Cheese Additives: - قۆناغی جواره م بیشه سازی خۆراك

The following may all be added to the cheese milk:

1-Calcium chloride: -

Calcium chloride is added in a few amounts ranging between 0.01-0.02% of milk weight which used in cheese manufacturing to replace calcium redistributed during pasteurization to achieve constant coagulation time and produce curd with suitable time and properties. Milk coagulation by rennet during cheese making requires an optimum balance among ionic calcium and both soluble and insoluble calcium phosphate salts.

Because calcium have reverse solubility with respect to temperature, the heat treatment from pasteurization causes the equilibrium to shift towards insoluble forms and reduces soluble calcium or ionic calcium.

2-Hydrogen peroxide

Hydrogen peroxide is used (0.05-0.08 %)as an alternative treatment for pasteurization(antimicrobial agent)after milking , it is inexpensive substance and easily decomposed by the catalase enzyme, using of

hydrogen peroxide in cheese making leads to the negative results such as longer flocculation times ,Weak curd formation .loss of fines , Poor syneresis (moisture release) and decreasing of nutritional value by oxidation of some essential amino acids like Threonine and it resulted in production of (sunlight flavor).

3-Bleaching agent

Some types of cheeses such as mold-ripened cheeses (**Blue and Roquefort cheeses**) need to have white curd to **make the mold growth and color more clear, Benzoyl peroxide** (BP) has been used for over 50 years as a bleaching agent in whey processing and milk for cheese making at levels of about 0.001 to 0.002%.

Goats' and sheeps' milk are white in color because they lack -carotene. Cows' milk (contains more carotene) it whitened especially in spring to be similar in color to goats' or sheep’s milk.

4-Carbon dioxide

Is added to pasteurized milk to **produce carbonic acid which lowers the pH to calf rennet optimal pH** and in turn assists coagulation, Increased rate of gel firming and higher curd firmness at cutting

5-Starter stimulating substances are added to stimulating starter microorganisms growth such as yeast extract, hydrolyzed proteins, free amino acids vitamins…..

6-Emulsifying agents Sodium citrate or phosphate and Glyceryl-monostearate (GMS) usually added to emulsifying fat in some types of chesses such as process and ricotta which results in **texture improving**

7-Ripening Agents

A wide range of products are available to accelerate cheese ripening or to develop a broader flavor profile.

1- Lipase: Lipases, normally present in raw milk (endogenous) are inactivated during pasteurization. The addition of (kid goat lipases and Lipases from Mucor . miehei and Aspergilli strains are commercially

available)are common to induced Lipolysis and useful for the manufacture of mold-ripened cheeses, blue cheeses, and some Italian types(Romano).

Lipases hydrolyze triacylglycerols to di- and mono-acylglycerols and short-chain free fatty acids which plays a significant role in the flavorful and volatile flavor formation.

2-Enzyme Cocktails

Mixtures of enzymes from various sources added to the milk to accelerate ripening of aged cheeses. These cocktails include both lipases and proteases, with a predominance of proteases for Cheddar. Bacterial enzyme extracts from lactic acid bacteria have also been used.

Colorants:-

- Annatto cheese color is added to some cheese to standardize seasonal changes in color or to create orange cheese such as Cheddar and Cheshire.

The most important dyes for coloring chesses are derived from plants and vegetables and include yellow-orange annatto, carotene and paprika. Annatto is the most widely used color material for natural and process cheese.The fruit of the annatto tree (*Bixa orellana*), found in the tropics, is the source of annatto color for cheese and butter. Its active coloring agent is bixin which becomes norbixin when extracted with an alkaline solution.

For use in cheese; annatto is extracted by an alkaline solution such as 0.1M NaOH. Commercial annatto solution is added in range 10-20ml \100kg milk depending on cheese type and should be diluted with water about five times before adding to cheese milk then stirred in well. The alkaline extracted form is water soluble and attaches to casein in cheese.

Annatto is also used for coloring butter, It is prepared by extraction with vegetable oil. This product, unlike the annatto for cheese ,is fat soluble.

