

## STARTER CULTURES IN RAW MILK MANUFACTURING INDUSTRY

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*This article sets out the starter culture classification in cheese production, their requirements and objectives for the cheese production. The term starter culture is an English expression and has been translated into German as Säuerungskultur or Säureweckerkultur (abbreviated form Säurewecker). Now even ripening or flavour cultures are included in the term starter culture (short "starter"). The following definition is valid today: Starter cultures are - based on their specific properties - selected, defined, and viable microorganism in a pure or mixed culture.*

*Starter cultures in cheese production are special types of bacteria or bacteria of one or more families, developing a clot, help obtaining raw-finished product. Individual varieties of cheese with their corresponding characteristic properties can only be manufactured when using specific and finely-tuned starter cultures.*

*Production of individual lactates can de- or increase with increasing age of the culture. Manufacturers of starter cultures are constantly developing new optimal cultures, contributing to production safety, improvement and stabilization of cheese quality.*

***Key words:** starter culture, manufacturing, industry, rennet cheese, raw milk, dairy products*

## СТАРТОВІ КУЛЬТУРИ В СИРОВИРОБНИЧІЙ ГАЛУЗІ

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*У статті викладено класифікацію заквасок при виробництві сирів, їх вимоги і цілі по виробництву сиру. Термін закваска є англійським виразом і був перекладений на німецьку мову як Säuerungskultur або Säureweckerkultur (скорочено Säurewecker). Тепер навіть дозрівання або смак та ароматика включаються в поняття закваска (коротко "стартова"). Таке визначення є чинним сьогодні.*

***Ключові слова:** закваска, виробництво, промисловість, сичужний сир, сире молоко, молочні продукти.*

## СТАРТОВЫЕ КУЛЬТУРЫ В СЫРОВАРЕННОЙ ОТРАСЛИ

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*В статье изложена классификация заквасок при производстве сыров, их требования и цели в производстве сыра. Определение «закваска» является английским выражением и было переведено на немецкий язык как Säuerungskultur или Säureweckerkultur (сокращенно Säurewecker). Теперь даже созревание или вкус и*

ароматика включаются в понятие закваска (коротко "стартовая"). Такое определение является действующим сегодня.

**Ключевые слова:** закваска, производство, промышленность, сычужный сыр, сырое молоко, молочные продукты.

**Formulation of the problem.** In milk production microflora cultures (starters) perform various functions. They affect the taste, smell, texture of cheese, showing inhibition products through its own metabolism. In the production of cheese milk clot is formed by the action of yeast, its main objective is the transformation of milk sugar into organic acids. That's why starter cultures are paid much attention to.

**The purpose of research.** Starter cultures in cheese production are special types of bacteria or bacteria of one or more families, developing a clot, help obtaining raw-finished product. At the beginning of the new millennium markedly improved macroeconomic situation in Ukraine, primarily as a result of production growth in cheese production industry. To increase the competitiveness of Ukrainian cheese, improving their quality indicators, food security is important to develop scientific foundations of a new technology with regard starter cultures, rational use different combinations and improve existing methods of production of natural cheese. It is natural cheese production is relevant today.

**Formulation of the problem.** The article shows the classification of starter cultures, which is required to select the crops on which depends the future kind of cheese and cheese to some degree to local consumers. The challenge for the industry is cheese production methods of concentration of lactic acid bacteria cells, increasing their stability during manufacture and storage of products in modern production technologies [1].

Selected, defined, and multi-functional microorganisms - in function of their specific properties - in pure or mixed form are considered starter cultures. Cultures are strains of microorganisms, enriched in a nutrient broth, and cultivated. Its subsequent propagation by inoculation of a defined culture is called sub-cultivation.

So, it is obvious that careful selection of starter cultures can get different kinds of cheese, which in taste, rational use, combination and improvement of existing production methods give new types of natural cheese.

