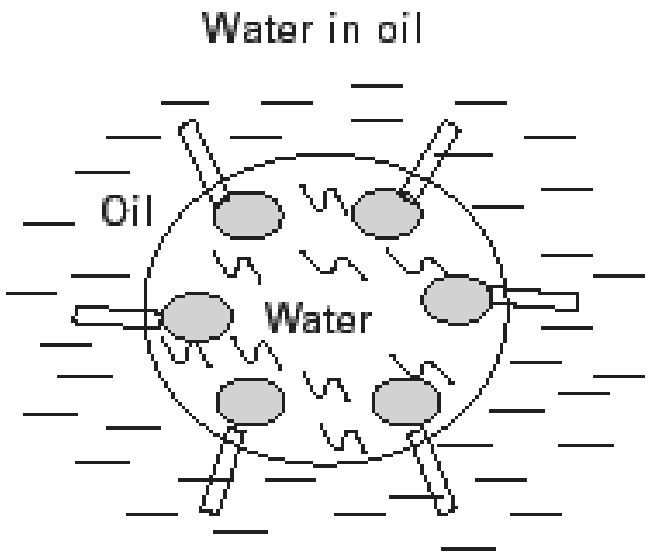
BUTTER

Definition

- It is a plasticized dispersion of the emulsion type " **water-in-oil**", in which water droplets, crystallized fat and air cell are dispersed in butter oil.

