

BIHAR ANIMAL SCIENCES UNIVERSITY

Bihar Veterinary College, Patna

Department of Animal Nutrition

UG Lecture (UNIT-I)

Conservation of Livestock Feed through Silage Making

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Conservation of fodder ?

It means preservation & careful maintenance of certain quantities of fodder unchanged during chemical reactions or physical transformations of fodder when it is excessively available for future needs.

Objective

- To preserve feed when it is available in excess
- To maintain optimum nutritional value of fodder
- To shift available feed from the present to the future
- To move feed from one location to another location
- To assist pasture management

Methods of Conservation

- Hay & silage are the main methods of conserving forage
- Hay is preserved by drying
- Silage involves natural fermentation, which produces lactic & other acids, which 'pickle' or preserve the forage

What is silage?

- Silage is the green material produced by controlled fermentation of the green fodder crop retaining the high moisture content
- Contain 25-35% DM & 14-16% CP

Advantages of silage making

- **Prepared from green fodder**
- **Prepared from plants having thick stems & are generally not very suitable for haymaking like sorghum, maize etc.**
- **Weeds can also be utilized along with main fodder crops for silage making**
- **Silage making kills majority of weed seeds**
- **Highly palatable**
- **Organic acids produced in the silage are similar to those normally produced in the GIT of ruminants so, used in the same manner**

What is the Principle of Silage making?

- Anaerobic condition is first & foremost requirement for silage making, as it allows lactic acid bacteria to grow, which converts sugars into lactic acid, a strong organic acid.
- When pH declines, the degrading actions of plant enzymes and undesirable bacteria are inhibited & at pH 3-4, most degrading enzymes are inhibited & the growth of lactic acid bacteria is also inhibited.
- **Sugars + Oxygen** \longrightarrow **Carbon dioxide + Water + Heat**
(this reaction is prevented and nutrient loss is reduced).
- In simple words the principle of silage is the same as that in making pickles.

Selection of crops for silage making

- **Contain high level of fermentable sugar**
- **Low level of protein**
- **Should have about 35 % dry matter at the time of ensiling**
- **Pasture grasses like Elephantgrass (Napiergrass), Guineagrass, Rhodesgrass, Sudangrass, Setaria, Ruzigrass, etc.**
- **Pasture legumes like Stylo**
- **Fodder tree like Leucaena, etc.**
- **Corn & Sorghum**
- **Farm by-products**

Site for construction of silo

- **Silo should be elevated from other places.**
- **Place must be free from water logging**
- **Walls of silo pit must be leak proof**
- **Should be at least six feet away from animal shed**
- **Try to construct the silo **south side** of the animal shed**
- **Silo size is determined by a herd size, amount of daily feed intake, and packed density of the raw materials.**

Making of Silage ?

- **Harvesting of Pasture grasses: From early heading to heading stage**
- **Pasture legumes: From budding to early flowering stage**
- **Corn: Yellow ripening stage**
- **Sorghum: Dough/milking stage**
- **65-70 % moisture level in green fodder is ideal for silage making (if moisture level is high wilting is required).**
- **High moisture content leads to poor fermentation**
- **Chopping of forage to short length (1-3 cm), so, that the packing density is kept higher, lactic acid fermentation takes place in good condition**

Cont....

- **Chopped fodder to make a bed of 2 feet height in Silo-Pit**
- **Compact forage as tightly as possible with help of tractor or hand roller**
- **Sprinkle Molasses solution over it @ 2-3% of the material weight**
- **If the moisture content is high, molasses addition may have no effect**
- **When the moisture content of the raw materials is 80% or higher, brans are evenly sprayed @10% of material weight**
- **Seal the pit airtight with plastic cover & should be pressed with heavy objects like bricks or tire**
- **Maintain sealing for 45 days**
- **Once silo-pit will be open, it should be finished within 45-60 days to avoid fungal contamination**

