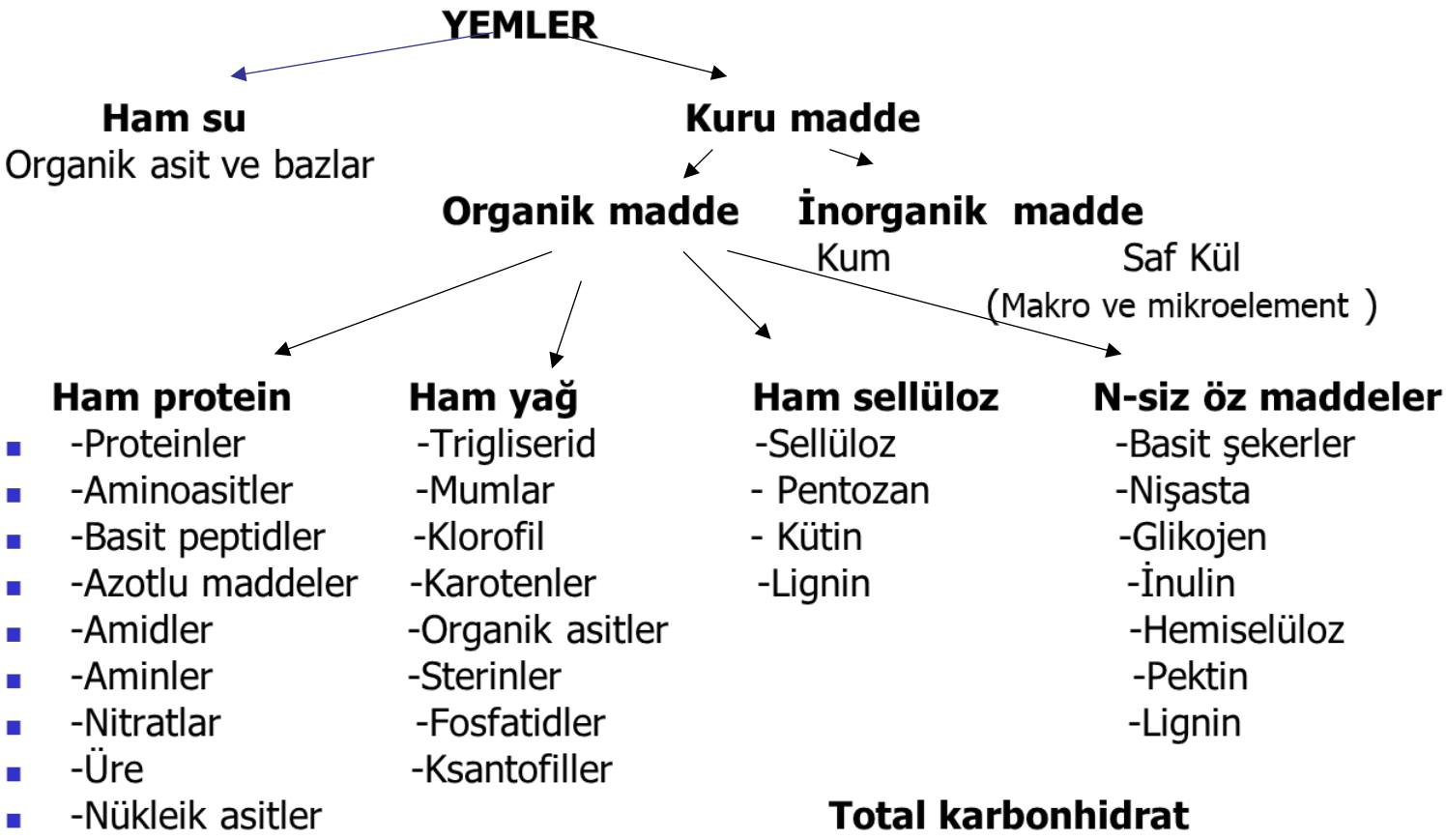
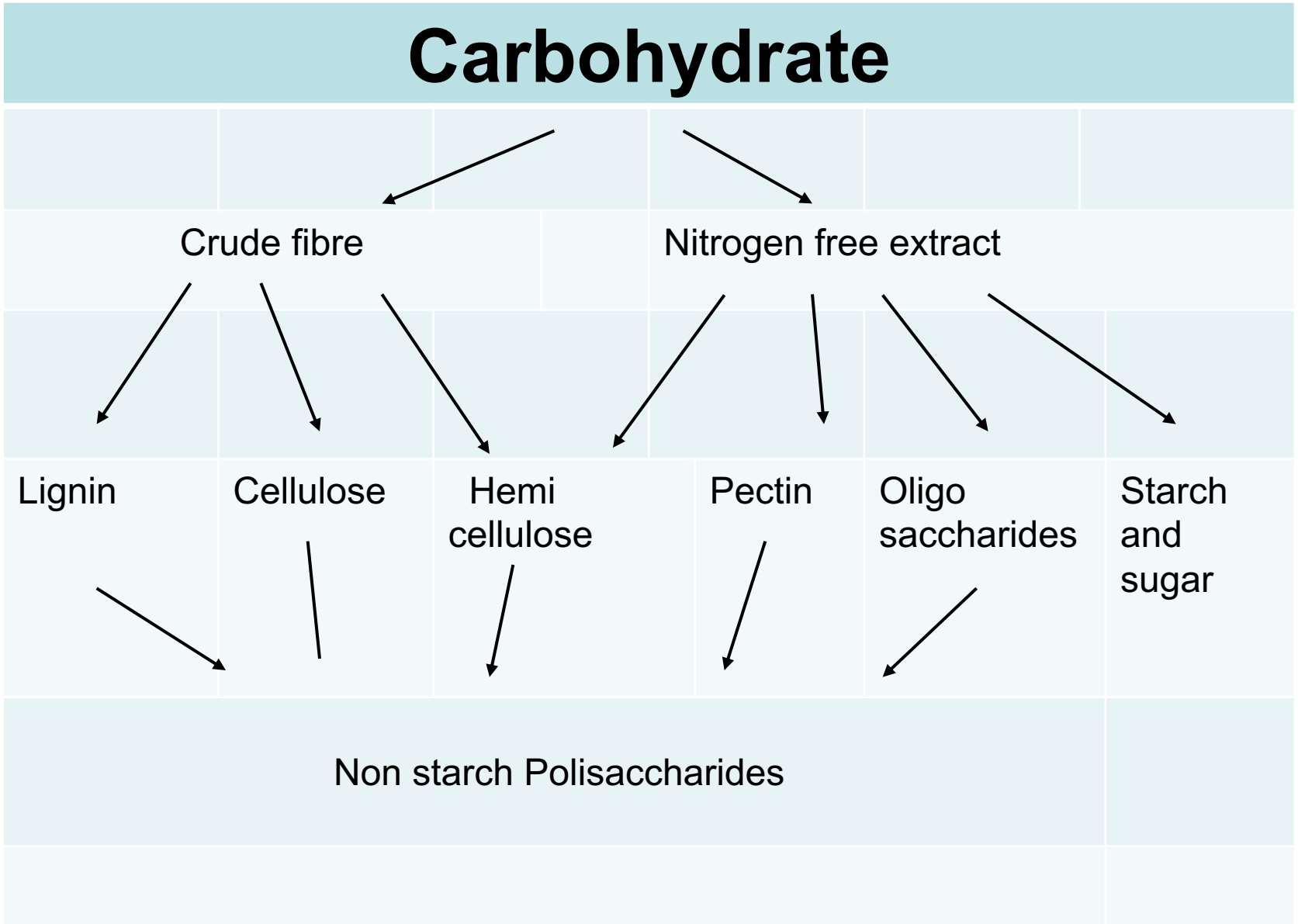
GRAINS
INDUSTRIAL BY-PRODUCTS

Prof.Dr. Sakine YALÇIN

CHEMICAL ANALYSIS OF FEEDS



Total Carbohydrate



Nitrogen Free Extract

- Nitrogen free extract,% =

  100-
(Moisture%+%CP+%EE+%CA+%CF)

- Nitrogen free extract,% =

  %DM - (%CP+%EE+%CA+%CF)

ORGANIC MATTER

OM % =

DM %- Inorganic matter (Crude ash) %

DETERGENT FIBER ANALYSIS

- Carbohydrate part of the plant is divided into cell contents and cell wall in detergent fiber method,

- **Cell contents:** (soluble in neutral detergent solution)
- Lipids, sugars, organic acids, water soluble matters, pectin, starch, NPN, soluble proteins
- Fully digestible if not lignified

- **Cell wall content (not soluble in neutral detergent solution but soluble in ADF solution)**
- Hemicellulose, cellulose, lignin, cell Wall nitrogen, chitin, silica
- Partly digested according to the lignification degree
- **Acid detergent fiber**(not soluble in acid detergent solution) **ADF**
- cellulose, lignin, chitin, silica

- Cellulose : ADF- ADL
- Hemicellulose : NDF-ADF

- NFC (g/kg DM): 1000- (NDF+ CP+ EE+ CA)

Grains

- Most important in nutrition of all animals
- Obtained after vegetation at harvest time
- High in dry matter
- High in digestible nutrients
- Three groups
- **1. Cereal grains**
- **2. Legume grains**
- **3. Oil seeds**