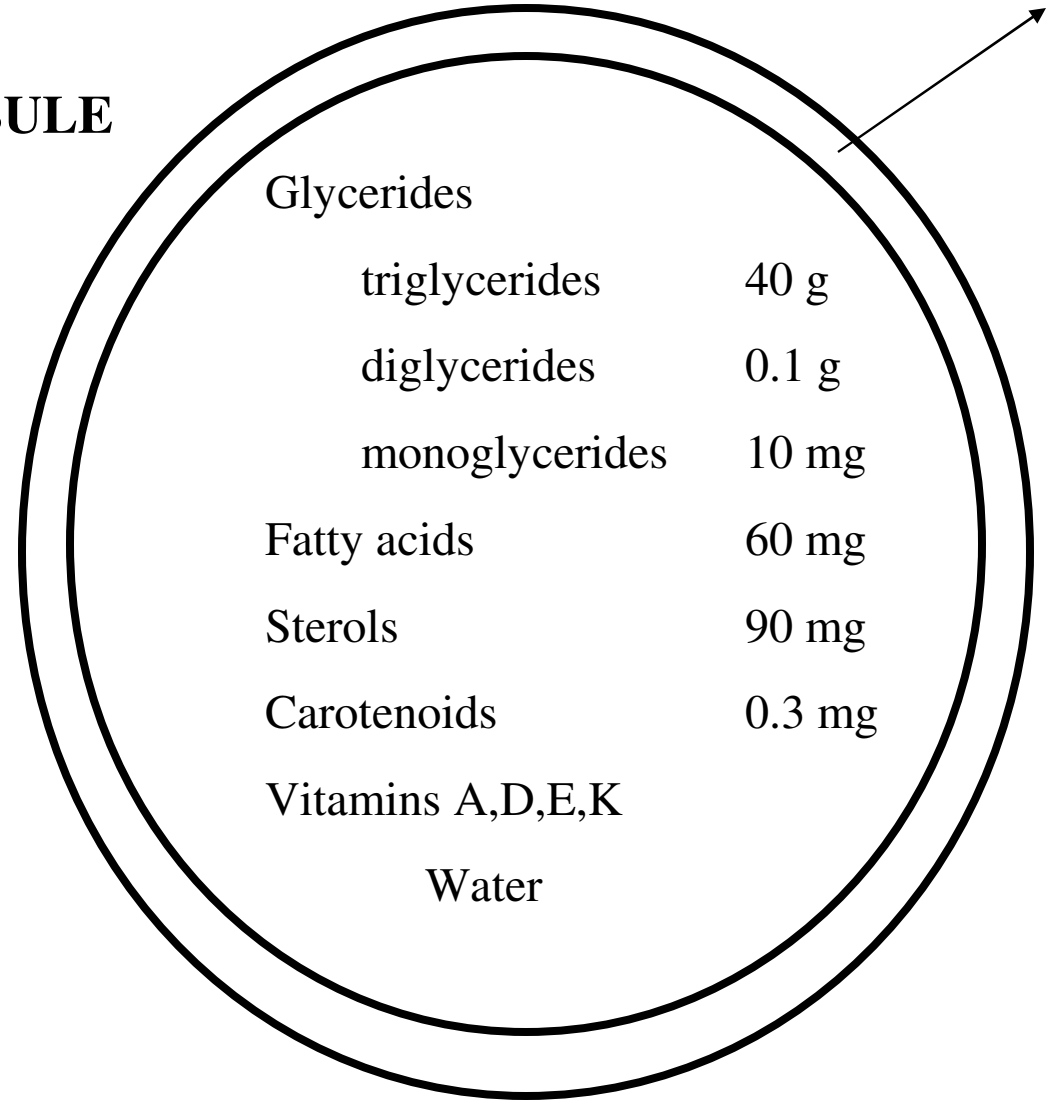


Source: Gunstone (2006)

- Based on the legislation (FAO/WHO), the max. fat content is 95%.

Composition and structure of milk

FAT GLOBULE



MEMBRAN

Water

Protein	700 mg
Phospholipids	250 mg
Cerebrosides	30 mg
Glycerides	+
Fatty acids	15 mg
Sterols	15 mg

Other lipids

Enzyms

- alkaline phosphatase
- xanthine oxidase
- many others

Cu and Fe

Essential composition of milk fat and margarine products:

•Milk fat products, e.g. butter	•Milk fat 100% of total fat
•Margarine products (vegetable oils and fats)	•Milk fat max. 3% of total fat

Name of milk fat products

Fat content (%)	Milk fat products
•80 - 95 •60 - 62 •39 – 41	Butter Reduced fat butter (3/4 butter) Low fat butter (half fat butter)

Butter

- Flavor depending on used culture; off-flavors should be avoided
- Shelf-life depends on moisture distribution and pH
- Consistency largely dependent on fat crystals
- Number and size of fat crystals depends on temperature and temperature history

Butter composition:

Fat	: 80%
Moisture	: 16 – 18*
Salt	: 0 – 2%
Protein	: 0.7%
Specific energy	: 3140 (kJ/100g)
Vitamin A	: 2500 (IU/100g)
Vitamin D	: 300 (IU/100g)
Keeping quality at 6-7^{o}C	: 2-3 months

*Varies with salt content

(Source: Livsmedelsbranschens Utbildningsorgan, Sweden)

The characteristics of butter:

- Fat content min. 80%.
- The water content depending on salt concentration.
- Containing vitamins A and D.
- The color of butter varies with the content of carotenoids (11 - 50% of the total vitamin A activity of milk).

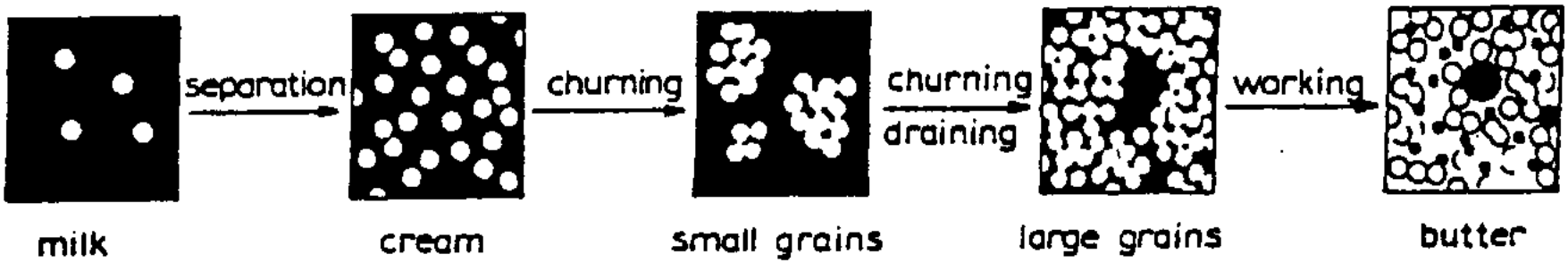
  For butter made from buffalo milk, the color is white.
- It should be dense and taste fresh.
- The water content should be dispersed in fine droplets → looks dry.
- The consistency should be smooth →easy to spread and melts readily in the mouth.