Application of Silage additives

- Increase DM (nutrient) recovery
- Improve animal performance
- Decrease heating & molding during storage & feed out
- **Direct acidifiers** like Inorganic/organic acids – decreases pH (e.g. Sulphuric and formic acids)
- **Fermentation inhibitors** that immediately decreases pH (e.g. formaldehyde, Maxgrass, Add safe, sorbic acid salts)
- Provide substrates for fermentation e.g. molasses
- **Enzymes** - speed-up fermentation e.g.. cellulase

Silage inoculants

- Primary purpose for adding bacterial inoculants is to increase the number of lactic acid-producing bacteria
- Homo- fermentative lactic acid bacteria e.g. *Lactobacillus plantarum*, *Enterococcus faecium* and *Pediococcus* spp.
- Hetero-fermentative LAB include, *L. buchneri*

Types of fermentation during Silage formation

- **Homolactic fermentation (homofermentative pathway)**
 - Very desirable, common in high sugar grasses
 - Sugars fermented to lactic acid, low pH nutrient loss
 - Mediated by *Lactobacillus plantarum*, *L. acidilacti* etc.

- **Heterolactic fermentations (heterofermentative pathway)**
 - Less desirable, occurs when limited sugars are available
 - Mediated by *Lactobacillus brevis*, *L. buchneri*
 - Sugars mainly fermented to acetic acid, & alcohols
 - Less efficient than Homolactic fermentation

Secondary fermentation

- **Very undesirable**
- **Degradation of lactate by clostridial bacteria**
- **Facilitated by high moisture contents & high pH**

Fermentation process of silage

First stage (respiratory stage)

- **The packed raw materials are still respiring immediately after chopped and consumes oxygen**
- **The temperature will rise to about 32°C around 4 days after packing**

Second stage (early fermentation)

- **Production of acetic acid, formic acid and other organic acids as a result of the growth of facultative aerobic bacteria such as Enterobacteria**
- **The silage pH slowly changes from about 6.0 to 4.0**

Third stage (Lactic acid fermentation)

- **Lactic acid fermentation begins by lactic acid bacteria which are strictly anaerobic about 3 days after packing chopped materials and acetic acid production decline**

Fourth stage (Lactic acid fermentation)

- **Lactic acid production continues for about 2 weeks**
- **The temperature goes down slowly to about the normal atmospheric temperature and pH is maintained at 4.0**

Fifth stage (Stabilization phase)

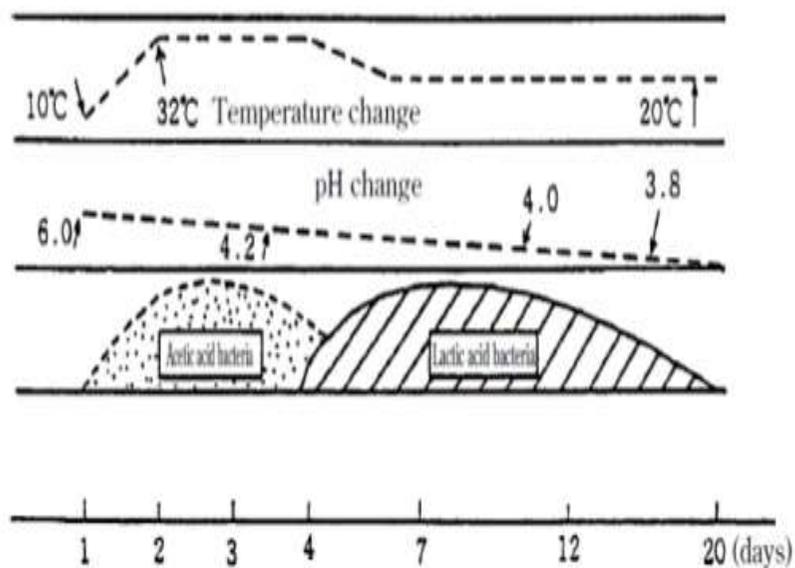
- **Due to the presence of lactic acid, further degradation is inhibited, as bacterial and fungal growths are checked**
- **The lactic acid fermentation completes in about 20 days**