Cereal grains

- Easily soluble carbohydrate ↑↑↑
- Major component is starch

- Wheat
- Oat
- Rye
- Rice

Barley
Corn
Sorghum
Triticale

Cereal grains

- Rich in energy
- 70-95% of cell wall is NSP

Non starch polysaccharides

– Poultry don’t contain enzymes degrade NSP
– NSP find as soluble and insoluble form

Water soluble NSP show antinutritional effect, increase viscosity in intestine, negative effect on nutrient utilization, sticky excreta, management problems

– Beta-glucans, arabinoxylans, cellulose

- Barley and wheat: beta glucans
- Wheat, rye, triticale: mostly arabinoxylans,

water soluble form has antinutrient effect

– Proper enzyme supplementation is required

Cereal grains

- Dry matter: 88-90%
- (especially second harvest product corn DM: 83-85%)
- Crude protein: 8-14% (Corn 8%, Wheat, barley, oat 12%)

-85-90% of nitrogen is protein

-Poor in some esential amino acids (especially lysine, metionine)

* Oat contain more lysine than other cereal grains

Cereal grains

- Ether extract : 2-6%
- Corn 4-6%
- Oat 6%
- Barley, wheat 2%
- Most of fat is in embrio of cereals
- Oat and corn fats are rich in unsaturated fatty acids especially linoleic and oleic acids

Cereal grains

- Crude fibre

Corn, wheat 2%, barley 6%, oat 11%

- Fibre is found mainly in hull and husk.
- Dehulled and dehusked cereal grains are high in nutrient digestibility
- Husk is seperated from wheat and rye grains at harvest

Cereal grains

- Crude ash: %2
- Ca ↓ P, K, Mg ↑
- P → as phytin
- Not utilized in single stomach and poultry

- phytates→ P, Ca, Mg, Zn utillization↓
- it binds protein and starch and reduces utilization

Cereal grains

- Vitamin
- Yellow corn provitamin A ↑

- Cereal grains caroten, vitamin D ↓
- Vitamin E, B group vitamins↑

Cereal grains

- Nitrogen free extract

Starch

Small amount sugar

Starch digestibility of cereal grains in ruminants from the fastest to the slowest

oat>wheat>barley>corn>sorghum

Cereal grains

Utilized in all of the animal nutrition

Given as

crushed

broken

In the determination of feed value of grains: Grain weight, moisture content, foreign matter, foreign seed rate, broken, amount of damaged grain, colour changes in grains

Wheat (*Triticum vulgare*, buğday)

- Human food, animal feed, DM: 90%
- High in digestibility
- CP: 12% (13-15), Low in essential amino acids

poor in lysine

70% of protein is gluten in the endosperm

has viscous gluten that improves pellet quality reducing the need for a pellet binder (10% or more in the pellet).

Gluten→ contain gliadin and glutenin

- Because of high gluten, when it is given in excess amount in fine form, dough balls occur, blocking digestion, lead to digestive upsets.

Wheat

- EE: 2%
- CF:2%
- Dehulled wheat digestibility ↑↑↑
- Crude Ash: 2% Ca↓ P↑ phytate form
- NSP, especially arabinoxylans
- water soluble arabinoxylans
  diet viscosity ↑ in poultry
  has antinutritional effect

- Starch: 60-65%

fermented more rapidly than the starch of maize,

Causes digestive upsets

(including acidosis, bloat, laminitis)

Decreases rumen pH, forage digestion.

no problems occur even at high inclusion levels when given in combination with hay

Dairy cattle

- up to 30-50% in the diet of cows,
- Dairy cows cannot utilize efficiently whole wheat grains
- processing, such as grinding, rolling and pelleting ↑ digestibility

- generally fed dry and rolled or ground.

Wheat

- For beef cattle:
  - wheat should be fed in combination with more fibrous or slowly fermented feed grains and limited to 40% of diet.

  For sheep:
  - up to 25% for lambs and 35% for ewes.

  - Feeding with 10-20% forages is important to prevent acidosis and mortality in wheat-based diets

Poultry

- energy source due to high starch content.
- palatable if not ground too finely
- used efficiently in all classes of poultry.
- ME=3100 kcal/kg
- broiler and laying hen diets
    - Upto 60% wheat with enzyme addition
    - supplementary sources of xanthophylls necessary

Horses

- useful energy grain for horses,
- 500 g/100 kg LW-day
- Larger amounts
  - cause colic and digestive upsets
  - if not chewed efficiently,
    - large amounts of starch passing into the hindgut,
      - causing hindgut acidosis with digestive disturbances,
      - hyperactive behaviour and
      - a high risk of laminitis.

Maize grain (Zea mays, corn, mısır)

- major feed grain
- used as a source of energy.

- Many by-products of maize processing
- flour (hominy feed, bran, germs, oil meal),
- starch (corn gluten feed, corn gluten meal)
- alcohol/biofuel industries (distillers' dried grains and solubles)

Maize

- Palatable, suitable for all livestock.
- DM: 88-90%
- CP: 8%
- Proteins are mainly zein and glutelin,
- in the endosperm and germ respectively.

Zein, is deficient in lysine and tryptophan

Maize varieties such as Opaque-2 or Flour-2
better amino acid profile

Maize

EE: 4%(3-6%)

Rich in polyunsaturated fatty acids, especially in linoleic acid

- CF: 2% Digestibility is high
- low fibre content (10% NDF)
- Crude ash: 2%
- Calcium ↓↓
- 75% of phosphorus as phytate
- niacine ↓↓
- Yellow maize
  - vitamin A content (caroten and xsantofil)↑↑

Ruminants

- Maize grain is a valuable energy source in ruminants.
- In dairy cows, high milk yields because of its high starch content (about 65%).
- Maize starch is less readily fermentable than other cereal starches (30% of starch escapes rumen fermentation).
- a slowly degrading starch in the rumen, maize grain has a low acidogenic value and provides by-pass starch, allowing glucose absorption in the small intestine.

Poultry

- highly digestible starch,
- low fibre
- relatively high oil content,
  - resulting in high metabolizable energy values.
  - ME: 3300-3400 kcal/kg
- good source of polyunsaturated fatty acids (linoleic acid).
- Upto 60% in diets

Barley (Arpa)

- Dry matter: 88-90%
- Crude protein: 11-12%
- EE: 2%
- CF: 6% (higher than wheat and corn)
- Soluble NSP beta-glucans
- causes sticky excreta, wet litter, dirty eggs
- reduces nutrient digestibility, increases viscosity of digestive contents
- Enzyme (ß-glucanase) supplementation
- 20% in diets for adult poultry

- Starch: 55%
- ME= 2650 kcal/kg for poultry
- Dehulled barley CF ↓↓, digestibility ↑

- Ash: 2%

- Barley with low phytates

Ruminants

- Barley grain is one of the most common grains used in diets for dairy and beef cattle.
- high energy digestibility (80%),
- high content of rapidly degradable starch (nearly 50% of the DM),
- processes

rolling (dry or steam rolling), flaking, grinding, and pelleting.

Ruminants

- 50% in diets for dairy cattle
- Upto 70% in diets for beef cattle

- High levels in beef cattle,
- meat fat will be hardened
- meat quality decreases

Oat (Avena sativa, Yulaf)

- DM: 88-90%
- CP: 11-12% (lysine ↑)
- EE: 4-6% (unsaturated fatty acids ↑)
- CF: 11% (ADF: 16%)
- 20-30% husk, therefore digestibility is lower than other cereal grains
- Starch: 40%

- Pozitive effects on milk yield and milk fat due to having unsaturated fatty acids

- Cause soft butterfat when given in excess amount
- vitamin A, vitamin D, niacine ↓↓

- Oat is a valuable food for ruminant and horses
- Limited in poultry diets due to its arabinoxylan content
- Effective in prevention of cannibalismus in poultry
- Calf and dairy cattle upto 20%
- Beef cattle upto 30-40%

Rye (Secale cereale, çavdar)

- DM:88-90%
- CP:12% EE:2% CF:2%
- Ergotamine alcoholoids
- causes contraction of arther muscle
- blood pressure ↑
- increases contraction of utherus muscle,
- causes abortus in cows in gestation

- less palatable
- high amounts of soluble arabinoxylans and β-glucans,
- increase viscosity in the gut in monogastrics,
- Decrease the activity of digestive enzymes and nutrient bioavailability in pigs and poultry
- sticky droppings.

- Cattle: upto 40%
- Sheep: 500 g/day,
- When given alone it is dangerous for horses
- Laxative effect when given in excess amount
- Horses 15-20%
- Cracked roughly and rolling

Triticale

- A hybrid of wheat and rye.
- more protein and more exogen amino acid than corn
- More lysine and more methionine than wheat
- More phosphorous than wheat and rye

- Digestibility similar to wheat
- NSP arabinoxylan
- Negative effects on especially young poultry
- Proper enzyme to the diets
- Alternative to corn and wheat
- Dairy cattle, beef cattle: upto 30%
- Poultry 30-40%

Sorghum (sorghum vulgare, sorgum)

- Similar to corn
- Used in all animal diets
- Especially in poultry nutrition
- Feed value is about 95% of that of corn
- Energy is about 97-100%of corn
- Vitamin and mineral content is similar
- yellow corn is rich in provitamin A and pigments

- CP:10-15% is higher than corn
- Limited amino acids are lysine and threonine
- Ether extract is lower than corn
- Fibre is higher
- Contain fenoleic acid, flavonoids and tannen
- Brown sorghum rich in tannen causes constipation and colics
  - Tannen decreases digestibility and palatability

LEGUMINOUS SEEDS (LEGUMINOSAE)

- Broad bean (Bakla)
- Common Pea (Bezelye)
- Lupin (Lüpen)
- Common vetch (Fiğ)
- Bitter vetch (Burçak)
- Lentil (Mercimek)
- Grass or Indian pea (Lathyrus sativus)
  Adi mürdümük
- Chick pea (Nohut)
- Soybean (Soya fasulyesi)

CHARACTERISTICS OF LEGUME SEEDS

- Nutrient contents vary depending on species, growth, harvest and storage conditions.
- In leguminous seeds such as broad beans, peas and vetch have **high content of starch** (30-40%), whereas in soybean the **fat content** (18-20%) is high.

