lactic acid bacteria remain active only in the first few days (10-14) of ensilage, during which time they account for 85% of the total bacterial population. As fermentation of silage proceeds, the heterofermentative bacteria become dominant because the homofermentative bacteria are less tolerant to acidity than the heterofermentative types. In well-made silages, the overall amount of lactic acid should be 60% of the total acids by the end of ensilage so that homo-fermentation of silage is encouraged.

If the forage is too rich in proteinaceous substances, the butyric acid type of fermentation will predominate. Butyric acid has a sharp, disagreeable odour and the silage is not relished by the animals. Clostridia are the principal anaerobic microorganisms which are detrimental to silage quality. They are classified into saccharolytic and proteolytic groups, both of which require wet conditions for an active growth. The result of the saccharolytic clostridial fermentation is mainly butyric acid, with some byproducts such as carbon dioxide and hydrogen. Proteolytic fermentation results in a variety of products such as ammonia and volatile amines. The presence of ammonia in silage may contribute to the high silage pH and often leads to a reduced intake of silage by ruminant animals. Hence, optimum moisture content of the fodder ensiled is important.

Under optimal conditions, lactic acid forms rapidly and lowers the pH to 4.0 or below, where it remains constant. This normally inhibits clostridial growth but, with excessive moisture, clostridial growth can occur at a pH as low as 4.0. Clostridia attack already formed lactic acid and residual soluble carbohydrates and thereby raises the pH and set the stage for putrefactive organisms to operate. A rapid fall in pH inhibits such degradation of amino acids and its effect on the quality of the silage.

Grasses, legumes are more difficult to ensile. Grasses are low in soluble carbohydrates. Legumes have higher moisture levels, higher proteins and minerals which raise the buffering capacity of plants and thereby their ability to resist pH change and these must be overcome to make satisfactory silage.

Buffering Capacity of Plants

The buffering capacity of plants or their ability to resist pH change is an important factor in ensilage. Most of the buffering properties of herbage can be attributed to the anions (organic acid salts, orthophosphates, sulphates, nitrates and chlorides) with only about 10-20% resulting from the action of plant proteins. Legumes usually contain higher amounts of organic acids than grasses. The level of organic acids is about 60-80 g/kg DM in legumes compared to 20-60 g/kg DM in grasses. Malate and citrate are the major acids, and they are metabolized by plant enzymes to varying degrees to succinic acid and lactic and acetic acids, respectively. Other acids include malic, quinic, fumeric, shikimic. Because of the buffering power of these products, there are often difficulties in ensiling legumes successfully.

Preservatives

Sodium metabisulphite causes partial sterilization. Dose is 4 to 5 kg per 1000 kg of forage. It checks bacterial growth, and reduces the final acidity.

Bacterial cultures and other microorganisms

Mixed culture of lactic acid producing bacteria

Important Conditions for Success in Silage Making

1. Storing the plant material at a moisture content of 65 to 75%
2. Excluding air
3. Encouraging a rise of temperature to 30 to 38°C. When it is not possible to secure these optimum conditions, it is helpful to add some preservatives or 'silage conditioners'. Molasses, salt, cereal grains, citrus pulp act as preservatives and enhance feeding value. Sodium metabisulphite modify fermentation process and reduce the smell.

Why is Exclusion of Air from the Silo Needed?

1. To minimise the loss of nutrients due to respiration
2. To initiate the growth of lactic acid producing bacteria rapidly
3. To prevent the development of undesirable aerobic organisms which produce a lot of heat at the expense of nutrients which they oxidise
4. Aeration promotes the activity of mould, which spoil the silage and make it unpalatable.

Colour of the silage

When the temperature in the silo is moderate the silage tends to be yellowish or brownish green and sometimes even golden in colour. This is due to the action of the organic acids on the chlorophyll, and converts chlorophyll into the brown magnesium-free pigment, phaeophytin. Silage is dark brown or black, when temperature in the silo is high.

A.I.V. method of silage making

Silage was popularised in America in 1917, when lucerne was successfully ensiled. The method of making silage by using acid additives was