“Fermentation at glance If the lactic acid production is insufficient, butyric acid fermentation begins and quality deterioration occurs”

Chemical changes during fermentation

- **Sugars are fermented into volatile fatty acids (VFA) like lactic, acetic, propionic & butyric) acids by anaerobic microorganisms**
- **The formation of the acids reduces the pH (target = 4)**
- **Protein is degraded into ammonia & NPN (target =<100g ammonia/kg total N)**

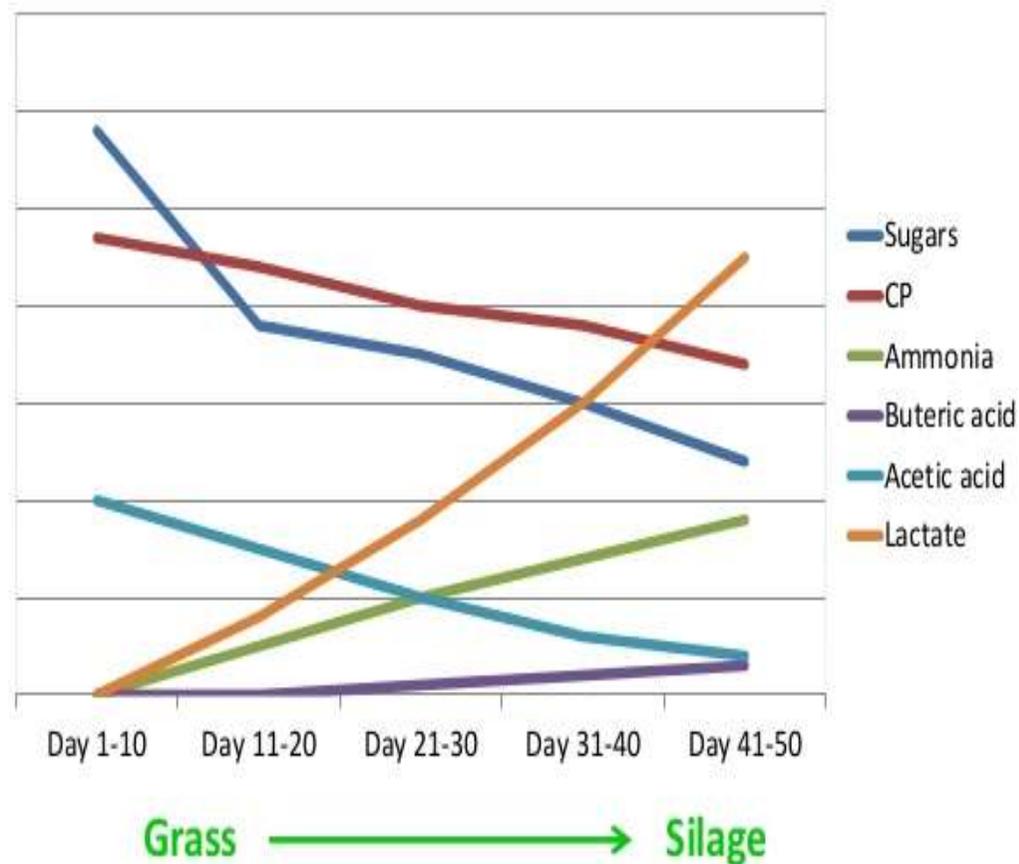
Figure 2. Diagram showing the fermentation process of silage



Fermentation at glance

If the lactic acid production is insufficient, **butyric acid fermentation** begins and quality deterioration occurs.