- Butter usually is divided into 2 main categories:
  - **Sweet butter cream**:
    - Made from pasteurized fresh cream
    - The flavor is mild and creamy
    - pH 6.4 or more
  - **Cultured butter**:
    - Made from fermented or cultured cream
    - The flavor cultured butter is originated from lactic acid bacteria, such as *Lactococcus lactis* sub*spp. lactis*, *Lc. Lactis* sub*spp. lactis* biovar *diacetylactis*, and *Leuconostoc mesenteroides* sub*spp. cremoris*.
    - The starter is added to the pasteurized cream
    - pH 5.1 or less
    - The aroma is richer

- About 25 years ago, NIZO (Netherland Dairy Research Institute) established another variant:
  - **Mildly sour butter:**
    - Adding culture / flavor concentrates after churning process
    - pH is 6.3 or less

- According to the salt content, butter can be classified as:
  - Unsalted
  - Salted
  - Extra salted

Stages in the formation of butter



General Butter Making Process (Cultured Butter)

1. Milk reception
2. Preheating (63-65^{o}C for 15 sec)
3. Fat separation (cream and skim milk)
4. Cream pasteurization (85 - 95^{o}C for 15 sec)
5. Vacuum de-aeration (if necessary)
6. Cultured preparation
7. Cream ripening and souring
8. Temperature treatment
9. Churning
10. Working
11. Packaging

The raw material

- Good bacteriological quality, without taste/ aroma defects
- Iodine value is an important parameter.
  - High iodine value (high unsaturated fatty content) → soft milk fat → greasy butter.
  - Low iodine value →hard milk fat
- Cream containing antibiotics or disinfectants is unsuitable

Vacuum de-aeration

- Removing undesirable flavor of a volatile nature, such as onion flavor.
- The cream is first heated to 78^{o}C
- Then pumped to a vacuum chamber, where the pressure corresponds to a boiling temperature of 62^{o}C.
- The reduced pressure causes volatile flavor and aromatic matter to escape in the form of gas when the cream is flash-cooled.

Culture preparation

- Using lactic acid bacteria (LAB), which is first cultured in pasteurized skim milk (90-95^{o}C for 15-30 min).
- Lactic acid, **diacetyl** and acetic acid are the most important of the aroma substances.
- The production of diacetyl depends on the availability of oxigen.
- The cultures must be active → bacteria growth and acid production are rapid.

Cream ripening & souring

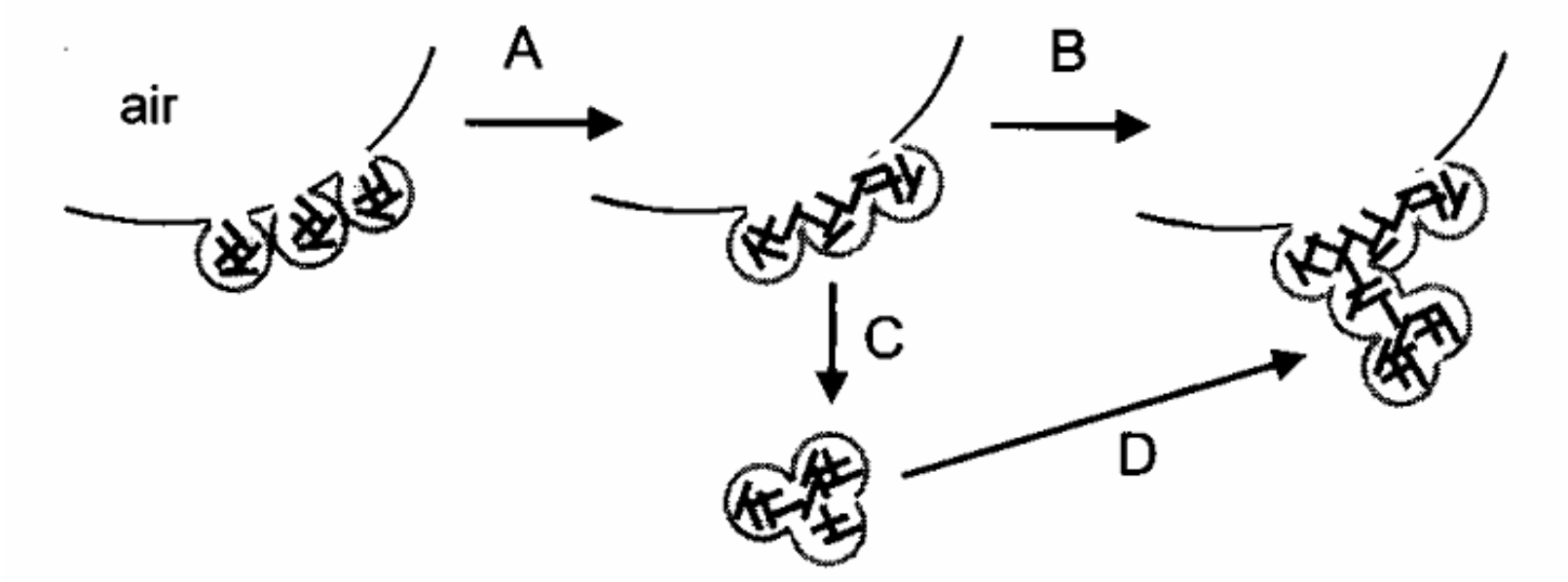
- The bulk starter cultured should be well mixed before pumped into the ripening tank.
- The cream needs temperature treatment if the butter requires certain consistency → depends on the iodine value of the cream.
- The amount of the starter is considered based on the temperature program.
- Bulk starter dosage: 1 – 7% of the amount of cream

