



SILAGE MAKING AND SILAGE FEED

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WHAT IS SILAGE ?



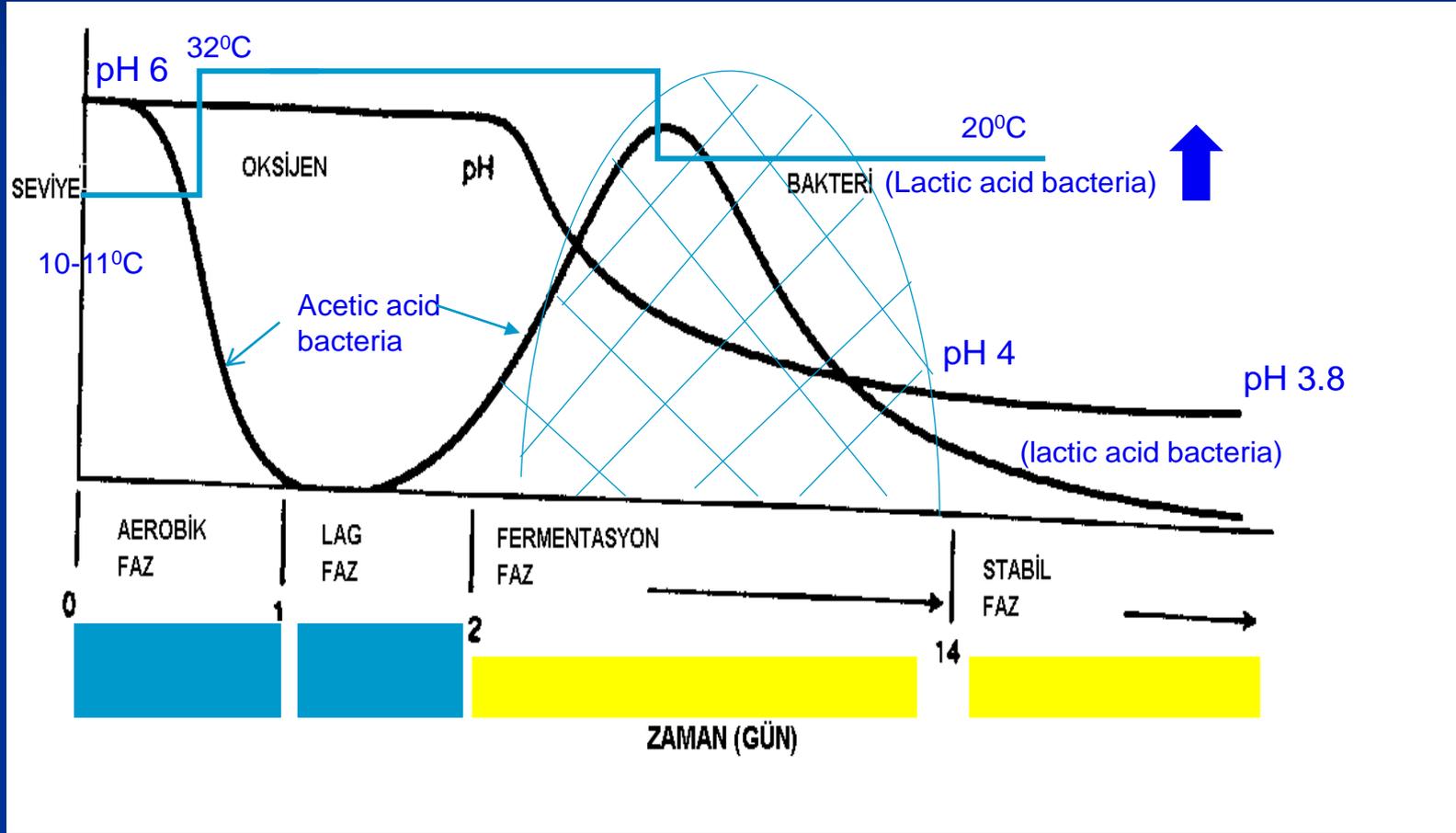
WHAT IS SILAGE ?

The fermented feed obtained by storing the green feed containing sufficient dry matter (30-40%) under anaerobic conditions after harvesting is called silage feed.



There are three important factors in making silage feed .

1. Chemical composition of silo feed, (readily soluble carbohydrate)
2. Oxygen input to silo feed, (risk of feed spoilage)
3. Activation of bacterial population (Level of lactic acid bacteria)





Continuation of fermentation depends on the composition of roughage. In order to provide good protection in fermentation, lactic acid production in the silage feed should be high, pH should be low, sugar content should be sufficient and buffer capacity should be low.



Question;

What should be done to maintain good fermentation in silage feed?

- lactic acid production in the silage feed should be high,
- pH should be low,
- sugar content should be sufficient
- buffer capacity should be low.



Suitable Forage Crops to be Preserved as Silage

Corn is preserved as silage more easily than grasses or alfalfa because of its high sugar content, low protein content and low buffering capacity. In contrast, alfalfa is more difficult to ensile well because of its low sugar content and high buffering capacity, which is due in part to its high protein content. Thus the higher the quality of alfalfa, the more challenging it is to ensile successfully.

Table. Chemical Composition and Buffering Capacity of Typical Forage Crops.