Annatto intended for use in butter is not recommended in cheese as is it may not disperse well and the cheese surface may appear spotty.

The following are some facts about annatto.

-Annatto is a carotenoid similar to -carotene and Vitamin A in structure, but it has no Vitamin A activity.

-About 10% of annatto goes into the whey.

-Annatto color is red to yellow pigment but it usually appears as orange. --

-The red constituent is more apparent with decreasing pH (6-4.8) changing the orange to pink while at pH < 4.8 the pink becomes nearly white.

-About 10% of annatto goes into the whey.

9-**Antibiotics** are added to inhibit growth of gas forming bacteria Clostridium tyrobutyricum or E.coli in the cheese during fermentation ,usually Nisin (antimicrobial agent) is used for this purpose.

10-Spices and Herbs:-Some spices and herbs is Added to give the desired flavor in cheese such as mint (Sage cheese), onions, garlic (Besa or owshary cheese) and cinnamon and cumin(Kuminost cheese).

Inoculation and Milk Ripening:-

The basis of cheese making depend on the fermentation of lactose by **lactic acid bacteria** (LAB). LAB produce lactic acid the milk is held for 45 to 60 min at 25 to 30° C to ensure the bacteria are active, growing and have developed acidity. This stage is called **ripening the milk** and is done prior to renneting.

Starters (Cultures):-

Basic Definition:-

Dairy starter cultures are pure cultures of microorganisms usually growing in sterilized skimmed milk that are on purpose added to milk in order to create a desired outcome in the final product,. Starter cultures have essential roles to play during all phases of the cheese making and maturation (ripening) process.

General Functions of Cheese Cultures:-

Culture, refers to prepared inoculate of bacteria, yeast and molds which are added to cheese milk and cheese.

1-Primary cultures have two purposes in cheese making:

A-to develop acidity **B- to promote ripening**.

Lactic acid cultures contribute to both of these functions, while secondary **cultures** are added to help with the second function.

A-Development of Acidity:-

In controlled conversion of milk to fermented dairy products, a primary component of fermentation is development of acidity by lactic acid bacteria. Acid development in cheese making is absolutely essential to cheese flavor, cheese texture and cheese safety. Acid is required to:

1-Assist coagulation. Lower pH results in faster coagulation and in acid coagulated cheese is the only factor which induces coagulation.

2-Promote syneresis. This is a most critical means of controlling moisture content. Low acidity causes the protein matrix in the curd to contract and squeeze out moisture.

3-Prevent growth of pathogenic and spoilage bacteria(" (LAB) has ability to produce antimicrobial ,bacteriocins compounds such as Nisin).

4-Develop cheese texture, flavor and color.

B-Assist curing:-

1-Enzymes (both lipases and proteases) produced by lactic cultures contribute to interior ripening of cheese and are important to both flavor and texture development.

2-Growth factors produced by lactic cultures are required for other non-starter microorganisms which contribute to the desired flavor and body of cheese

Classification of Lactic Acid Cultures (primary starters):-

LAB is grouped by four criteria:-

A-Principal metabolites (end products of fermentation):homo and htero-fermentative:-

Homofermentative means that lactic acid is the principal metabolite **without** production of gas (CO_2) and flavor compounds.

Heterofermentative means that lactic acid is the principal end product of fermentation but significant amounts of one or more of the following metabolites are also produced.

-Carbon dioxide (CO_2) which causes the **small gas holes** in **Havarti.**

-Short chain fatty acids such as acetic acid and propionic

-Acetaldehyde, a principal component of yoghurt flavour

-Diacetyl, a principal flavour note in sour cream, butter milk, Dutch cheese and Havarti cheese.

B-Optimum growth temperatures:

1-Mesophilic cultures as the name implies prefer medium range growth temperatures, (Cheddar, Dutch, Blue, surface mold and surface-smear families).

-Optimum growth range for mesophilic cultures is 30 - 35C°.

-Acid production is slow or absent at temperatures less than 20C°.

-Growth is inhibited at temperatures greater than 39C°.