CHARACTERISTICS OF LEGUME SEEDS

- DM: 88-90%
- CP: 20-45% (NPN, free amino acids, purine & pyrimidine bases, nucleic acids, albumin, globulin, alkaloids, globulins including legumelin or vicilin)
- Essential amino acid level better than cereal grains
- Poor source of sulfur containing amino acids

CHARACTERISTICS OF LEGUME SEEDS

- Lysine↑
- Tryptophan, cystine, methionine ↓
- Protein biological value is not high
- Only soybean protein is good in terms of quantity and quality, close to animal-derived proteins
- CF 4-8%
- EE Soya 18-20%,
- Common vetch & Grass pea1-2%

- Crude ash: 3-4%
- Ca and K ↑ (compared to cereal grains)
- Most of P is in the form of phytate
- Carotene (provitamin A) is abundant in green peas and broad beans, but its amount significantly decreases in mature seeds
- Vitamin D content is poor
- Vitamin E is ↑ in their embryos
- They should be roughly ground or crushed before feeding.

Anti-Nutritional factors present in Leguminous seeds

- Tannins (cause constipation due to slowing the bowel movement)
- Cyanogenic glycosides
- Alkaloids
- Toxalbumin
- Lectins
- Proteinase inhibitors

- When consumed excessively by poultry and single stomach animals problems arise like Liver degenerations, hypertrophy of gallbladder and pancreas, renal damage

- To increase the feeding value of leguminous seeds

i. Cooking
ii. Boiling
iii. Steaming

- Lectins

- They have the ability to bind glycoproteins and carbohydrates.
- They impair the digestion and absorption of nutrients in the digestive tract.

- Proteinase inhibitors

- Inhibit trypsin and chymotrypsin and reduce the value of proteins.

Broad Bean

- CP ↑ 22-26%
- Lysine ↑ Methionine & cystine ↓ BV ↓
- Vicine, convisine

- Egg production and egg size ↓
- Tannin ⇒ Constipation
- Consistency of butter ⇒ Hard
- For dairy cows should not exceed 20% in compound feed
- For fattening beef cattle up to 25% (Tight and brittle meat formation)
- For young calves (aged 3 months) up to 15%
- For horses max. 1.5-2 kg (as tannins cause cholic in horses)
- Poultry breeder 2.5-10% (Young), 5-10% (adult birds)

Common Pea

- Digestibility ↑
- CP 16-26% (Methionine ↓)
- Young poultry breeders 2.5-10%,
  for adult 5-15%
- Dairy cattle 1-1.5 kg/day (20% in
  compound feed)
- Beef cattle 0.5-1 kg/100 kg live weight
- Sheep 250-500 g/day

Lupins

- According to the color of the flowers white lupin, blue lupin, yellow lupin
- Bitter and sweet types
- Alkaloid in blue lupin ↑
- White lupin is used in poultry feeding
- Sweet lupins in animal feeding
  - ✓ dairy cows, fattening cattle, horses 1.5-2 kg / day
  - ✓ sheep 300 g / day
  - ✓ Up to 10% for poultry

Common Vetch

- Common vetch (*Vicia sativa*), Hairy vetch, Narbon vetch, Hungarian vetch
- Vicin, vicianin cyanogenic glycosides
- If over-consumed
  - Cholic in horses
  - The deterioration of milk taste in cows
- Cooking and Steaming
- CP 25-30% (Choline and betaine)
- Cattle 2 kg / day
- Sheep 250 g / day
- Young poultry breeder 5%, for adults 5-10%

Bitter Vetch (*Vicia ervillia* L.Wild)

- CP 21-23%
- ME 2750 kcal/kg
- Due to tannin content: should not use in horse feeding
- Anti-nutritional factors ↑
- It is useful to give it to animals after grinding and with slowly adaptation

Grass Pea (*Lathyrus sativus* L.)

- CP: 25-32%
- EE: 1-3%
- CF: 2-6%
- Crude Ash: 2.5-4.5%
- Most of NFE is starch
- Alkaloids, protease inhibitors, tannins, lathyrogens
- Up to 10% for poultry
- Up to 10% in compound feed for ruminant

Grass Pea (*Lathyrus sativus* L.)

When consumed too much:

- Skeletal disorders
- Reduce sexual development
- Paralysis cases
- Death

These are the basic symptoms of disease called Lathyrism.

Chick Pea

- CP 16.5%
- Young poultry 5-10%
- Adult poultry 20%
- Cattle 1.5-2 kg/day
- Sheep 250 g/day
- Protease inhibitors → protein value ↓

Soybean *(Glycine max)*

- EE 18-20% linoleic acid ↑
- CP 36-38% lysine ↑ methionine ↓
- Raw soybean protein fermented quickly in rumen
- Digestibility ↑
- Protease inhibitors (trypsin inhibitor)
- Guatrogenic substances
- Rickets-forming factors
- Urease
- Hemagglutinin called Soyin
- B12 Antagonist
- Factor causing pancreatic hypertrophy

❑ Dairy cows 1 kg / day, Horses 0.5 kg / day
❑ Ruminant concentrate feeds up to 15-20%

Extruded Soybean

- Processed under heat and pressure
- Extruded
- Full fat soya
- Free of antinutritional factors
- Nutrient composition is same as soybean
- In extruded soya soluble protein ↓
- Protein degradability in rumen ↓
- Digestibility of rumen degradable protein ↑
- Metabolizable protein ↑

Up to 15-20% in poultry rations
Up to 15-20% in ruminant compound feeds

OIL SEEDS

Oilseeds

- Soyabean
- Canola seed
- Cotton seed
- Safflower seed
- Sunflower seed
- Linseed
- Hempseed
- Black seed

Canola seed

- DM: 90%
- CP: 20-25%
- EE: 43-50%
- Unsaturated fatty acids ↑
- Oleic acid, linoleic acid ↑
- Alpha linolenic acid ↑
- Ash: 4%
- CF: 8%
- Glucosinolates and erusic acid ↓ (In rapeseed they are high)

- Upto the level diets containing 5% fat

- Poultry diets 10%
- Ruminant diets 5%

Cottonseed (Pamuk tohumu)

- Crude protein 20%
- Oil 20%
- High fibre (crude fibre 28% DM)
- Used as whole grain, dehulled, raw, crushed.
- Excellent for beef and dairy cattle due to high energy (fat), protein and fiber content

Cottonseed

- Methane production in rumen is low due to its low fermentable carbohydrate

- Used in the diets in order to bring the total fat content in the diets at 5-7%.
- Free gossypol
  - İron sulphate can be added

Cyclopropenoid fatty acids

Whole cottonseed

- DM 90%
- CP 20%,
- N degradability in rumen is higher than 70%
- CF 27%, ADF: 35%, Lignin: 10%
- EE: 19% (linoleic, oleic, palmitic ↑)
- Ash: 4%
- ME(ruminant):2870 kcal/kg

Dehulled cottonseed

- DM: 90% CP: 32% Ash:5%
- CF: 13%, ADF: 18%, lignin: 6%
- EE: 31%

  (palmitic acid is higher than other oilseeds),
- Cattle: 1kg/day
  – 10-15% (in diet DM)

  Sheep: 300 g/day

Sunflower seed

- DM: 90%
- CP: 16-20%
- CF: 16-20%
- EE: 42-50%
  - (oleic acid, linoleic acid↑)
- Ash: 3-4%

Sunflower seed

- Important high energy feedstuffs
- Dehulled sunflower seed:
  - CF ↓, nutritive value ↑
  - Laying hens: 10%
  - Broiler: 20%
  - Lamb, sheep, goat: 10%

Sunflower seed

- Dairy cattle: 8%
- PUFA ↑, Conjugated linoleic acid, omega 6 fatty acid ↑ in milk
- High fat diets decrease feed intake and
- milk production
- Finishing period of fattening: 15% sunflower seeds added instead of barley:

Feed efficiency ↑, conjugated linoleic acid in meat ↑, fecal energy lost ↓

Linseed, flaxseed (Keten tohumu)

- DM: 90%
- CP: 20-28%
- CF: 10-12%
- EE: 31-43%
- Unsaturated fatty acids ↑
- Alpha linolenic acid (ALA, omega 3 fatty acid 45-60%) ↑
- Conjugated linoleic acid ↑
- Crude ash: 4%
- MEruminant: 4300 kcal/kg DM
- MEpoultry:3800 kcal/kg DM