Crops	Water Soluble Carbohydrate (g/kg DM)	Crude protein (% DM)	Buffering capacity (mEq/kg)	“Aptitude” for silage preservation
Corn	80-300	80-100	150-300	High
Grasses	35-300	100-160	250-550	Intermediate
Alfafa	20-150	140-200	350-650	Low



Criteria to determine silage feed requirement and silo size ;

- Number and type of animals to be given silage feed
- Feeding time
- Percentage of silage in the total ration;
- Moisture/dry matter content of silage;
- The percentage of loss that will occur during and after silage making;
- Silage volume





Calculation of silage feed requirement and silo area;

- A cow;
- 180 days feeding period;
- 30% of 40 kg feed ration;
- 65% water content for silage;
- On average, 15 percent loss occurs due to spoilage.
- 0.8 metric ton/m³ volume
- Calculating the amount of silage needed and silo area with using this informations.



Calculation of silage feed requirement and silo area;

- Required amount of feed: 1 cow x (30% of 40 kg) x 180 day = 2160 kg feed;
- When total losses are subtracted (15% loss): In this case, 15% more silage is required, so $2160 \text{ kg} \times \%115 = \underline{2484} \text{ kg}$ silage, required for each cow for 180 days.
- Required silo area: 400 kg/m³ volume; so $2484 \text{ kg} / 400 \text{ kg} = 6.21 \text{ m}^3$ silo capacity for each animal.



Calculation of silage feed requirement and silo area;

- Considering 10 cows for 30% of the ration for 180 days;
- $10 \times 2160 \text{ kg} = \underline{21\,600 \text{ kg}}$ silage; and $10 \times 6.21 \text{ m}^3 = \underline{62,10 \text{ m}^3}$ silage area. Therefore, a trench, pile or bunker silo that is 8.7 meters long, 3.7 meters wide and 1.9 meters high will be sufficient. However, it is recommended to build a slightly larger permanent silo for future expansion. .

ADVANTAGES OF SILAGE

- 1. Loss of nutrients in silage feeds is minimum.
- 2. Better quality feed in bad weather conditions.
- 3. In the winter months when there is no green feed, in dry summer months and even in cases where pasture is inadequate, animals are provided with high quality, cheap and rich water-rich feed.



- 4. When dried, the feeds that harden enough to be eaten by the animal become softer and silent when consumed.
- 5. For fermentation, green fodders retain their freshness and softness, resulting in a delicious and fragrant, slightly laxative feed and eagerly consumed by the animal.



- 6. Silage feeds provide maximum yield from each acres of land.
- 7. Silage is easier to store than hay and requires less space per kg DM.
- 8. The field is emptied early, so a second crop can be prepared for planting.
- 9. No fire hazard.
- 10. When the silo feed is obtained properly, it can be stored for a long time without losing its value.

DISADVANTAGE

- 1. In order to produce a high quality silo feed, structures called silos are needed. The construction of said structures is more expensive than the drying method.
- 2. Silo feed contains less vitamin D than the sun-dried herb.
- 3. The same amount as it contains a high level of water requires 3-4 times more labor for the service of the dry substance.
- 4. During silos, it is necessary to use additives and condoms especially for forage crops which are difficult to silage. These costs extra.
- 5. It creates extra costs for transportation and transfer.
- 6. Leakage losses when the dry matter content is less than 32%. Loss of spoilage due to unnoticed bird/rodent damage to bags. Too much moisture(gas/ Leakage losses) or too much dry matter content (spoilage).

OPTIMUM CONDITIONS FOR THE FORMATION OF MILK ACID BACTERIA

- 1. Withering and Degradation of Green Plants ★
- 2. Anaerobic environment ★ ★ ★
- 3. Heat ★
hot milk acid bacteria (40-45 C⁰)
cold milk acid bacteria (8-30 C⁰)
- 4. pH: pH 3.8-4.2 ★ ★ ★
- 5. Carbohydrate Rich Environment ★

SUITABLE FORAGE PLANTS FOR SILO FEEDING

- 1. The most suitable feed for silo: CORN YIELD, SUGAR BEET LEAVES, SUGAR BEET HEADS
- 2. Less suitable for silo: GRAIN AND GRAIN STRAWS
- 3. Forages that are difficult to silo: BODY MORTARS AND SOME WHEATS, SUNGLASSES AND HERB
- 4. The most difficult to silo feeds: Alfalfa, sainfoin and vetch



CRITERIA THAT MUST BE IN GOOD SILAGE

- 1. Anaerobic Environment
- 2. Odor (vinegar acid)
- 3. Color (olive green)
- 4. pH
- 5. Tissue Integrity of the Plant



In determining the quality of silage;

- 1) Numerical evaluation (Flieg score)
- 2) Evaluation according to physical characteristics

Flieg score can be found by regression equation;

$$\text{Flieg score: } 205 + (2 \times (\text{silage\%DM})) - (40 \times \text{pH})$$



Evaluation of silage according to Flieg score

Evaluation	Score
Excellent	81-100
Good	61-80
Modarete	41-60
Bad	21-40
Very bad unusable condition	0-20