**Nutrient medium (bio-activators) for propagation of starter cultures.** Previously, fresh skim milk was used as a culture medium. A higher safety is provided by reconstituted inhibitor-free skim milk or whey (made from powder). In function of used strains, a dry matter content of 5... 9% is optimal. By adding biofactors, growth and activity of these cultures can be improved.  $Mn^{2+}$  (Manganese) - 0.2 mg  $MnSO_4$  per litre of culture - increases growth of, e.g., *Leuconostoc mesenteroides subsp. cremoris*. Propagation of bacteriophages is inhibited by  $Ca^{++}$ -binding ions. Manufacturers of cultures have developed media containing natural additives such as skim milk or whey powder and specific growth factors for various starter cultures. RITTER(2005) recommends an addition of whey permeate to the growth medium for propagation of *Lactococcus lactis* [2].

#### **Classification of starter cultures**

*Single-strain starter cultures* - strain of one species

*Single-species, multiple-strains starter cultures* - a culture with more than one strain of a single species

*Multiple species starter culture* - more than one strain of various species (WEBER)

Mesophilic cultures (without gas formation)

*Lactococcus lactis subsp. lactis*

*Lc. lactis subsp. cremoris*

Mesophilic DL-cultures [D(-)- and L(+)-lactate-formation]

*Lc. Lactis subsp. lactis biovar diacetylactis*

*Leuconostoc mesenteroides subsp. cremoris*

*Leu. Mesenteroides subsp. dextranicum*

*Leu. Lactis*

Thermophilic cultures

*Streptococcus salivarius subsp. thermophilus*

*Lactobacillus delbrueckii subsp. bulgaricus*

*Lb. helveticus*

Probiotic cultures

*Bifidobacterium subsp. bifidum*

*Lactobacillus acidophilus*

*Lb. casei subsp. casei*

*Lb. casei subsp. rhamnosus*

Propionic cultures

*Propionibacterium freundreichii subsp. Freundreichii*

*Prop. freundenreichii subsp. shermanii*

Surface cultures (red smear cultures)

*Brevibacterium linens*

*Br. casei*

Mould cultures

*Penicillium caseicolum*

*P. camemberti*

*P. roqueforti*

*Geotrichum candidum* (is considered yeast according to MUNCH and GRILLENBERGER) [2].

Cheese flavour cultures

*Geotrichum candidum* (previously "White milk fungus" is now assigned to the group of "yeast-like organisms" sometimes species are assigned to mould, transitory and yeast types)

Yeast

*Kluyveromyces lactis* (lactose yeast) *Debaryomyces hansenii* (brine yeast) *Candida utilis*

*Rhodospiridium infirmominatum*

Protective cultures with an antagonistic activity against harmful germs (bloaters, *Listeria* and others)

*Lactobacillus paracasei* (antagonistic strain)

*Pediococcus pentosaceus* (bacteriocin forming strains)

*Lactobacillus rhamnosus* (a subspecies with inhibitor-effect against *Clostridia*)

*Lb. rhamnosus* + *Propionibacterium freundenreichii* (=multiple species culture, it acts against growth of yeast, mould and heterofermentative lactic acid bacteria)

*Lb. plantarum* (a unique strain forms biological-active bactericidal protein, called pedzin)

*Streptomyces thermophilus* (specific strain develops bactericides against pathogens)

*Enterococcus faecalis* (a specific strain inhibits development of *Listeria innocua*)

Specific cultures and strains are required for individual types and varieties of cheese [3]. They have to comply with type-specific requirements, and need to reach certain growth targets (Table 1).