Iodine value	Temp. program (^{0}C)	Approx. % of starter in cream
< 28	8 – 21 – 20	1
28 – 29	8 – 21 – 16	2-3
30 – 31	8 – 20 – 13	5
32 -34	6 – 19 – 12	5
35 – 37	6 – 17 – 11	6
38 – 39	6 -15 – 10	7
> 40	20 – 8 – 11	5

Beating / churning

- Cream is agitated violently to break down the fat globules.
- A foam of large protein bubbles forms
- The membranes of the fat globules are drawn towards the air/water interface
- The fat globules are concentrated in the foam
- Continuous beating cause some of the membranes of the fat globules disintegrate
- Air bubbles coalescence
- The liquid fat spreads out on the surface of the bubbles and fat globules, and act as sticking agent.
- As consequence fat globules forced together
- Continuous beating leads to fat clump formation
- Large clumps are floating; fat can be separated

Mechanisms of churning



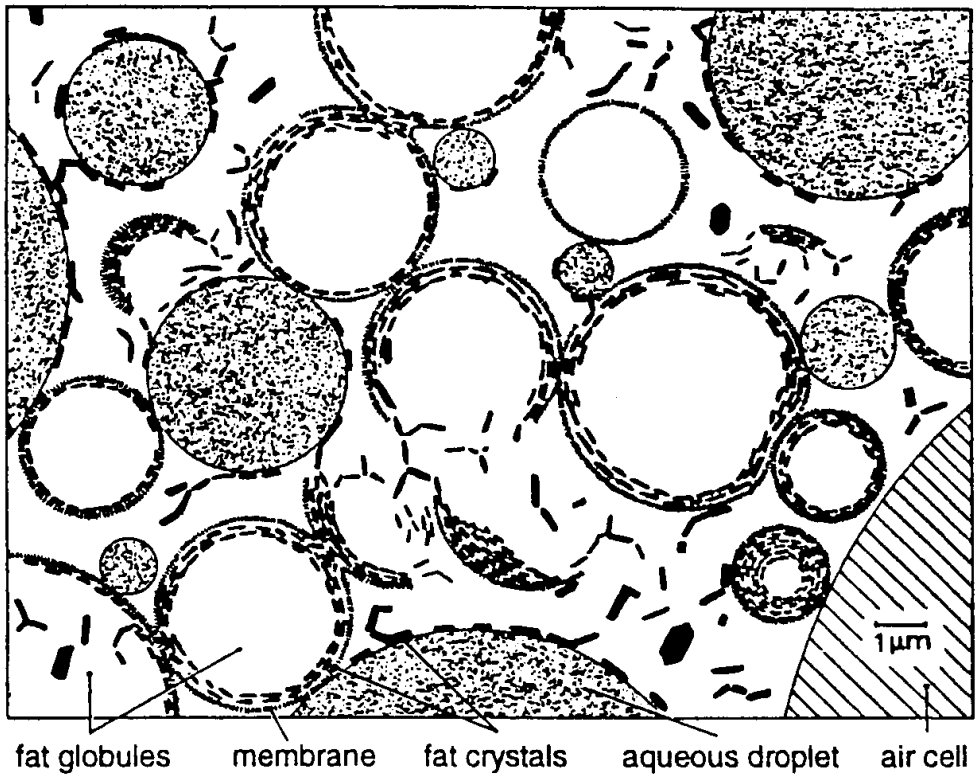
Features of churning

- Part of milk fat should be crystallized
- Churning temperature important; 8-12 ^{0}C
- Pre-cooling regime of cream important for butter consistency
- Churning results buttermilk (the liquid phase) and butter grains.
- The buttermilk then is drained off.
- The churning yield is acceptable if the value is less than 0.7