Evaluation of silage according to its physical properties

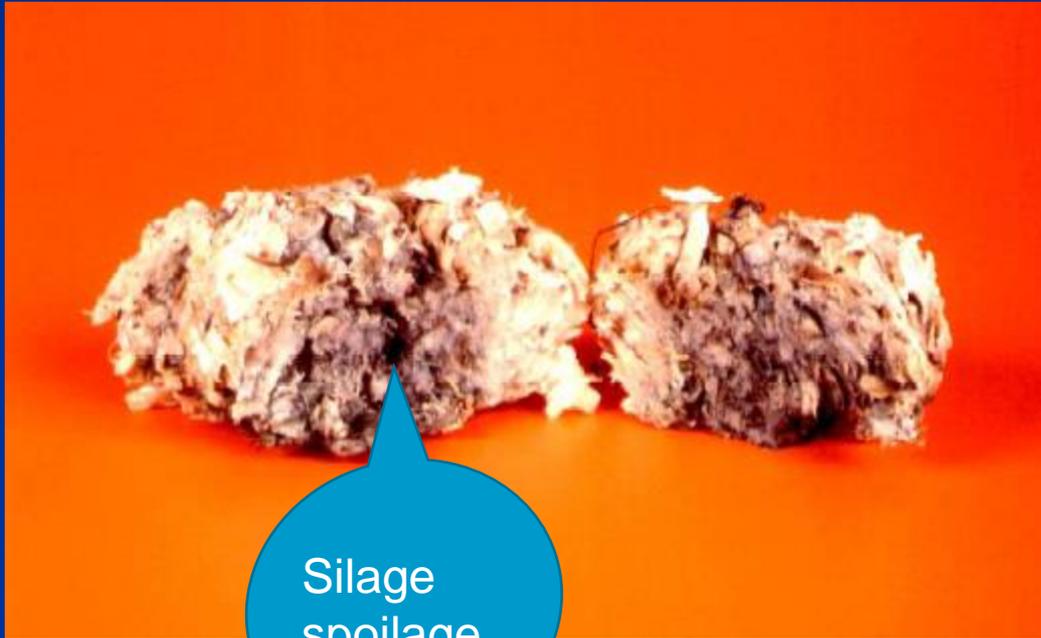
CRITERIA	SCORE
ODOR (total 20 Score)	
Its unique smell is aromatic, no buttery smell is felt.	14
Weak buttery smell, acid and aromatic smell	8
Moderate buttery or musty smell	4
Strong buttery or musty odor	2
Very strong butter odor, irritating mold and rot	0
condition (total 4 score)	
Leaves and stems are intact and intact	4
The leaf structure has begun to deteriorate	2
The leaf structure is damaged and mold has begun.	1
Completely lost leaf structure, severe mold growth	0
COLOR (2 puan)	
The material has a unique olive green color	2
The material turns from slightly yellow to brown	1
It has lost its color characteristic and mold growth dominates the environment.	0
Evaluation	
Excellent	18-20
Good	14-17
Modarete	10-13
Bad	5- 9
Very bad unusable condition	0- 4



Good silage



Bad silage



Silage
spoilage







What do you think this is, it is the best example of bad silage material.





Do you think silage should be like this

CORN SILAGE

- The advantages of corn silage can be listed as follows;
 1. As it has a high energy content, it allows less use of concentrated feed.
 2. Increases the flavor of feed.
 3. It contains sufficient energy for the production of milk and the continuation of the body condition and sufficient cellulose for a regular rumination.
 4. It is easier to manage and use than meadow and other legumes.
 5. Nutritional value of corn silage is also high.

- There is a large amount of corn grain in corn silage and this level reaches approximately 40%.