- Laxative property
- Pozitive effects on skin and hair
- Contains lignan: phytoostrogenic and anticarcenogenic properties
- Linemarin: cyanogenic glycosides
- Linatin: vitamin B6 antagonist
- Phytic acid
- Goitrogenic matters
- Musilage (absorbs water, increases intestinal viscosity, laxative effects)

- Dairy cattle, beef cattle; 10%
- Poultry 10%

In animal products:

- Omega 3 fatty acids ↑
- Omega 6/omega 3 fatty acids ↓
- Egg yolk cholesterol ↓

Ketencik (*Camelina sativa*)

- ❑ Winter/summer
- ❑ Low cost cultivation
- ❑ High yield potential
- ❑ Short vegetation period (60-90 day)
- ❑ Resistance to many diseases and pests
- ❑ adapts very well to cold and semi-arid climates

Ether exctract	Crude Protein	Seed yield
42-45%	19-22%	300kg/da

Camelina sativa

- High essential fatty acids, especially omega-3 fatty acids and linolenic acids
- Erusic acid 2-5% in fat of camelina sativa
- Maximum allowable level is 5% in the oil
- Camelina with low erusic acid

- Glucosinolates
- Allowable level of glucosinolates for monogastric animals: 1.5 mmol/kg

- In Camelina:

19.9-24.5 mmol total glucosinolates/kg, 21.0-24.8 g phytic acid /kg, 1.81-2.59 g condanse tannen/k, 2.19-3.21 g sinapin/kg in dry matter

INDUSTRIAL BYPRODUCTS

Prof.Dr. Sakine YALÇIN

INDUSTRIAL BYPRODUCTS

- 1. Milling byproducts
  - Flour industry byproducts
  - Starch industry byproducts
- 2. Sugar industry byproducts
- 3. Fermentation industry byproducts
  - Beer Industry
  - Alcohol Industry
  - Wine Industry
  - Bakers Yeast Industry
- 4. Fruit Juice Industry Byproducts
- 5. Oilseed Industry Byproducts

6. Biofuel Industry Byproducts

7. Aromatic extract, volatile oil industry by products

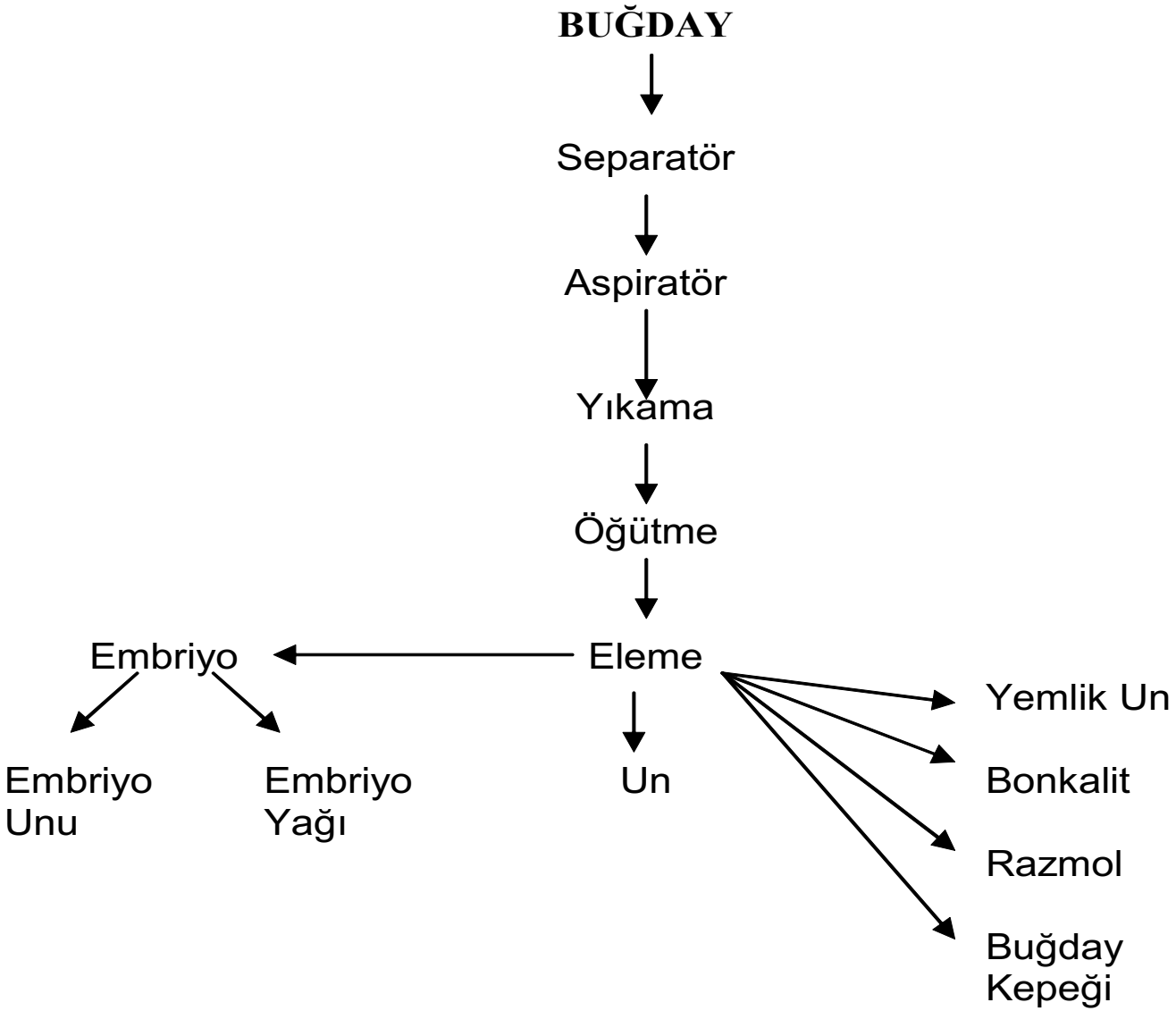
MILLING INDUSTRY BYPRODUCTS

- Cereal grains and legume seeds are processed in mills
- After separating flour, breakfast cereals and starch
- **Obtained milling byproducts**
  - Used as animal feeds.

MILLING INDUSTRY BYPRODUCTS

- **1. FLOUR MILLING BYPRODUCTS (Dry milling)**
  - **Wheat Flour Industry Byproducts**
  - **Corn Flour Byproducts**
  - **Others**
-
- **2. STARCH INDUSTRY BYPRODUCTS (Wet milling)**
  - **Corn Starch Industry**
  - **Potato Starch Industry**

Wheat Flour Industry Byproducts


BUĞDAY
Separatör
Aspiratör
Yıkama
Öğütme
Eleme
Embriyo
Embriyo Unu
Embriyo Yağı
Un
Yemlik Un
Bonkalit
Razmol
Buğday Kepeği

WHEAT BRAN

Protein, minerals, oil and fibre are mainly found in the outer layers of the wheat grain, therefore wheat bran is richer in these nutrients than the whole grain

One ton wheat → 150-160 kg bran

Bran depending on particle size

- coarse, medium coarse and fine bran

Coarse bran has more hull than fine bran

- Crude fibre ↑
- crude protein ↓

Digestibility of organic matter

- ruminants %70-75
- Poultry low digestibility

WHEAT BRAN

- Crude protein = 14-17 %
  Lysine ↑ than wheat grain
- Ether extract = 3-4 %
- Crude fibre = 10-17 %
- NDF = 42 %, ADF=12 %
- Crude ash 4-6% Minerals ↑
- Calcium 0.13%
- Phosphorus 1.3% 90% of phosphorus are in phytate form
- B group vitamins ↑ (Niacin ↑ , Thiamin ↑)
- Riboflavin two times higher than that of grain

- Starch: 15-28%
- ME (poultry) = 1350 - 1650 kcal/kg
  (average 1500 kcal/kg)
- ME (ruminant) = 2500 kcal/kg
- Pelleting with steam
  enerji level increases 10%,

available phosphorus level increases 20%

Antinutrient factors

- NSP, Pentosans

  antinutritional activities in poultry,
  result in reduced nutrient utilization
  and poor growth

- Phytate

Wheat bran

- *a bulky feed that can be used to lighten dense, heavy feed mixtures
  - Increase palatability,
  - Increase digestibility
- *Slightly Laxative effect
- *P ↑ (90 % of phosphorus is phytate) ⇒
  - P sources in ruminants
- Fibre ↑, Energy ↓ ⇒
  - It is not used in high-energy poultry diets
- In poultry diets
  - Not used in chickens
  - %% in adult birds

Wheat Bran

- Slightly Laxative effect
- High in fiber
  - Pozitive effects on milk production and milk fat
- Dairy cattle and beef cattle
    - » Concentrate feeds upto 25%
- If given high amounts↑ ⇒
  - Softening in milk fat and internal fat
- Last period in fattening in beef cattle
- Bran in diets↓ feeds rich in energy↑
- Lamb concentrates 5%
- Sheep concentrates 20%