Table 1

**Utilization of specific cultures (species) for individual groups (varieties) of cheese typical requirements - growth objectives (mod.acc. to REINER)**

Cheese type (variety)	Species	Typical requirements	Development objectives
<b>Cheddar</b>	O-Culture	Harmonized proteolysis without bitter peptides+ flavor development, high acidity activity	Taste differentiating, closed cheese mass
<b>Gouda Edam Russian</b>	LD-cultures ( <i>Lc. lactis subsp. lactis</i> )	Stable acidification, minor eye formation during fermentation, flavour development	Cost-effective inoculation solutions with high activity
<b>Pasta filata Mozzarella</b>	<i>Sc. thermophilus</i> <i>Lb. bulgaricus</i> <i>Lb. helveticus</i>	Rapid acidification, sugar decomposition, stretching properties	Good melting properties, closed texture, minor eye formation
<b>Camembert Brie</b>	LD-cultures <i>Sc. thermophiles</i> Ripening cultures	Supple texture or core formation, rapid acidification, minor proteolysis	Inoculation solution for small curd vats
<b>Feta</b>	O-culture	Very rapid acidification to low pH	Closed body

A basic prerequisite and growth target is a high phage stability and good standardization. Major organisms for individual lactates are:

- *D (-)-Lactate former: Lb. bulgaricus(100%), Lb. lactis(100%)* & well as species of *Leuconostoc*
- *L (+)-Lactateformer: Sc. thermophilus(100%), Lc. lactis (~97%)* and *6/ bifidum(-95%)*
- *DL-Lactate former: Lb. acidophilus, Lb. helveticus.*

Production of individual lactates can de- or increase with increasing age of the culture (KLUPSCH). Manufacturers of starter cultures are constantly developing new optimal cultures, contributing to production safety, improvement and stabilisation of cheese quality. Development is concentrating on:

- Improvement of phage resistance
- Decrease of post-acidification after cooling
- Increase in acidity activity
- Improvement of flavour development and stability
- Generation of health-enhancing properties.

Manufacturers of cultures are all certified and offer an excellent service. Some artisanal cheese dairies still insist on propagation of cultures from raw milk and/or their own flora (whey and others) [4].

***Tasks of starter cultures during manufacture of rennet cheese***

Individual varieties of cheese with their corresponding characteristic properties can only be manufactured when using specific and finely-tuned starter cultures. Proper selection and adequate application are required. During the manufacture of rennet cheese, starter cultures have the following functions:

- Acidification resp. acidity-enzymatic effects
- Flavour development by proteolytic processes, i.e. formation of flavour compounds (always amino acids, but also diacetyl, acetone, propionic-, acetic-, capronic-, butyric, citric-, isovaleric acid, also acetaldehyde, ethanol and ketone)
- Texture development in function of acidification and proteolytic decomposition, further eye formation by CO<sub>2</sub>-generating microorganisms (propionic acid bacteria, heterofermentative lactic acid rods, DL-cultures)
- Preserving effect by formation of acid and sometimes bacteriocine by, e.g., *Lactococcus lactis subsp. Lactis*
- Surface deacidification (*Geotrichum candidum*, various yeasts)
- Proteolytic surface ripening and protection (*Brevibacterium*, *Edible mould*)

- Cultures forming uniform EPS (exopolysaccharide) do improve
- Water-binding capability of soft cheese
- Texture of low-fat cheese (FAERGEMOND).

#### ***Requirements for starter cultures***

Starter cultures have to comply with high requirements (PEDERSEN). They should be genetically stable, reproducible and controllable [4]. When asked, manufacturers of starter cultures issue a certificate with information on these properties. For cheese cultures, there are the following characteristics:

- High acidity activity, guaranteeing a safe and constant rate of acidity
- Wide tolerance spectrum for substrate conditions occurring in cheese, especially increased acidity and salt tolerance as well as minimal temperature sensitivity
- Characteristic proteolytic activity and good flavour development
- Release of bacteriocine with suppression of unwanted accompanying flora
- Synergism with other utilised microorganisms by formation of growth stimulators, resulting in operational improvements
- Low phage sensitivity, a high phage resistance would be better (KAUTZ) [5].

#### **Conclusions**

The article analyzes the classification of starter cultures in wet industrial sector effect on cheese ripening. The issue of dairy cultures in the area requires further research.

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