<u>■ PART OF PLANT</u>	<u>■ DRY MATTER, %</u>
■ LEAVES	15-25
■ GRAINS	20-50
■ CORNCOB	6-10
■ HUSK	6-8
■ STEM	17-40

GRAIN > LEAVES > HUSK > CORNCOB > STEM

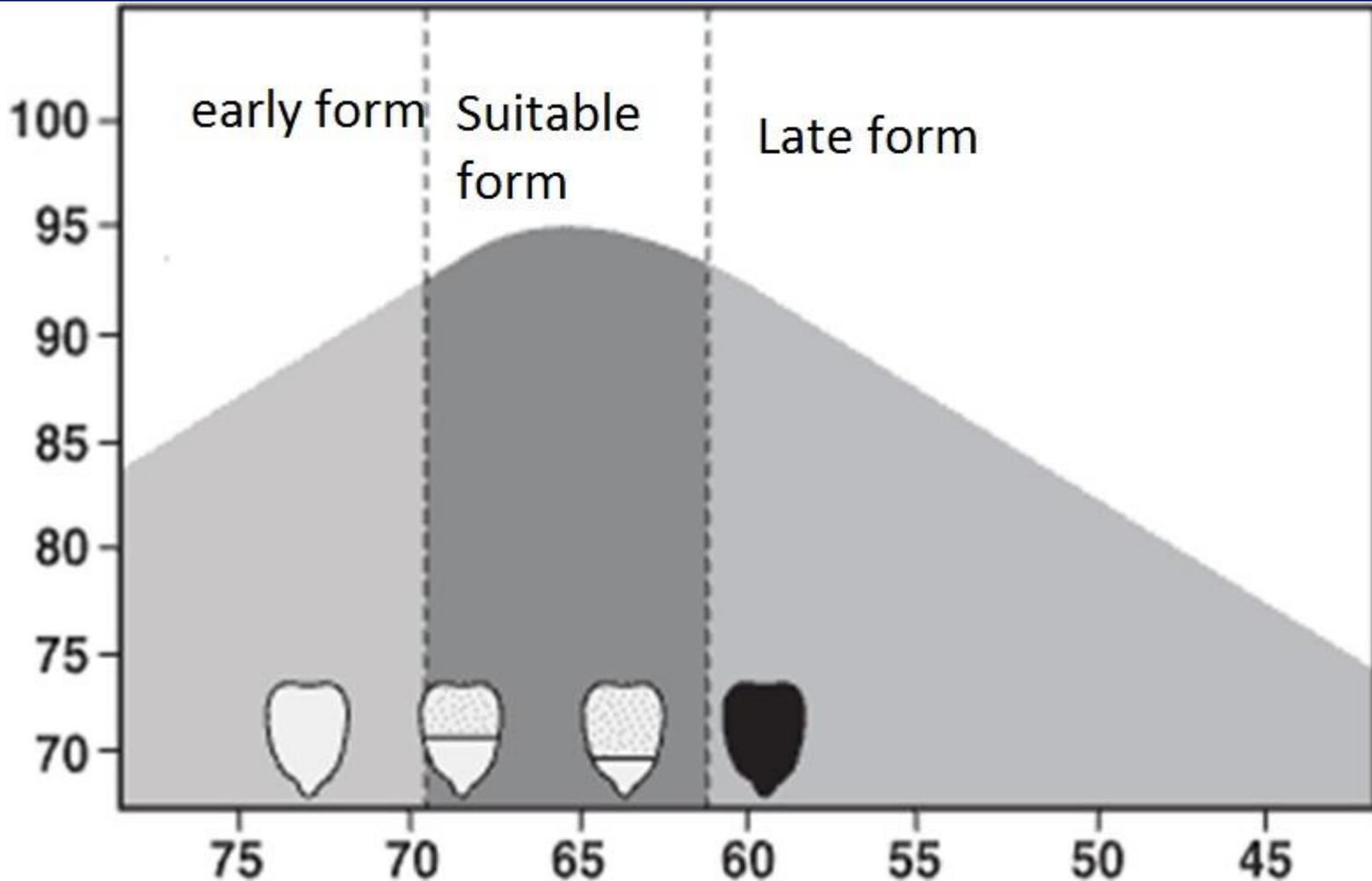


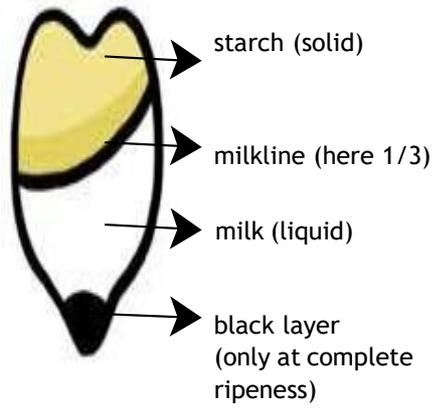
- Corn yield can be harvested in 4 different periods.

1. Milk-granulated period,
2. Dough consistency,
3. Dough consistency last period,
4. The period can be listed as the full hardening period.

The most appropriate form time in corn yield is the period in which a black layer is formed where the grain meets the cob.

Graph showing the forming time in silage material





stage **1**

milkripe
grain is white, yellow contents look like milk

stage **2**

soft-doughripe
grain is yellow, partly doughripe sap spills out

stage **3**

soft-doughripe
dark yellow only out of the lower part of the grain comes sap

stage **4**

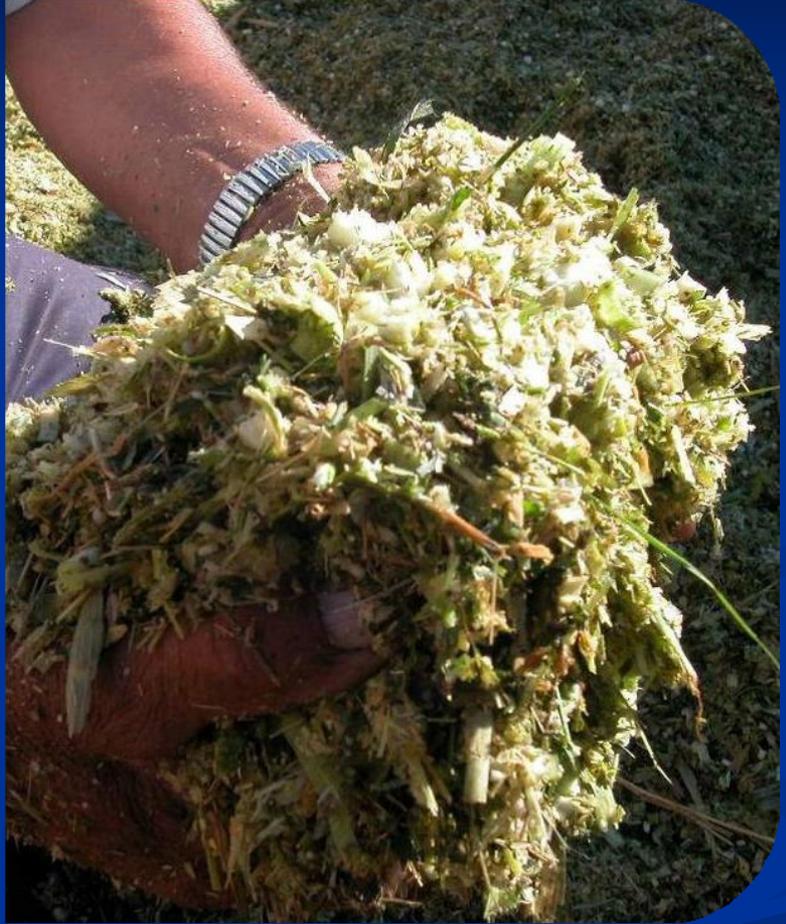
doughripe
dark yellow, still wet on the axisside, grain still can be scraped