Horse nutrition

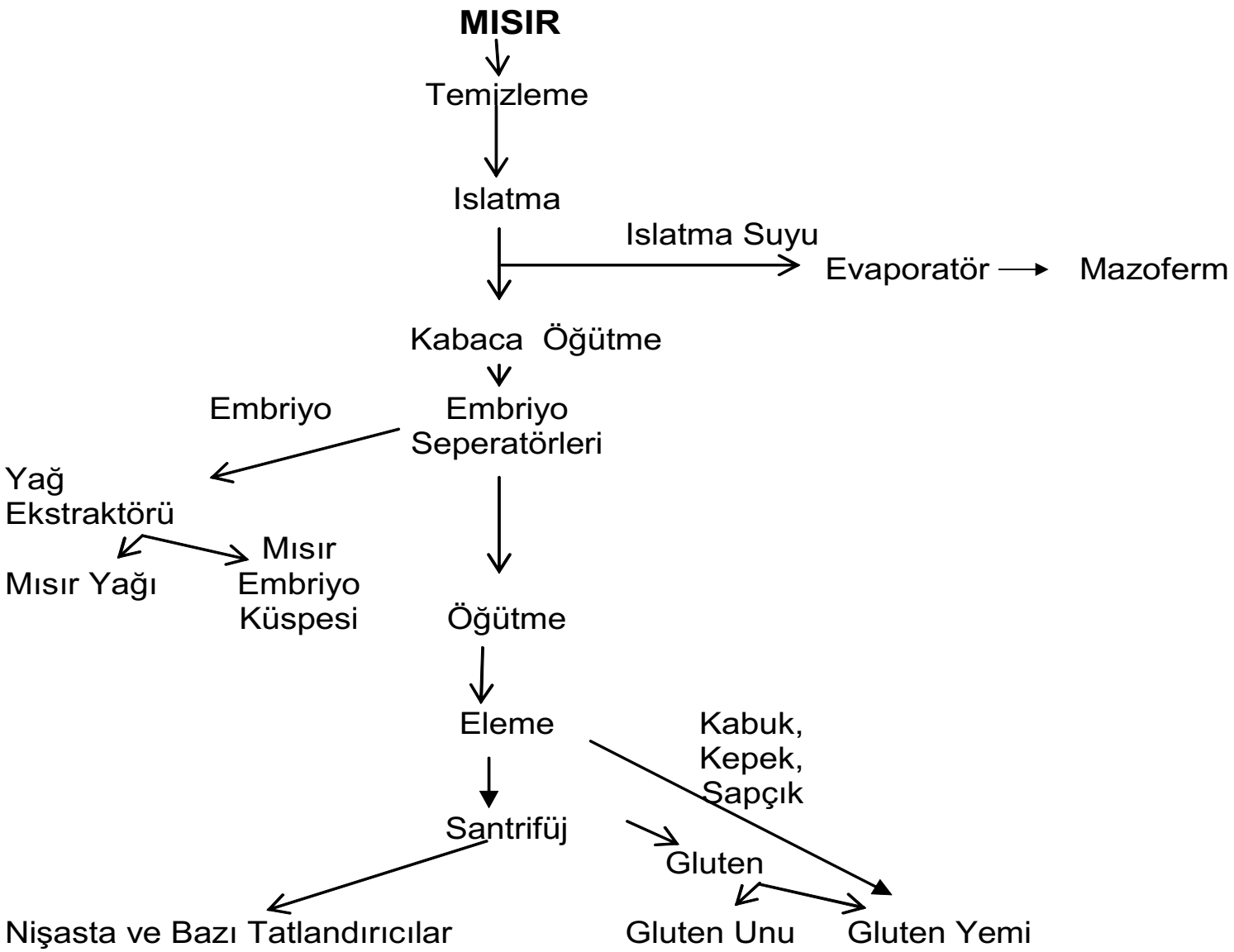
- fibre ↑ and slightly laxative
  - ideal feed.
- Constipated horses,
  - Bran is soaked in hot water for half an hour or more
- When it is given for a long time,
  - No more than 500 g should be given.
- Otherwise diarrhea and work weakness can be seen.
- Horse concentrates 5-20 %

STARCH INDUSTRY BYPRODUCTS

- Feeds rich in starch such as corn, wheat, sorghum, potato
  - Byproducts obtained after starch production

CORN STARCH INDUSTRY BYPRODUCTS

- Corn grains were processed by wet milling methods
- Various products are obtained from corn grain during starch production


MISIR
Temizleme
Islatma
Islatma Suyu
Evaporatör
Mazoferm
Kabaca Öğütme
Embriyo
Embriyo Seperatörleri
Yağ Ekstraktörü
Mısır Yağı
Mısır Embriyo Küspesi
Öğütme
Eleme
Kabuk, Kepek, Sapçık
Santrifüj
Gluten
Nişasta ve Bazı Tatlandırıcılar
Gluten Unu
Gluten Yemi

CORN GLUTEN MEAL

- Corn gluten named as according to the manufacturing technique
  - Corn gluten feed
  - Corn gluten meal
- Corn gluten feed
  - After removal of starch and embryo (24% CP)
- Corn gluten meal
  - After removal of starch, embryo and bran (60% CP)

- Corn gluten meal
  - CP ↑ lysine and triptophane ↓
  - Most of protein is not degraded in rumen, bypass methionine ↑
  - Valuable in high-yielding dairy cattle
  - Average 15% starch
  - ME(poultry):3500-3700 kcal/kg,
  - (ruminant): 3050 kcal/kg
  - poultry, lamb, calf 5%
  - Cattle, sheep 10%

CORN GLUTEN

- Steep water (20-30%) can be added to corn gluten feed
- Corn gluten feed

broiler, laying hen, turkey diets 10%

- in poultry diets
  - If used instead of some of animal protein
  - Cost of diet ↓ egg production↑
- Gluten feed from yellow corn
- More vitamin A than yellow corn
- Gluten color indicates the type of corn used.

CORN GLUTEN

- Corn gluten feed
  - Digestible nutrients↑
  - Digestible protein↑ ⇒
    - protein supplement in cattle feed

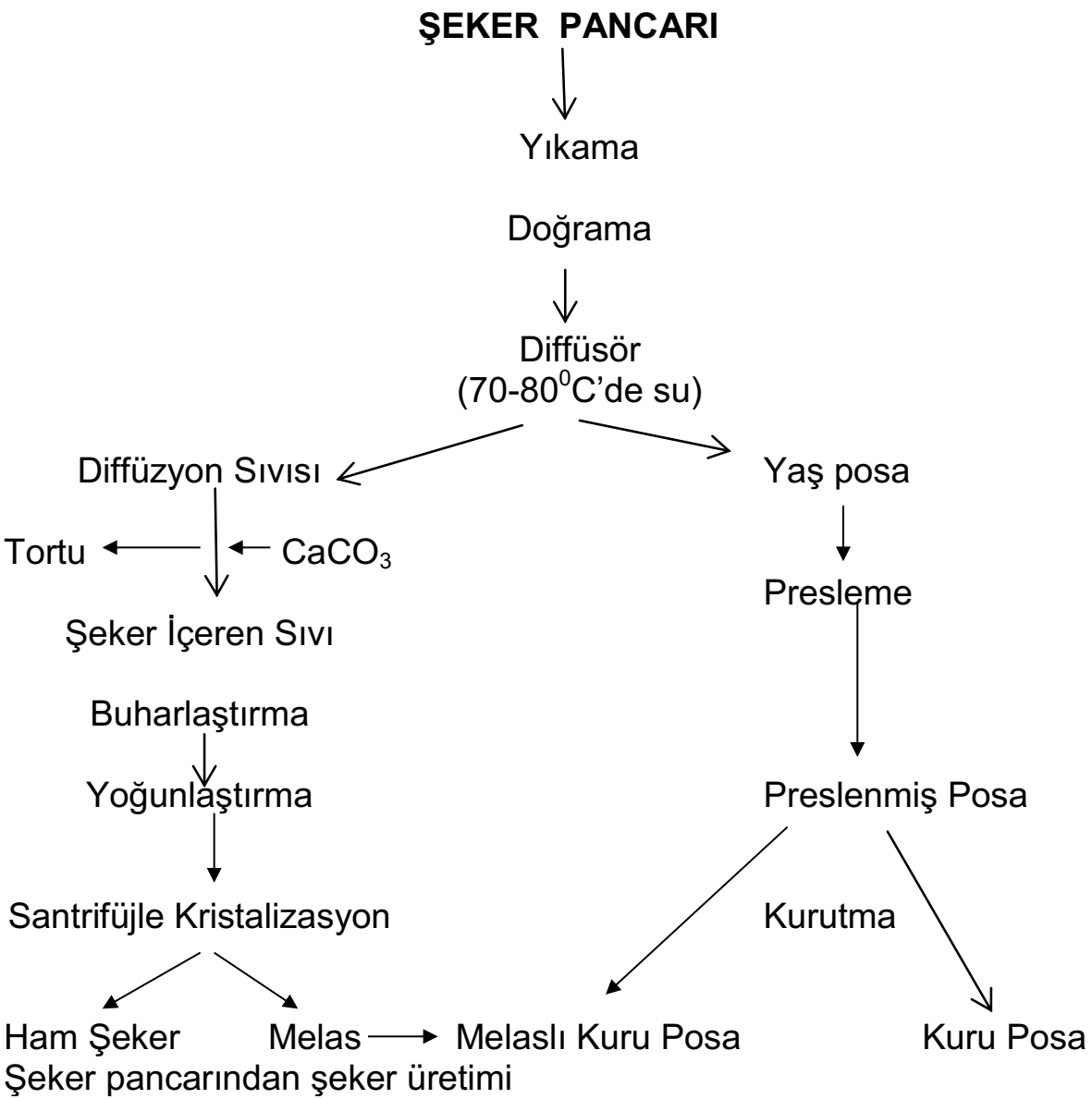
- 15-20% corn gluten feed in cattle diets