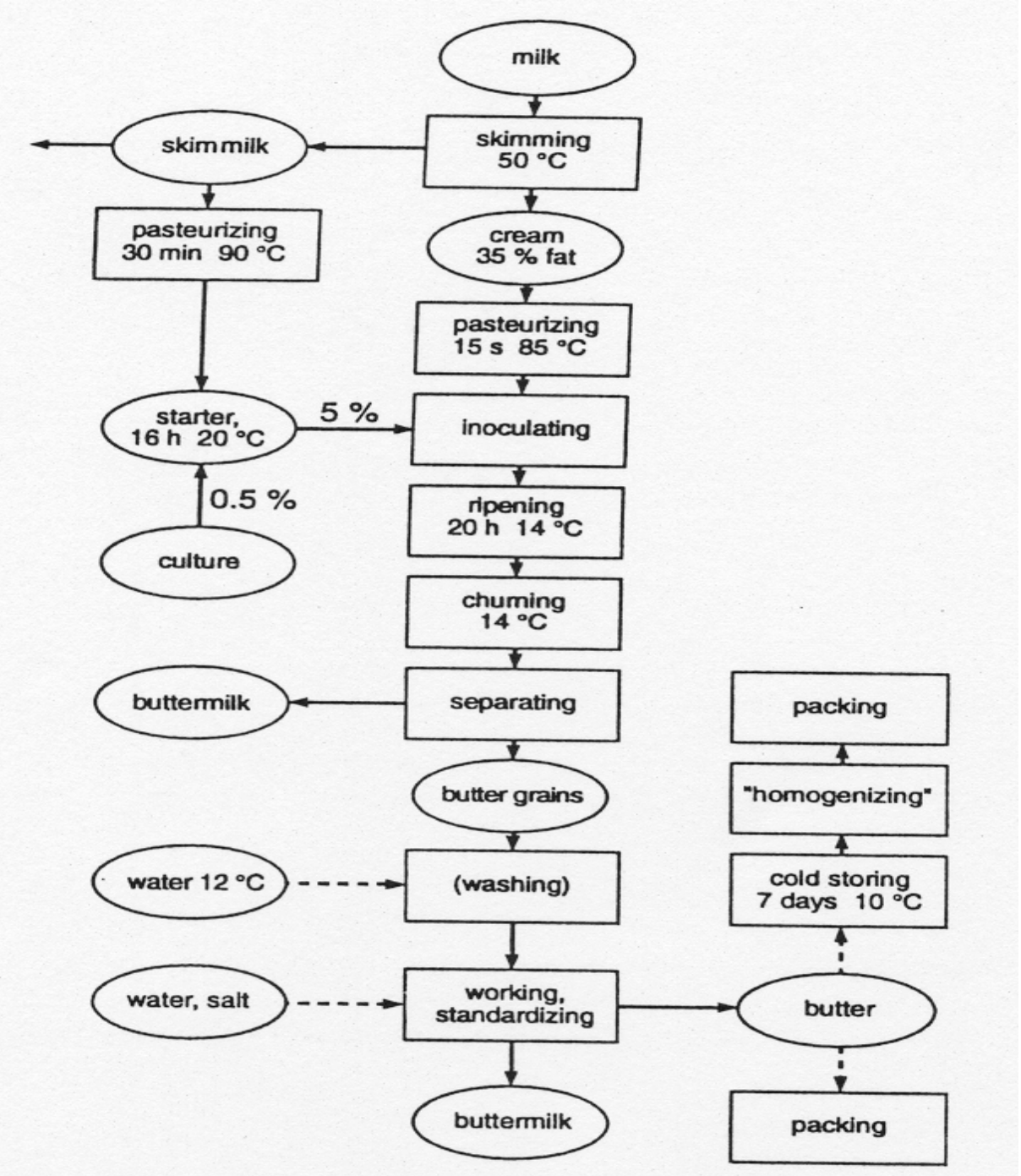
Kneading milk fat granules (Working)

- Excessive moisture squeezed out
- Small water droplets disrupted
- A steady state droplet size will be the end result
- Butter must have a dry surface (the water phase must be very finely dispersed)
- Too small droplets results in flat taste