stage **5**

hard-doughripe
dark yellow, grain is hard and difficult to scrape

stage **6**

completely ripe
grain is hard with glassy parts, black layer is visible



Corn Yield Silage Production

- Corn harvested milk is chopped 4-5 cm long during the formation period. Then the feed material is left in sunlight for 1-2 hours and the amount of dry matter is increased.

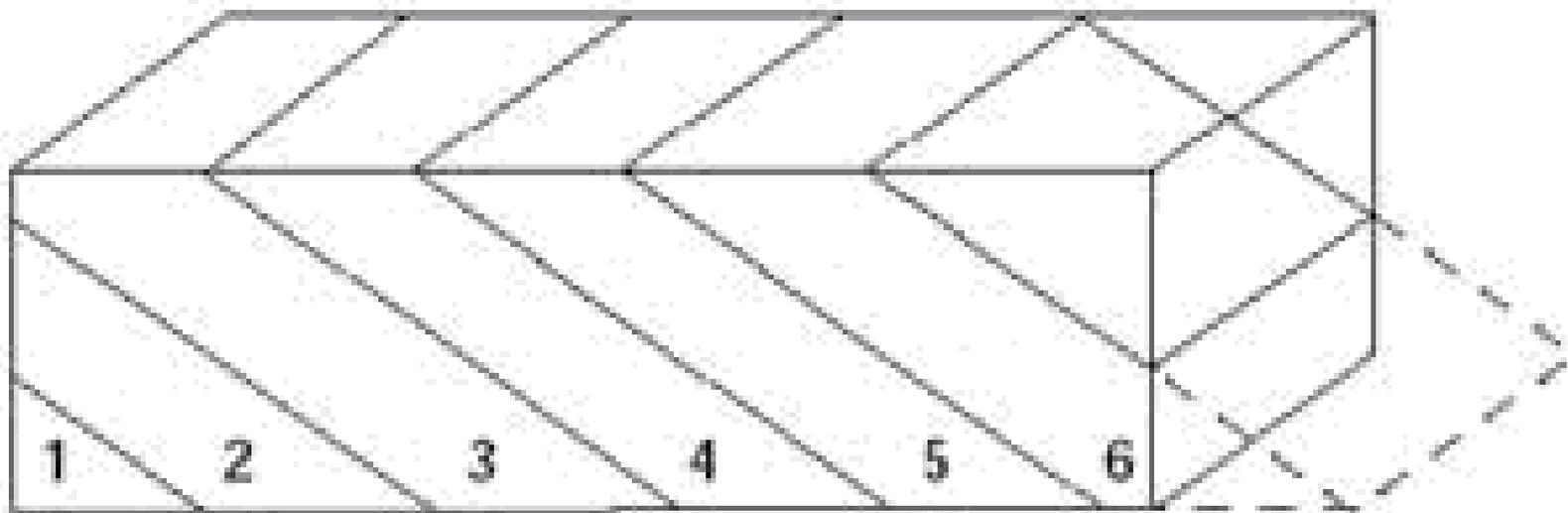


Corn Yield Silage Production

- A small amount of water (optimum moisture content of 60-65%) corn is filled into the silo pit by going through the tractor several times and a good compression is made. Following this process, depending on the height of the silo pit, the corn products are filled into the pit and compacted with the help of a tractor.



Graph showing the forming time in silage material





the transportation of the harvested grass to the silo



Spreading and compacting weed





Covering the silo with soil

kersan

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The operation of the meadow forage harvester



Loading the
cut material
into the trailer





The grass that was harvested and brought into pieces is being downloaded



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compaction of silage material with

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Factors Causing Corn Silage spoilage

- DRYNESS
- HIGH TEMPERATURE
- MOLD AND FUNGUS FORMATION
- FROST AND HAIL

WHEAT SILAGE

- Although the moisture content of wheat silage varies between 55-70%, the ideal moisture content is 60-65%.
- Harvesting of barley, wheat and oat crops should be done during the period when maturation is moderately doughy.

SORGHUM SILAGE

- Sorghum silage is used in similar applications to corn silage. Its nutritional value is lower than corn. Additionally, since it has a higher water content, it must be dried for a longer time.
- If sorghum is harvested during the milk or dough formation period, the dry matter ratio of the feed increases and becomes suitable for ensiling.
- Good quality sorghum silage produces a bright green color, a slight vinegar odor and a pH below 4.5.
- If the harvesting time in sorghum silage is delayed, the protein rate and digestibility level decreases, while the carbohydrate rate drops below 5% when ripening is completed.