-Generally any cheese which does not require high temperatures to dry the curd will utilize mesophilic cultures. These include Cheddar, soft ripened cheese, most fresh cheese, and most washed cheese.

-Leuconostoc spp. are included in the starter for some cheese varieties, e.g. Dutch types; the function is to produce di-acetyl and CO2, from citrate rather than acid production.

2-Thermophilic cultures

- are defined by their ability to grow at temperatures above 40C°.

-Optimum growth in the range of 39-50C°.

-Stay alive 55C° or higher .

-Minimum growth temperature is about 20C° below which cell counts decrease rapidly.

-Thermophilic starters are normally mixtures of cocci and rod cultures which at the time of inoculation are about equal in numbers. That is, the initial inoculum is 50% cocci and 50% rods.

-Rod/cocci blends grow together in a relationship referred to as 'mutualism' where the overall growth rate and acid production is faster than either culture on its own. The rods produce amino acids and peptides which stimulate the growth of cocci, and the cocci produce formic acid which is required by rods.

The balance between the rods and cocci can be controlled by temperature and pH The cocci prefer higher temperatures (optimum about 46C°) than the rods (optimum about 39C°).

The rods are more acid tolerant than the cocci, so, normally the cocci develop the initial acidity and outgrow the rods.

-Some thermophilic rod cultures have the ability to ferment galactose as well as glucose which is desirable in some cheese, especially Mozzarella.

- a thermophilic Lactobacillus culture is used, either alone (e.g. Parmesan) or with Streptococcus thermophilus (e.g. most Swiss varieties and Mozzarella).

-Although yoghurt cultures which include both rod and cocci, produce acetaldehyde which is the principal component of the characteristic yoghurt flavour, none of the thermophilic LAB are considered heterofermentative.

Some lactic acid bacteria commonly used in cheese making.		
Old Name	**New Name**	**Comments**
Mesophilic Cultures		
Streptococcus cremoris ***Streptococcus lactis***	***Lactococcus lactis* ssp *cremoris*** ***Lactococcus lactis* ssp *lactis***	**As a mixed blend these two form the most common mesophilic and homofermtative culture.** **Used for many low temperature varieties; fresh cheese, Cheddar, American varieties Dutch, Cottage,**

		Cream, Feta,Blue, surface mould and surface-smear families.
Leuconostoc citrovorum ***Leuconostoc lactis***	***Leuconostoc mesenteroides spp cremoris*** ***Leuconostoc lactis***	**Hetero cultures; ferment citrate; produce both CO_2 and diacetyl Leuconostoc spp. are included in the starter for some cheese varieties, e.g.** **Dutch types; the function is to produce diacetyl and CO_2, from citrate rather than acid production.** **Often mixed with *L. lactis* ssp *cremoris* / *lactis* for traditional butter and butter milk** **May be used for cheese with small holes** **to produce flavor compound in cottage cheese**
Streptococcus diacetylactis	***Lactococcus lactis* ssp *lactis* biovar *diacetylactis***	**Hetero culture; ferments citrate; produces both CO_2 and diacetyl ,Mixed with homofermentative lactococci for cheese with small holes, Goad & Edam cheeses.**
Thermophilic Cultures		
Streptococcus	***Streptococcus***	**Commonly used coccus/rod blend**

thermophilus ***Lactobacillus helveticus***	***salivarius* ssp *thermophilus*** ***Lactobacillus helveticus***	**for high temperature varieties, Swiss and Italian (Parmesan,Rommano, Emmental,Mozzarella)** ***L. helveticus* galactose +ve, and to promote proteolysis in Cheddar**
Lactobacillus bulgaricus	***Lactobacillus delbrueckii* ssp *bulgaricus***	**Commonly blended with *S. salivarius.* ssp *thermophilus* for yoghurt** **Alternative to *L. helveticus* in high temperature cheese , Grana cheese**
Lactobacillus lactis	***Lactobacillus delbrueckii* ssp *lactis***	**Alternative to *L. helveticus* and *L. bulgaricus* where low acid is preferred as in mild and probiotic yoghurts**

C-*Starter composition*:-

1-Single strain cultures:-

are single strain microorganism cultured in skim milk and added separately to cheese vat for specific properties such as proteolytic .Have the advantages of uniform rate of acid development and uniform flavor profiles.