SUGAR INDUSTRY BYPRODUCTS

- Important in animal nutrition

  Preparation silage

- a large part of the sugar-free part is made of pectin.
- Pectin is not utilized well in animals except ruminants
- Sugar beet and molasses rich in sugar are preferred by dairy cows due to delicious



Şeker pancarından şeker üretimi

WET SUGAR BEET PULP

- From 100 kg sugar beet
  - 40-60 kg wet pulp or
  - 4.5 kg dry pulp
- Sugar beet pulp

  Easily digestible

  Consumed with appetite

- Should be consumed in a short time in a farm because of having more water
- Conservation without deterioration for a long time
- - tightly squeezed in silos and covered

- Wet pulp
- DM = 12-16% DM digestibility= 77%

- **On Dry Matter**
- CP= 9% DCP ↑
- CF = 20%
- Nitrogen free extract = 60%
- Digestibility of CF and Nitrogen free extract ↑
- ME (ruminant) = 2400 kcal/kg (almost all fermented energy)
- Crude ash = 6%
- Ca = 0.80% Ca ↑ but Ca oxalate
- P = 0.10% required phosphorus supplements
  - (Cottonseed meal, Linseed meal, Bran = Prot ↑ P ↑)
- Wet pulp digestibility↑ = nutritive value↓

- Wet sugar beet pulp in the diets↑
  - Careful for the level of protein and phosphorus in the diets
  - Protein supplements rich in phosphorus
    (cottonseed meal, linseed meal or bran)
- moisture ↑ and contains one-way nutrient
  Not given as larger quantities
  Otherwise diarrhea ocur,
  affects metabolism negatively
- If wet pulp is given for the first time,
- initially being given in small quantities, then should be gradually increased, and
- normal amount should be reached after a few weeks

- It should be given after milking.
- It should not be given to the animals at late gestation because they cause abortions

- If animals fed with wet pulp as a sole feed,
  - night blindness, bones and joints disorders, diarrhea and light-colored meat production occur

  due to lack of

  protein, vitamin A, calcium, phosphorus and other minerals

Wet beet pulp

- Upto 10-20 kg/day for fattening cattle
- Upto 20-30 kg/day for dairy cattle,
- Upto 2 kg/day for fattening sheep ,
- Upto 10 kg/day for horses at light work

- Since it is not suitable for fine wool sheep

it is either never given or in very small quantities.

Dry sugar beet pulp

- For drying pressed wet pulp and for keeping in a good condition
- It should not contain more than 13% water
- Therefore the difficulties in transport, storage, marketing and feeding of the wet pulp disappears
- Dry sugar beet pulp
  - CP %9, DCP %6
  - ME 2600 kcal/kg for ruminants
    (similar to barley energy)

- CF↑　organic matter digestibility ↑
- Most of N free extract is pectin
- Pectin in pulp ↑

  constipation effect however positive effects on milk fat

Ca 0.67%, P 0.25%

Mineral and vitamin ↓

Dried sugar beet pulp

- Daily maximum amounts
- 2 kg for horses,
- 5 kg for dairy cattle,
- 1-3 kg for fattening cattle,
- 0.5 kg for sheep
- Care must be taken to ensure that the inadequate nutrients in the pulp are met by other feedstuffs

MOLASSES

- During sugar production, after vaporization of sugary water and crystalization of sugar
  the remainder called molasses

* Colour and consistency similar

- 3 kg molasses obtained from 100 kg sugar beet.

MOLASSES

- Uncrystallized sugar,

Water soluble minerals and

Other water soluble parts are collected in molasses

- 70-75% DM,
- 50-55% sugar,
- 7-9% CP
  - Most of it NPN
- ME 2300 kcal/kg for ruminants (FME ↑)

MOLASSES

- Crude ash 10%
- Most of crude ash K (3.6%)
- P ↓
- Various micro elements especially Co ↑

- Vitamins

  niacine and panthotenic acid ↑

In ruminants, due to microbial degradation of the sugar in molasses in the rumen,significant energy loss occurs.

Molasses supplementation increases consumption of straw due to its delicious.

Since molasses is rich in easily soluble carbohydrates, it is useful in balancing protein-rich diets.

- It has a laxative effect due to having high levels of potassium salts and sugary substances.
- Molasses should be given to the animals by starting with a small amount and increasing gradually, and the amount to be given should be limited.
- Before use, it is usually diluted twice with water and mixed with hay, straw or chopped hay or other roughages.

- Molasses is of great importance as a carbohydrate source for lactic acid bacteria in the ensiling of green grasses, especially legume grasses that are difficult to ensile.
- Molasses according to the type of green grasses

1-4 kg for every 100 kg of green grasses or

8-12 kg can be added for every m3 of green grasses

MOLASSES

In Feed manufacturing industry:

- Prevent dusting,
- Enrich in energy in feed especially pellet feed manufacturing
- used to give better and more durable form to pellets
- For this purpose molasses
- 8-10% for ruminant concentrate feeds
- 2-5% for poultry feeds

FERMANTATION INDUSTRY BYPRODUCTS

Starch or sugar in products containing starch or sugar (cerreals, potato and fruits)

Converted to alcohol via fermentation with microorganisms

The remainder after the manufacturing of alcohol and alcoholic beverage is called fermentation byproducts