SUGAR BEET LEAVES AND PULP SILAGE

- sugar beet leaves;
- It is rich in carbohydrates and has a high water content (use of additives; broken grains 4-8%, hay or straw 8-12%).
- Şeker pancarının hasatı yapıldıktan sonra yaprakları üzerindeki toprakların temizlenip alt kata oranında saman veya kuru ot, üzerine pancar yaprakları ve katkı maddesi konularak sıkıştırılır. İkinci tabakada da aynı işlemler kap (veya silaj çukuru) dolana kadar devam edilir ve üzeri kapatılarak fermentasyona bırakılır.



Clover Silage



- Alfalfa silage is the most difficult feed material.

Protein level



Carbohydrate level



- The optimal time for clover is the beginning of flowering (**When flowering reaches 1/10 level**) or the full flowering period

Clover Silage Production

- After the alfalfa is cut, it is filled into the silage pit after a pre-withering. After laying a layer of 10-15 cm thickness in the silage pit, the process of compacting is done with the help of the tractor.



Clover Silage Production

- In the alfalfa silage, additives such as molasses, barley and whey are applied to the feed material by spraying or sprinkling to enrich the carbohydrate environment. After this process, approximately 10-15 cm thick clover is laid in the silage pit and trapped by tractor. These operations are continued until the silage pit is filled.



COMBINED SILAGE

- Sugar beet, sunflower leaves+ corn forage, clover (% 70 - % 30)
- Silage product from a mixture of grain and legume grasses ; (% 70 - % 30 or % 60 -%40)
- Ideal ratio if corn + clover combined silage will be made ; Using 40% corn forage is sufficient for good fermentation.



ADDITIVES IN SILAGE

- 1. Molasses
- 2. Whey
- 3. Sugar
- 4. Carbohydrate rich substances





ADDITIVES IN SILAGE

- 1. **Molasses** (When molasses are added to the silo feed, it is diluted 3-4 times and sprayed on the feed to provide a homogeneous mixture).
- 2. **Whey** can also be used directly in silage feed or in the form of dried.
- 3. **Sugar** can be 2-3% added to the silage .
- 4. **Carbohydrate rich substances**; For this purpose, animal beet, turnip, potato and various cereal fractures can be used as silo additives.

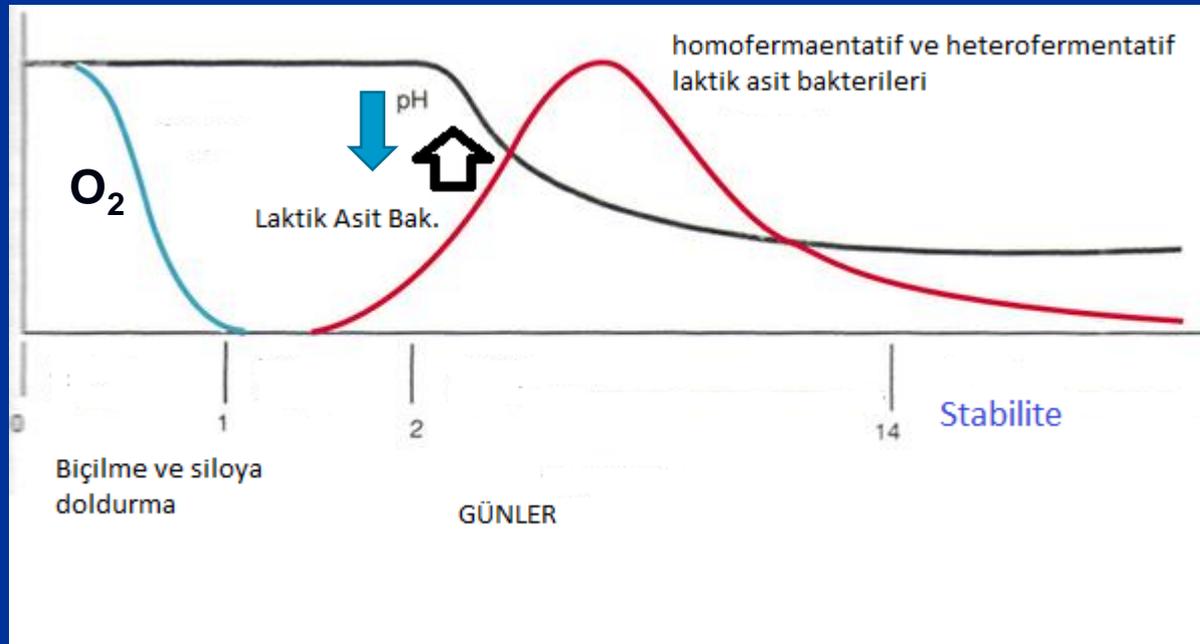
POINTS TO BE CONSIDERED IN DETERMINING SILO PLACES

- 1. The silo should be near the barn.
- 2. Silos should not be near sherbet and manure pits. Otherwise, leakage and silo feed may break down.
- 3. Ease of filling and emptying.
- 4. The silo should be built in a slightly sloping place. If it is to be carried out in a flat place, it is necessary to give 1-2% slope to the silo floor, especially for the discharge of rain water.
- 5. Very good ventilation is required in stables where silage is used.