2- Mixed cultures :-

-are a blend of single strain cultures.

Mixed cultures grow together in a relationship referred to as 'mutualism'e.g. mixed cultures used for Emmental(*Streptococcus thermophilus+ Lactobacillus bulgaricus+ Propioni bacterium shermaniee)* The *Lactobacillus bulgaricus* produce amino acids and peptides which stimulate the growth of *Streptococcus thermophilus+ Propioni bacterium shermaniee* which produce Large holes and

the *Streptococcus thermophilus* produce formic acid which is required by *Lactobacillus bulgaricus*.

-Have the advantages of uniform flavor profiles.

-are nonspecific blends of cultures.

Normally have complex systems of phage resistance, rotated to avoid phage infection or resistance to phage (bacterial viruses).

-Have resistance to scalding temperatures.

-Disadvantage is non uniform rates of acid development from vat to vat

D-Forms of Inoculation:-

Cultures can be carried and prepared for cheese milk inoculation in one of three general formats:

1-Traditional starters:

Which need several scale up transfers. This system requires some microbiological facilities and expertise and is only feasible for very large plants or perhaps for smaller plants which use mixed strain cultures.

2-Bulk set culture.

In this system, the culture supplier does all the purification and transfer work, and delivers a bulk set culture which is used to inoculate a bulk culture, which in turn is used to inoculate the cheese milk. Bulk cultures are the norm in medium to large plants because the cost savings are significant.

3-Direct to the vat cultures:-

Require no scale up at the cheese plant. Concentrated cultures ready to inoculate the cheese milk are supplied directly by the culture supplier.

Technological properties of lactic acid cultures:-

-Lactose metabolism. Most but not all LAB are able to metabolize lactose.

-Galactose metabolism. The ability to ferment lactose is important for late acid development in Italian cheese and to control browning on Mozzarella cheese.

-Proteolytic characteristics which determine cheese flavor development.

-Resistance to phage (bacterial viruses).

-The ability to metabolize citrate which is associated with flavor development (diacetyl or butter milk flavor) and gas formation.

-Production of bacteriocins, that is, antibiotics produced by bacteria against other bacteria.

-Resistance to bacteriocins.

-Antibiotic resistance

2- Secondary cultures

In addition to lactic acid cultures Special or secondary cultures are responsible for specific ripening (both flavour , texture and color) characteristics such as

eyes (CO2 formation) development, surface ripening and color Chanchiang to blue or green.

Many secondary cultures are used to promote Large holes:

Propioni bacterium shermaniee

Produce CO_2 gas which forms the holes (or eyes) and the characteristic "nutty" flavor in Swiss.

White moulds: *Penicillium camembertii, P. caseiocolum, and P. candidum*

Blue/green moulds: *Penicillium roqueforti, Penicillium glaucum*

Smears:

yeasts and moulds

Various coryneform bacteria including *Brevibacterium linens*, several species of *micrococci*, and several species of *Staphylocci* .

Commercial culture preparation:-

-Lactic cultures are grown in buffered media to facilitate maximum growth without acid inhibition .

-The cells are concentrated by centrifugation.

-The cell concentrate is fast frozen or freeze dried (lyophilized). Frozen (-40C) or lyophilized cultures can be stored for several months without large loss of activity.

Culture Practice in the Cheese Plant:-

Direct to the vat cultures need only be stored under prescribed conditions and opened and delivered to the vat under aseptic conditions.

The following comments relate to the preparation of bulk culture at the cheese plant.

-Culture preparation should take place in a separate culture room which is kept at positive air pressure with filtered air (0.2 μm filter).

-All surfaces in the culture room must be of a material that can be sterilized.

-Use sterile pipettes and sanitize surfaces and equipment with 200 ppm chlorine. – for milk used , care must be taken to avoid rancid milk, mastitic milk, milk containing antibiotics, and milk with high bacteria counts.10 -12% reconstituted skim milk powder is adequate provided that the powder is tested and certified antibiotic free.