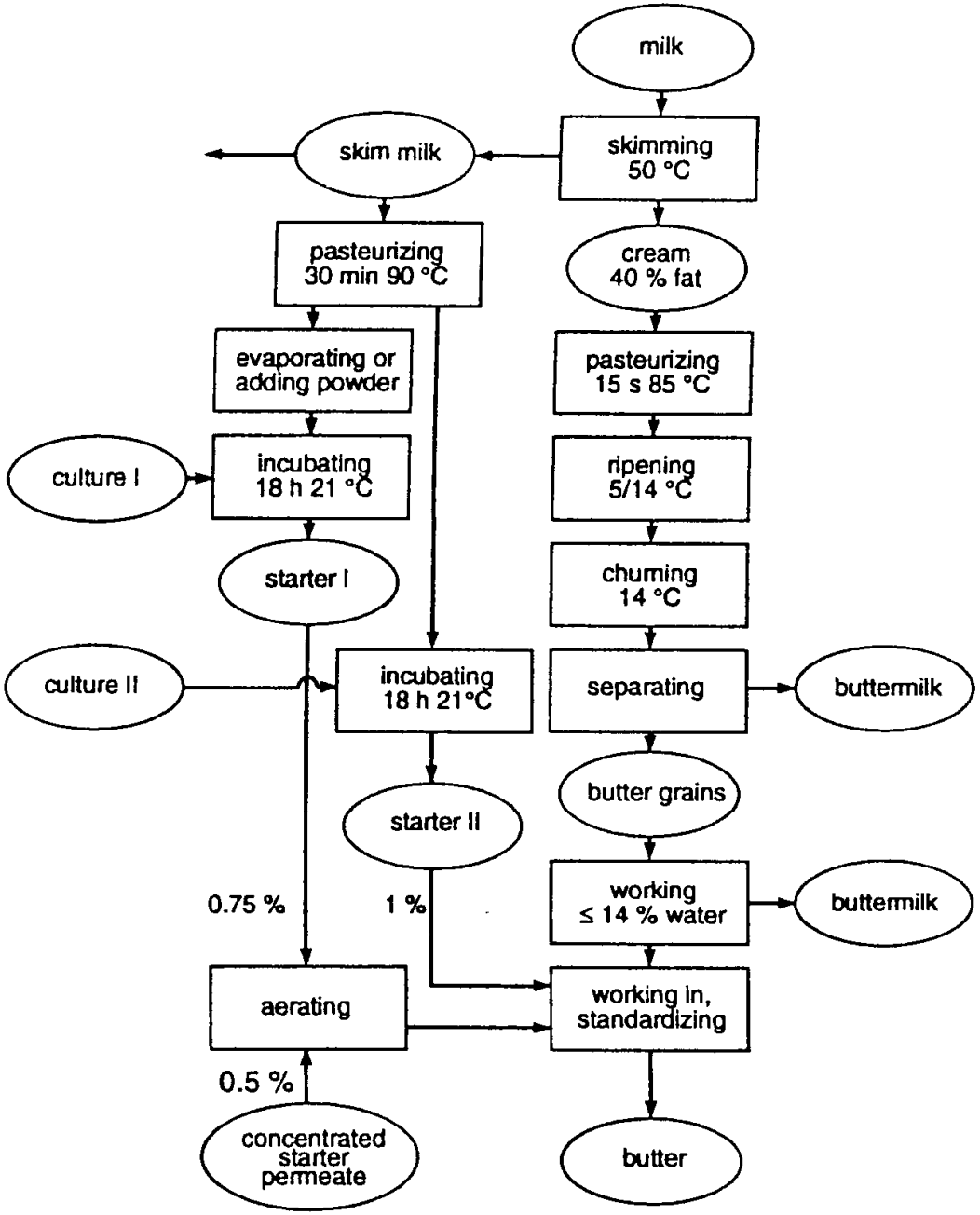
Butter micro structure



Butter making (classical way)



The NIZO method



Factors affecting firmness butter

- Crystal aggregate network
- Sintering of crystals increase firmness
- Percentage of solid fat
- Ratio large / small crystals
- Work softening process
- Fat composition
- Temperature treatment of the cream
- Temperature regime upon storage

References

1. Encyclopedia of dairy science.
2. Dairy processing handbook.
3. Modifying lipids for use in foods.