SILAGE MICROBIOLOGY

- Homofermentative lactic acid bacteria
- Heterofermentative lactic acid bacteria





SILAGE MICROBIOLOGY

Lactic acid bacterial fermentation of different sugars

Bacteria (lactic acid)	Substrat	Final product
Homofermentatif	Glukoz/fruktoz	Laktik acid 
Homofermentatif	Pentoz	Laktik acid + Asetik acid
Heterofermentatif	Glukoz	Laktik acid +Ethanol+CO ₂
Heterofermentatif	Fruktoz	Laktik acid +Ethanol+CO ₂ +Mannitol
Heterofermentatif	Pentoz	Laktik acid + Asetik acid

Harmful Microorganism

- Aerob Bacteria (high temperature, high dry matter ratio, nutrient deficiency)
-) *Aerobacter* ve *Echericia* species
- Anaerob Bacteria (lactik acid bacteria and butter acid bacteria) Buttery acid bacteria; They convert the sugars in the feed into butyric acid, CO₂ and H using lactic acid and other fermentation products.
- Nutrients and Sugar



Harmful Microorganism

- Yeast; They play a role in alcohol production and also create significant amounts of CO₂. It is preferred that they be present in a certain amount at the beginning. They use the residual O₂ in the air and give an aroma to the silo feed. Long-term fermentation causes loss of nutrients.

Harmful Microorganism

- **Mold Fungus;** When green feed is not compressed well, mold forms in the lower parts of the silo. The most common mold fungi in silage are *Penicillium* species. *Aspergillus* and *Mucor* fungi are also frequently encountered. They break down first the carbohydrates, then the proteins and lactic acid, causing the silage to suffer a loss in both quality and quantity.

silos gases

- Lethal gases may occur while filling silage feed into the silo. The greatest danger occurs 12-72 hours after silage is filled. Gas formed in silage feed may continue for up to 10 days after the silage is made and closed. Gas formation in silage feed is more important in tower type and vertical silos.

silos gases

- The most important silo gases formed in silo feed are NO_2 , N_2O_4 , NO and CO_2 . If NO_2 and N_2O_4 are in high concentration in the silo feed, an irritating odor and a bad color (dark brown) are noticeable. NO_2 is reddish brown and smells like bleach, while N_2O_4 is yellow. NO , a colorless gas, turns into NO_2 with oxygen in the air and is lethal. CO_2 is an odorless, colorless and tasteless gas. All the gases mentioned are heavier than air and generally collect in the top layer of the silo feed.

Nitrates in silo feed

- Plants growing on excessively fertilized land accumulate excessive amounts of nitrogen.



+ Fertilization (N) +



NITROGEN

Fungus formation in silo feed

- The risk of fungi is quite high, especially in tower type silos or in the corners and bottoms of wooden silo materials. Fungus formation is quite common in the areas of the silage pit that receive oxygen, and white and gray colored mushrooms are seen in these areas. The most well-known mushroom species here is *Monilla sitophilia*.

SILAGE CONSUMPTION

- Dairy cows can be fed a maximum of 40 kg (wet) silage feed. However, the ideal ratio is 15-30 kg / day. 15 kg / day for fattening cattle and calves, 3-4 kg / day for sheep and 5 kg / day for silage.

BALED SILAGE(HAYLAGE)

- Baled silage is obtained by baling and packaging green fodder without drying it. Bale silage is a form of roughage storage that can be used very easily when production standards are well planned and given to animals for appropriate periods of time. Bale silage is created by compressing the green fodder after reaching a certain dry matter ratio after pre-withering and fermentation in an anaerobic environment.

BALED SILAGE(HAYLAGE)

- This silage is prepared in various forms such as package, bale and sausage(sucuk balya). Humidity rate is very important during baling and the ideal rate at this stage is considered to be between 50-60%. There are advantages and disadvantages to moisture content being less or more than the ideal ratio mentioned above.