-Whey and reconstituted whey powder may be used, but may not achieve the same cell counts as skim milk (due to less buffer capacity).

-Addition of phosphates also confers phage resistance because phosphates bind calcium, and phage requires calcium to attach themselves to the bacterial cells.

-Culture media should be sterilized to destroy bacteria and some inhibitory substances. Heating also reduces the redox potential (lowers oxygen concentration) which encourages the growth of LAB.

-Optimum pH endpoint before cooling is between 4.5 and 5.0. At pH less than 4.5 some cultures will pass from growth (log) phase to stationary phase and will be less active when added to the cheese vat.

-Generally cultures should be cooled to 4C after the desired minimum pH and cell counts are obtained.

Bacteriophage (bacterial viruses):-

Bacteriophage is the stuff of a cheese maker's alarming. Like all viruses, bacteriophage are parasites, that is, part of their life cycle is dependent on the host bacteria. Here are a few facts about their characteristics and how they can be controlled.

-Extracellular phage, that is, phage particles existing separate from their bacterial hosts are called mature or resting particles.

-Resting particles are sperm shaped, < 1 micron in length.

-Resting particles consist entirely of DNA (genetic material) and protein.

-The basic life cycle, called the lytic cycle, is:

> The phage attaches itself to the bacterial cell wall by its tail, bores a hole in the wall with the help of enzymes and injects its DNA into the cell. The protein sheath remains outside the cell.
>
> From the moment of invasion the bacteria begins to reproduce phage DNA and protein in addition to its own.

Nucleic acid and protein strands assemble themselves into new phage particles which eventually lyse the cell (break it open) to release the phage particles into the medium. A new generation of resting phage are now available to repeat the lytic cycle .

Culture growth will stop when phage levels reach 10^3 to 10^7 per ml.

Phage have a short latent period (reproduce as quickly as every 30 to 50 min) and a large burst size (each lysed cell will release 50 to 100 new phage.

Fermented Dairy Products -

Many products are made through microbial fermentation of milk (**differ in type of milk used**, **type of starter, processing methods** ….)Including yogurt buttermilk, and many cheeses. Lactic acid Fermentation is primarily carried out by lactic acid bacteria.

The lactic acid pathway and the accumulation of lactic acid from the metabolism of milk sugar, lactose is common to the production of fermented dairy products. The differences in the flavor and aroma of the various dairy products are due to additional fermentation products that may be present in very low concentrations.

Yogurt:-

Yogurt is made with a lactic-fermenting process which creates the typical sour flavor and makes yogurt thick and creamy. Yogurt can be made with cream or milk with varying amounts of fat. The amount of fat in the starting materials is part of what determines which variety of yogurt is made. Another difference is the other ingredients such as fruit or gelatin that are added during the fermentation process.

Yogurt is generally cultured with the lactic bacterias ***Lactobacillus bulgaricus and Streptococcus thermophilus*** which are added to pasteurized, homogenized milk and heated to increase the starter bacterial activity. These bacteria convert the milk sugars (lactose) into lactic acid. There are many types of yogurt:-

1-Set Yogurt- this type of yogurt is incubated into containers and allowed to ferment and cooled in the containers **without stirring**. This yogurt is very thick ,Firm "jelly like" texture.

Some yogurts are made with high milk fat content. Swiss style yogurt can be made from either whole, low fat, or non-fat milk. Whole milk yogurt contains **3.25% milk fat**, low fat yogurt contains between **0.5% and 2% milkfat**, while non-fat yogurt contains less than0 .5% milkfat.

2-Stirred Yogurt:- incubated in a tank and **final coagulum is broken by stirring** before cooling. Less firm then set yogurt (like a thick cream). A little reformation of coagulum will occur after packaging.

3-Drinking Yogurt: -also has coagulum broken before cooling. Very little reformation of coagulum will occur.

4- Fruity yogurt: - Fruit on the bottom is a type of Swiss style yogurt where the fruit is not mixed prior to packaging, but poured in the bottom prior to adding the sweetened yogurt.