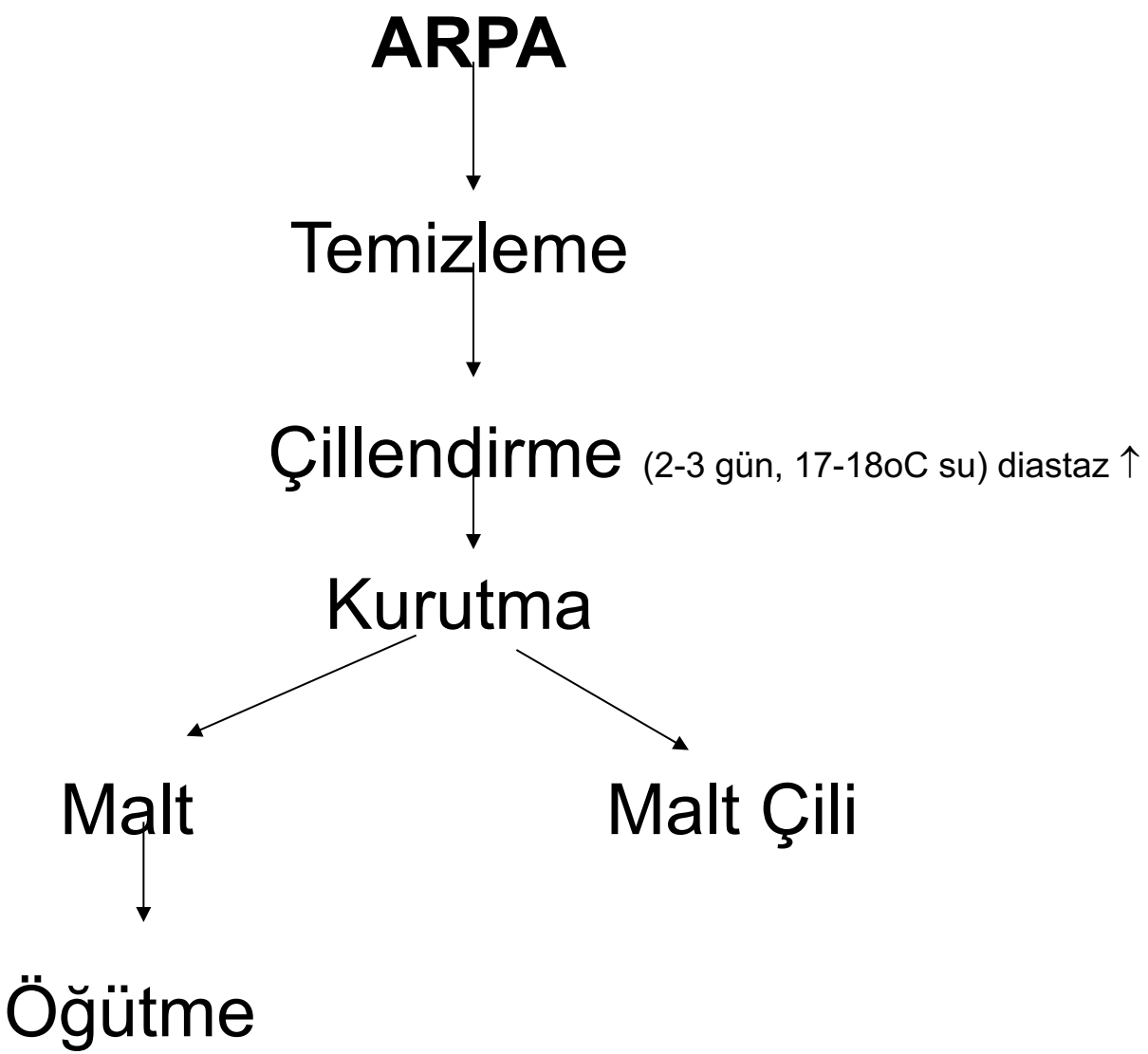
BREWING INDUSTRY BYPRODUCTS

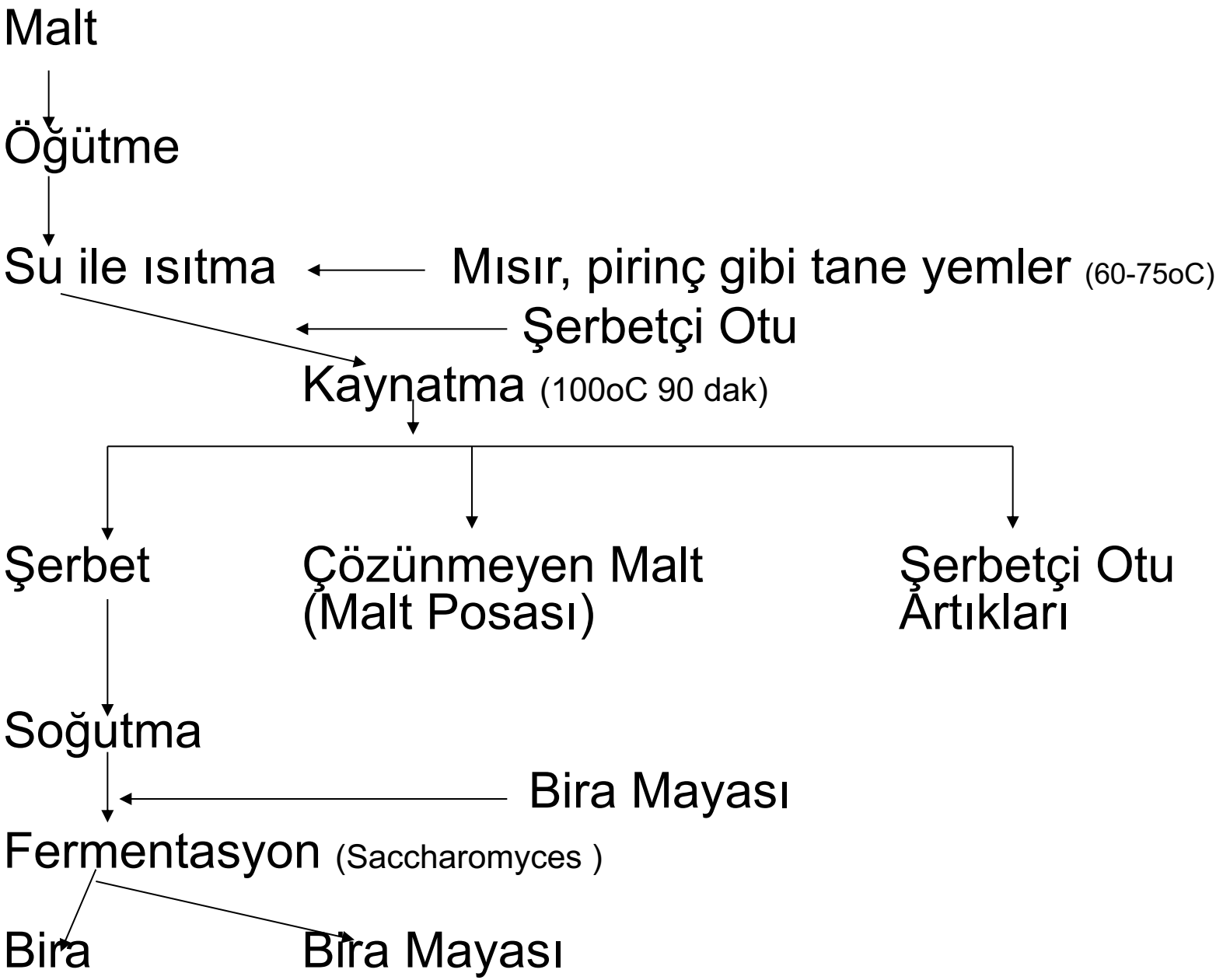
Beer

wheat

barley

Also maize, rice, sorghum


ARPA
Temizleme
Çillendirme (2-3 gün, 17-18oC su) diastaz ↑
Kurutma
Malt
Malt Çili
Öğütme


Malt
Öğütme
Su ile ısıtma
Mısır, pirinç gibi tane yemler (60-75oC)
Şerbetçi Otu
Kaynatma (100oC 90 dak)
Şerbet
Çözünmeyen Malt (Malt Posası)
Şerbetçi Otu Artıkları
Soğutma
Bira Mayası
Fermentasyon (Saccharomyces)
Bira
Bira Mayası

Malt Pulp

Wet malt pulp 20-25%DM

Malt pulp

- wet
- dry
- silage

High digestibility

CF 15-20% as energy and protein sources

- CP = 26% (90% DM)
- RDP 60% (RDP 80% in barley)
- CF: 15% EE: 7% Ash: 4%
- ME: 2300 kcal/kg for poultry
- ME : 2300 kcal/kg (in 90% DM) for ruminant

- Its nutritional value varies depending on
  the raw material used and
  the production technique.

The nutritional value of dried malt pulp is similar to that of wheat bran.

Excessive heat application
  darkens the color of the pulp and
  reduces the digestibility of the protein.

Dried malt pulp in feeds: 10-20% for cattle, sheep, horse, 5% for poultry

Daily maximum malt pulp (kg/day)

	Dairy cattle	**Beef cattle**	**Sheep**	**Horse**
Wet malt pulp kg/day	15	10	2	15
Dried malt pulp kg/day	3	2	0.4	3

BREWERS YEAST

- Wet or dried
- DM: 16% in wet brewers yeast
- used rapidly
- Dried brewers yeast

  light yellow to Brown in colour

  pleasant spicy flavor

  Protein is high (CP: 44%), Lysine ↑

  Methionine and cystine ↓

It is not suitable to use as a sole protein source

BREWERS YEAST

- B group vitamins ↑ (except B12)
- CF 1%
- Crude ash 6% (Phosphorus, iron ↑)

- ME: 2400 kcal/kg for poultry
- ME : 2800 kcal/kg for ruminant

- Cattle: 500 g dried brewers yeast or
  15-20 kg wet brewers yeast

Calf: important for vitamin and protein
  3-5% dried brewers yeast in calf feeds

Sheep: 100 g/day dried brewers yeast

Horse: upto 300 g/day dried brewers yeast

Poultry: upto 2-5% dried brewers yeast

ALCOHOL DISTILLERS BYPRODUCTS

In the production of alcohol,

fermentable sugars or

Substances that can be converted into

sugar

* sugary feed materials such as sugar beet, molasses and fruits (figs, grapes, apples),

* starchy feed materials such as potatoes and cereal grains,

* cellulose feed materials such as wood processing residues.

ALCOHOL DISTILLERS BYPRODUCTS

- For this purpose generally cereal grains rich in starch such as barley, wheat and corn

products:

- 1. Damıtma posası (Distillers grain, DG)
- 2. Damıtma çözünürleri (Distillers solubles, DS)
- 3. Kurutulmuş damıtma çözünürlü posa (Dried distillers grains with solubles, DDGS)

Corn DDGS

- Nutrients are 2.5-3 times more than that of grains
- CP 30% (RUP: 55% of CP)
- EE 9%
- CF 9%
- Crude ash 4% available P ↑

- ME 2800 kcal/kg for poultry
- ME 3050 kcal/kg for ruminant
- Starch 2%

- DDGS

- 20-25% for ruminant concentrates
- 10% for poultry
- (wet litter problem due to high Na content)

BAKERS YEAST INDUSTRY BY PRODUCTS

Bakers yeast (*Saccharomyces cerevisiae*)

Carbon source: molasses

Nitrogen source: amonyum, amonyum salts

Phosphorus salts

- Yeast (wet, dry)
- Inactive yeast
- Active yeast
- Yeast culture
- Yeast cell wall

- Bakers yeast: DM: 90%, CP: 46%
- Condanse solubles, vinasses, obtained after yeast removal
- Molasses as raw material

  called as molasses solubles
- molasses 50-55% sugar
- Vinasses 3-5% sugar (in DM)
- Potassium content is reduced to below 3% then it can be used in ruminant diets

- Molasses solubles (vinasses, condanse molasses solubles)
- Diluted molasses solubles: DM : 5-15%
- Condansed 60-70% DM
- CP: 30% Crude ash: 24-30% K.11-16%
- Most of the nitrogen (9-41%) betain

CONDANSED MOLASSES SOLUBLES

- Upto 5% for ruminant concentrates
- If K content is lowered to below 3%

- DM 70%
- CP 45%
- Crude ash: 9%

- Especially add molasses solubles to low-medium quality roughages
- Important role for increasing RDP

OIL INDUSTRY BYPRODUCTS

- After extraction of oil from oily seeds
  - Products rich in protein
  - meal
- **Oil is manufactured from oily seeds**
- 1.Hydrolic pres procedure
- 2.Continuous pres procedure (expeller)
- 3.Solvent extraction procedure
  - Direct solvent extraction procedure
  - Pre-pres solvent extraction procedure

solvent

- hexane
- benzene
- trichloroethylene
- carbonsulphur
- aceton

- trichloroethylene
  - İnternal bleeds in animals

Factors affecting nutritive value of meals

- Heat

Temperature ↑

amino acid degradation ↑

protein utilization ↓

* Heating period

Heating period ↑ protein utilization ↓

* Oil content energy source

If high oxidation and rancidity occur

Rancid oil

- Toxic effect
- Degradation of A, D, E vitamins, biotin

- causes deficiency of unsaturayed fatty acids due to oxidation of linoleic acid
- Various digestive disorders in animals
- Reduction in feed consumption and qualiy of product such as fat, meat and milk