Chemical changes during fermentation



Judging the quality of silage

The quality of silage can be judged by its color, smell, taste and touch

Color:

- **In general, pale yellow indicates good quality**
- **If the color is from dark brown to dark green, the silage underwent bad fermentation and is of bad quality**

Smell:

- **Acidic or a sweet-sour pleasant smell indicates good quality**
- **On the other hand, if there is a manure smell or putrid smell & it is so repugnant that one can't put the silage near one's nose, the quality is poor**

Taste:

- **If the silage tastes sour and there is no problem in putting it in one's mouth, the quality is good.**
- **On the other hand, if the silage tastes bitter and one cannot put it in one's mouth, the quality is poor.**

Touch:

- **When squeezing the silage tightly in a hand and then opening the hand, if the silage breaks slowly into two, that silage is of good quality**
- **If the silage breaks into small pieces separately, the silage is deficient in moisture content**
- **If water is dripping, the moisture content of the silage is too high.**

Feeding of silage

- **2 - 3 year old cattle 11-13 kg**
- **3 - 8 year old cattle 13-22 kg**
- **sheep 1-1.5 kg per 45 kg live wt.**
- **goats 1-1.5 kg per 45 kg live wt.**

Size of a silo

- The silo size is determined by a herd size, the amount of daily feed, the number of feeding days and packed density of the raw materials.

Approximate * Silage Bunker Capacities **		
Silo Dimensions height X width X length (feet)	Well Packed Silage ¹ (wet tons) 65% Moisture	Low Packed Silage ² (wet tons) 65% Moisture
8 X 50 X 100	979	795
8 X 50 X 150	1,551	1,260
8 X 50 X 200	2,397	1,947
12 X 75 X 100	1,980	1,609
12 X 75 X 150	3,238	2,631
12 X 75 X 200	4,495	3,653
12 X 100 X 200	6,244	5,073
12 X 100 X 250	7,497	6,498
12 X 100 X 300	9,750	7,922
16 X 150 X 300	18,601	15,113
16 X 150 X 400	25,460	20,686
16 X 150 X 500	32,319	26,259
20 X 150 X 300	21,810	17,121
20 X 150 X 400	30,040	24,408
20 X 150 X 500	38,721	31,095

Nutrient losses during silage making

- **Energy losses in silage**
- **DM content, season, unloading technique**
- **Seepage losses etc.**
- **Inhibition of bacteria and mold growth**
- **Formic and propionic acids are commonly used as preservative to prevent bacterial and mold growth**
- **Formic acid is added to hay crop silages @ 0.45% of the wet weight or 2.25% of the DM weight**
- **Propionic acid is added @ 0.5 to 1.0% of the wet forage weight**
- **To increase the nutritive value of silages, such as cereal grains, molasses, dry forages, limestone, urea & anhydrous ammonia etc., are added to silage**

Energy losses in silage and causative factors			
Process	Classification	Approximate loss (%)	Causative factors
Residual respiration	Unavoidable	1-2	Plant enzymes
Fermentation	Unavoidable	2- 4	Microorganisms
Effluent	Mutually	5 -7	Dry matter content is too low
Wilting losses	unavoidable	2- 5	Weather, technique, crop
Secondary fermentation	Avoidable	0 - 5	Buffering capacity, Dry matter content is too low
Aerobic deterioration during storage	Avoidable	0 -10	Delayed filling and compaction, sealing, crop susceptibility
Aerobic deterioration after unloading	Avoidable	0 -15	As above, DM content, season, unloading technique and rate
Total		7- 40	

Cont....

Table 1. Corn silage parameters

Parameters	Minim	Maxim
Dry Matter, %	27	37
Crude Protein, % DM	7	-
NPN, % DM	< 5	
Starch, % DM	25	-
ME, MJ/kg DM	> 8	
NEL, MJ/kg DM	> 6	
Ash, % DM	3	5
ADF, % DM	20	26
NDF, % DM	40	45
Sugar, % DM	2	4
Fat, % DM	3	5
Lactic Acid, % DM	3	7
Acetic Acid, % DM	< 2	
Butyric Acid, % DM	< 0,1	
Propionic Acid, % DM	< 1	
Ethanol, % DM	1	3
pH	3,8	4,5

Discussions.....

Questions, if any.....??

THANKS