5-Frozen Yogurt: - Incubated like stirred yogurt. Cooling is achieved by pumping through a freezer like ice cream. Has a texture like ice cream.

6-Flavored Yogurt: - Flavors are added just before yogurt is poured into pots. Add in usually contain about 20-50 % sugar.

7-Probiotic yogurt:-

which has other cultures (***Bifidobacterium bifidum)*** in addition to Lactobacillus bulgaricus and Streptococcus thermophilus. These additional bacteria are useful in preventing and treating many intestinal conditions including irritable bowel syndrome, constipation, diarrhea, C. Diff (Clostridium difficult), and intestinal flora imbalance caused by the use of antibiotics.

8-Prebiotic yogurt contains substances called fructooligosaccharides, like inulin, in addition to live probiotic cultures. These ingredients help the body to keep the probiotic bacteria alive where they can reproduce in the intestine.

9-Enriched yogurts: - have also become more common. These yogurts contain added vitamins, minerals, fatty acids and other healthy ingredients such as fiber, calcium, and omega-3 fatty acids.

2-- Cultured Buttermilk

This product was originally the fermented byproduct of butter manufacture, but today it is more common to produce cultured buttermilks from skim or whole milk. The culture most frequently used in ***Loctococcus lactis, als Loctococcus cremoris or Loctococcus diacetylactis.***

Milk is usually heated to 95°C and cooled to 20-25°C before the addition of the starter culture. Starter is added at 1-2% and the fermentation is allowed to proceed for 16-20 hours, to an acidity of 0.9% lactic acid. This product is

frequently used as an ingredient in the baking industry, in addition to being packaged for sale in the retail trade.

3- **Acidophilus milk**

Acidophilus milk is traditional milk fermented with ***Lactobacillus acidophilus (LA),*** which has been thought to have therapeutic benefits in the gastrointestinal tract. Skim or whole milk may be used. The milk is heated to high temperature, e.g**., 95°C for 1 hour**, to reduce the microbial load and favor the slow growing LA culture. Milk is inoculated at a level **of 2-5%** and incubated at 37°C until coagulated. Some acidophilus milk has acidity as high as **1% lactic acid**, but for therapeutic purposes **0.6-0.7%** is more common**.**

4-Sour Cream

Cultured cream usually has **a fat content** between **12-30%,** depending on the required properties. The starter is similar to that used for cultured buttermilk. The cream after standardization is usually heated to **75-80°C** and is homogenized at >13 M Pa to improve the texture. Inoculation with **Streptococcus cremoris or S. lactis for producing lactic acid and Leuconostoc cremoris for characteristic flavour. and fermentation conditions are also similar to those for cultured buttermilk, but the fermentation is stopped at an acidity of 0.6%.**

5-Kefir

Kefir is a symbiosis of many beneficial bacteria and yeasts, which form grains (solid kefir "grains). During the fermentation process the Kefir grains changes normal milk into healthy ‘living’ pro-biotic food. It takes between 5 and 24 hours

to produce a finished product, depending on temperature and the amount of milk used. Cow, goat, or coconut milk may used for kefir making.

Kefir starter:-*Streptococcus lactis ,Lactococcus cremoris ,Streptococcus diacetylactis , Lactobacilli bulgaricus ,Leuconostoc mesenteroides, Klyveromyces lactis or Saccaromyces cerevisiae*

6-**Koumis**

Kumis is a fermented dairy product traditionally made out of **mare's milk**. The drink remains important to the people from the Turks, Bashkirs, Kazakhs, & Russian……..

Kumis is similar to kefir, but is produced from a liquid starter culture, in contrast to the solid kefir "grains" & is made from mare milk. Because mare's milk contains more sugars than cow's or goat's milk, when fermented, kumis has a higher,, alcohol content compared to kefir.

Kumis starter:-*Streptococcus lactis ,Lactococcus cremoris ,Streptococcus diacetylactis , Lactobacilli bulgaricus ,Leuconostoc mesenteroides, Klyveromyces lactis or Saccaromyces cerevisiae*