Hull in meal

- Hull in meal↑ → CF↑
- Nutrient digestibility↓

General properties of meal

- 90% DM
- 30-50% CP
  - 95% of nitrogen is true protein
  - Digestibility of protein, biological value ↑
- 9-20% CF
- 6-7% Crude ash
  - Ca↓
  - P, K and Mg ↑
- Metabolizable energy
  - 2000-2300 kcal/kg for poultry
  - 2200-2700 kcal/kg for ruminant

Meals used for animal nutrition

- Soyabean meal
- Sunflower seed meal
- Cottonseed meal
- Linseed meal
- Camelina meal
- Peanut meal
- Sesame meal
- Hazelnut meal
- Canola meal
- Poppy meal

Soyabean meal-I

- Biological value of soya protein ↑
- Soyabean meal
- 44-50% CP lysine↑ methionine ↓
- CF 4-7%
- Total nutrient digestibility↑ 90%
- EE 1%
- CA 5-6%
  - Sufficient phosohorus (0.70%)
  - calcium (0.30%) ↓

Soyabean meal-II

- B group vitamins ↑
- A, C and D vitamins ↓
- Metabolisable energy
  - 2550 kcal/kg for poultry
  - 2850 kcal/kg for ruminants
- If heating treatment is not sufficient
  - tyripsine inhibitors, ürease
- üreaz enzyme activity in meal is determined to understand whether appropriate heat treatment has been carried out

Soyabean meal-III

- High protein value
  - Used in young animals and poultry
  - Upto 40% for poultry diets
  - (methionine levels in diets)
- 2 kg/day for dairy cattle
- 1 kg/day for beef cattle
- 300 g/day for sheep
- 1 kg/day for horses

Sunflower seed meal

- Quality depends on hull content
- Seeds with hull
  - Nutritive value of meal ↓
- CP 22-42%
  - Lysine ↓
  - Biological value of protein ↑

Sunflower seed meal-II

- Meal is obtained from seeds after hull removal
  - CP 40-44%
  - Digestibility of organic matter above 80%
- Meal is obtained from seeds with hull
  - CP 22-25%
  - Digestibility of organic matter below 40%
- CF 14-28% (depending on hull content)
- Crude ash 6-7%
- EE in solvent extraction procedure 0.5-2%
  - Expeller procedure 4-7%
- ME
  - 1900 kcal/kg for poultry
  - 2300 kcal/kg for ruminants

Sunflower seed meal-III

- Phosphorus, iron ↑
- Sunflower is consumed willingly by animals.
- Sunflower seed meal with hull is not used in poultry diets.
- NSPs arabinoxylan, water soluble
- When Sunflower seed meal with hull is used in laying hen diets, Stains form on the egg shell due to having chlorogenic acid

Sunflower seed meal-IV

- Meal without hull
  - 15% for laying hens
  - 5% for broiler
- 2 kg/day for dairy cattle
- 1 kg/day for fattening cattle
- 250 g/day for sheep
- 30% for diets of dairy and beef cattle

Cottonseed meal

- CP 25-45%
  - Content of hull
  - Manufacturing method
  - Lysine, methionine, cystine, triptophane ↓
  - Biological value of protein↓
- CF 10-20% (depending on hull)
- EE (depending on manufacturing technique)
  - solvent extraction 1-2%
  - expeller 4-7%

Cottonseed meal

- Crude ash 6-8%
  - Phosphorus ↑ (0.70-1.30%)
  - calcium ↓ (0.20-0.30%)
- ME
  - 2000 kcal/kg for poultry
  - 2500 kcal/kg for ruminant
- Limiting factors fot the usage of meal:
  - Polyphenolic compound: gossypol

Cottonseed meal

- Gosspol in cottonseed
  - Free and bound form
- Free form
  - Toxic effect
- During manufacturing of meal
  - Free gossypol
    - Some of it pass to fat
    - Some are bound with lysine and therefore lysine utilization ↓
    - Some of it pass to meal

Cottonseed meal

- Cottonseed meal produced in Turkey
  - Free gossypol 0.05-0.07%
  - bound gossypol 0.4-0.6%

Cottonseed meal

- Hen fed with cottonseed meal having low gossypol
- Gossypol in yolk was bound wih iron in ferrous form to create an olive green color in egg yolk. In this case:

Diets supplemented with easily soluble iron sulphate, By forming an iron-gossypol complex in the intestines, the absorption of gossypol decreases and the negative effects of gossypol are prevented.

Cottonseed meal

- Upper limits of gossypol in diets
- laying hens 40 ppm,
- broiler 150 ppm
- for each ppm free gossypol, by adding iron sulphate
- 4 ppm to laying hen diets
- 1-2 ppm to broiler diets
- upper limits150-200 ppm in laying hens, can be increased to 400 ppm in broiler

Cottonseed meal

- 10 ppm free gossypol is enough to change in colour of egg yolk
- Fermentative effect of the rumen protects ruminants from the harmful effects of gossypol
- in high producing cows high levels of gossypol reduces milk yield
- critical level for ruminants is 24 g free gossypol per day

- Another factor that limits the use of cottonseed is cyclopropene fatty acids.
- Cyclopropene fatty acids are malvalic and sterculic acids.
- The transformation of egg white to pink color in poultry

excessive accumulation of stearic

and palmitic acid in storage fat

The level of these acids in raw cottonseed oil is 0.6-1.2%, the level in meal is 0.01% (depending on the amount of oil remaining in the meal).

Cottonseed meal

- Poultry diets 5-10%
  - protein, fat, fiber, gossypol content must be determined
- Dairy cattle
  - Expeller meal 1 kg/day
  - solvent extraction meal 2 kg/day
- Large quantities of expeller meal
  - Negatively effects on the quality of milk ant butterfat
- Not given much to pregnant animals
  - Otherwise abortions occur
- Beef cattle1-2 kg/day
- Sheep 300 g/day
- 20% for ruminant concentrates
- 1 kg/day for horses with oat
  - More cottenseed meal causes digestive disorders

Canola meal

- Canola is a variety of rapeseed with reduced glycosinolate and erucic acid content
- Composition of canola meal depends on canola seed type and extraction method

- Solvent extraction meal
  - 38-46% CP
  - 1% EE
  - 11-13% CF
  - 8 % crude ash
  - ME
    - 2100 kcal/kg for poultry
    - 2500 kcal/kg for ruminant
- 20% in poultry diets

Camelina seed meal

- 35-40 CP,
- 4600-4800 kcal/kg Gross energy,
- %6-12 EE (rich in omega-3 fatty acids),
- %10-11 CF, %6-7 ash and
- Contains trace amounts of vitamins and other substances

Camelina seed meal

- Their proteins are good sources of sulfur amino acids compared to soya and legumes
- It also has antioxidant activity potential as it contains bioactive compounds such as tocopherols and phenolic compounds
- Flavonoids may provide defense against pathogens. It also has an important role in mineral absorption and synbiotic relationships with bacteria.
- Its biological value is very similar to that of soybean meal.

Camelina seed meal

- The US Food and Drug Administration (FDA) approved the use of camelina meal in 2009.
- It has been approved for use up to 10% in beef cattle and broiler diets.
- In 2015, the Canadian Food Inspection Agency (CFIA) approved the use of meal extracted without the use of solvents in broiler diets up to 12%.

BIOFUEL INDUSTRY BYPRODUCTS

- Biodiesel and
- bioethanol

- They are renewable energy sources for the livestock and feed sectors.

BIODIESEL INDUSTRY BYPRODUCTS

- In biodiesel production

- Plant oils, animal fat, waste fried oils
- Methanol as alcohol,
- Alkali catalysts as catalysts (sodium hydroxide, potassium hydroxide)

Glycerol

- obtained as a by-product in biodiesel production.
- From every 3 moles of methyl ester, 1 mole of glycerol is obtained. This constitutes 10% of the total product.
- gross energy: Glycerol 4300 kcal/kg
- carbohydrates 4200 kcal/kg,
- protein 5600 kcal/kg,
- Long chain fatty acids 9400 kcal/kg

Glycerol

- Especially in high-yielding dairy cows in the transition period (in the period covering 3 weeks before birth and 3-4 weeks after birth)
- Glycerol usage contributes to energy requirements,
- It prevents metabolic disorders such as fatty liver and ketosis and
- It increases lactation performance.

GLYCEROL

- For transition period dairy cattle:
  - 300-500 g/day
- 10% for dairy concentrates
- 10% for beef concentrates
- 5% for increasing pellet quality
- 10% for poultry diets

Bioethanol Industry By Products

- Raw materials used in the bioethanol industry are

cereal grains (corn, wheat, sorghum, barley, rye, oats, rice),

potatoes, sugar beet, sugar cane

and cellulose-rich feedstuffs

Cereal grains are mostly used for this purpose (Products shown in alcohol distillates)