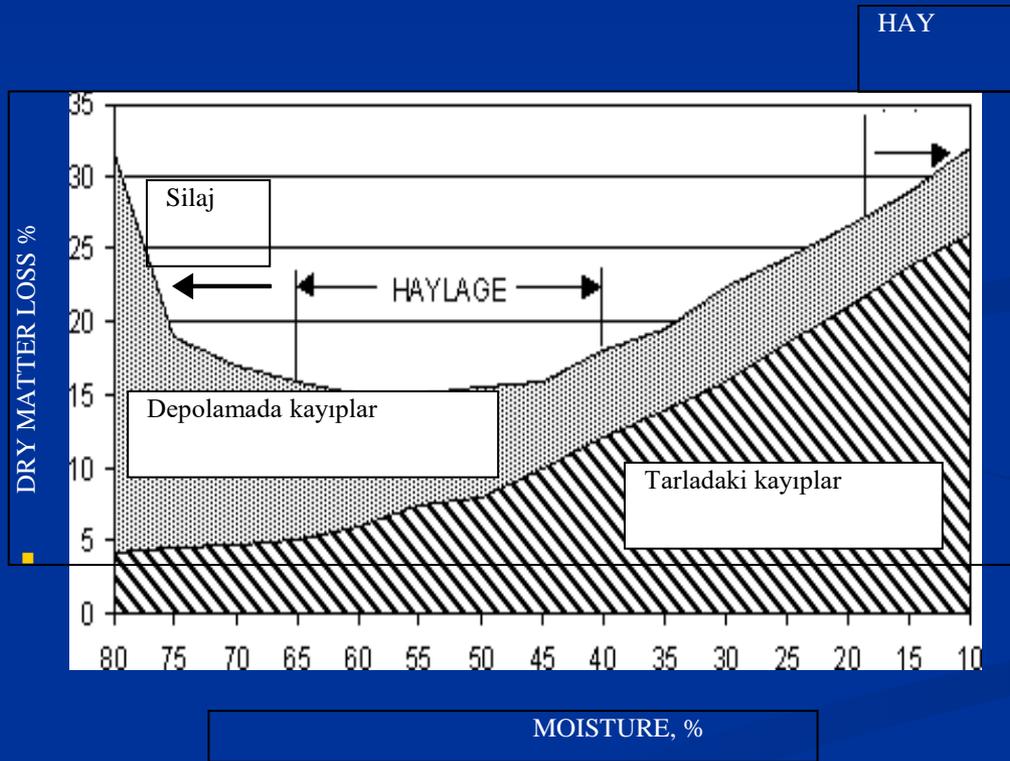
SUCUK BALYA SAUSAGE BALE



BALYA SİLAJ BALED SILAGE



BALED SILAGE(HAYLAGE)



Important informations

- If the silage material is not opened, it can be used even after a year.
- Easily silaged forages can be opened and used one month after the earliest, while those that are made difficult can be opened and used two months later.
- If the cutting time is exceeded in corn harvested silage, it is classified as feeds that are difficult to silage.
- all green feeds can be silaged

Question1. Which of the following is not a criterion for the growth of lactic acid bacteria in the silo material?

- a) Fragmentation and withering of green feed
- b) Adequate carbohydrate content
- c) pH value
- d) Anaerobic environment
- e) Sufficient protein content

Question 2. What is the best time to make silage in alfalfa?

- a) When the leaves are fully ripened
- b) When flowering reaches 1/10 level
- c) Before flowering
- d) When flowering is completed in the entire field
- e) When the leaf reaches the level of 1/3 of the stem and flowering

Question 3. Which level for dry matter is correct in a high quality silage?

- a) % 30-40
- b) % 50-60
- c) % 60-70
- d) % 80-85
- e) % 85-90

Question 4. Which of the following is the additive used in the silo material to increase the easily soluble carbohydrate level of the medium?

- a) Plover extract
- b) Clover stems
- c) Broken vetch
- d) Pulp residues
- e) Molasses

Question 5. Which of the following statements describes the silage best?

- a) It is called fermented feed obtained by storage of green feed containing sufficient dry matter (60-70) under anaerobic conditions after mowing.
- b) It is called fermented feed obtained by storing green feeds containing sufficient dry matter (60-70) under aerob conditions after cutting..
- c) It is called fermented feed obtained by storing the green feed containing sufficient moisture (60-70) under anaerobic conditions after harvesting.
- d) It is called fermented feed obtained by storing the green feed containing sufficient dry matter (30-40) under aerob conditions after harvesting.
- e) It is called fermented feeds obtained by storing green feeds containing sufficient moisture (60-70) under aerob conditions after harvesting.

Question 6. Which of the following statements is true?

- a) In a good silage, the color is dark brown and the pH is 3.8-4.3
- b) Silage bovine animals are given maximum 2 kg / day more than this level causes toxicity
- c) Silage is an excellent roughage for horses and must be included in their rations
- d) Silage is made on every green feed
- e) Clover grass is the most easily made silage

Question 7. Which of the following is one of the criteria for the growth of butter (fatty?) acid bacteria in the silo material?

- a) Grinding of green feed into fine particles, filling into silo and compressing and closing
- b) Low content of protein while containing sufficient easily soluble carbohydrates
- c) It contains sufficient sugar and starch, is moderate in terms of crude cellulose and raw ash content is around 2%
- d) Maintaining the anaerobic environment, the pH of the silo material is 4.8-5.2
- e) It contains sufficient crude oil and is rich in nitrogenous compounds which are not protein

Question 8. Which quality evaluated below for the silage material is the best?

- a) Color is determined from olive green to light brown and at pH 4.4-4.9
- b) Color is detected in light brown color and pH 4.8-5.2
- c) Odor resembles the smell of vinegar acid and is determined at pH 4.4-4.9
- d) The color is determined in olive green color and pH 3.8-4.2.
- e) Color is slightly brown and slightly acidic, pH is determined as 4.8-5.2

Question 9. Which of the following statements is true?

- a) The most important criterion for a good quality silage is the grinding of the plant to a size of 0.2 cm. Thus, animals can be consumed more easily.
- b) Silage should be slightly wetted first when applying to small ruminants
- c) Minimum 15 kg / day for silage horses 10 kg / day for pigs 8 kg / day for sheep and 7 kg / day for goats
- d) Vetch and alfaalfa grasses are difficult to silage
- e) pH 4.9-5.4 in a quality silage.

Question 10. How much kg of silage can be given per day to 400 kg live cattle?

- a) 15-30
- b) 45-50
- c) 55-60
- d) 40-42
- e) 60-62