Whey-based beverages- a new generation of diary products

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Summary

Whey is a by product in the process of cheese production. Composition and characteristics of whey are depending on the production technology of the end product and on the quality of the used milk. Liquid whey consists approximately 93% of water and contains almost 50% of total solids present in the milk of which lactose is the main constituent. Lactose is the main constituent of whey while proteins represent less than 1% of total solids. In fewer amount also minerals and vitamins are present. Production of whey based beverages started in 1970's and until today a wide range of different whey beverages has been developed. They can be produced from native sweet or acid whey, deproteinised whey, native whey which was diluted with water, whey powder or by whey fermentation. Non alcoholic whey beverages include wide range of products obtained by mixing native sweet, diluted or acid whey with different additives like tropical fruits (but also other fruits like apples, pears, strawberries or cranberries), crops and their products (mainly bran), isolates of vegetable proteins, CO_2, chocolate, cocoa, vanilla extracts and other aromatizing agents. Special attention is being paid to development of whey beverages production by whey fermentation with probiotic bacteria where the most important step is the choice of suitable culture of bacteria in order to produce functional beverage with high nutrient value and acceptable sensory characteristics. Non alcoholic whey beverages also include dietetic beverages, drinks with hydrolyzed lactose, milk like drinks and powder drinks. Whey is a very good raw material for production of alcoholic beverages due to the fact that the main constituent of the solid content is lactose (about 70%). Alcoholic whey beverages include drinks with small amount of alcohol (to 1.5%), whey beer and whey wine. Whey beverages are suitable for wide range of consumers - from children to the oldest ones. They have very high nutrient value and good therapeutic characteristics.

Key words: whey composition, alcoholic and non-alcoholic drinks, functional additives

Introduction

Diary industry has developed a large scale of new, nutritionally improved products which have achieved a very good success on the market. Therefore traditional diary products as we have known them for ages are evolving into the new generation of diary products with different characteristics and better health and nutritional properties. Whey based beverages belong certainly to this group of new products, although whey as a by-product in cheese manufacture is often disposed off as waste or used as provender.

What is whey actually?

Whey is a by-product obtained from cheese manufacture. Depending on the type of casein coagulation, whey can be sweet or acid. Composition and properties of whey mainly depend on the technology of cheese manufacture and on the quality of milk used for cheese production (Tratnik, 1998).

Table 1: Typical composition (g/L) of sweet and acid whey (Jelen, 2003)
Tablica 1: Prosječan sastav (g/L) slatke i kisele sirutke (Jelen, 2003.)

Component Sastojak	Sweet whey Slatka sirutka	Acid whey Kisela sirutka
Total solids/Ukupna suha tvar	63,0 - 70,0	63,0 - 70,0
Lactose/Laktoza	46,0 - 52,0	44,0 - 46,0
Proteins/Proteini	6,0 - 10,0	6,0 - 8,0
Calcium/Kalcij	0,4 - 0,6	1,2 - 1,6
Phosphates/Fosfati	1,0 - 3,0	2,0 - 4,5
Lactates/Laktati	2,0	6,4
Chlorides/Kloridi	1,1	1,1

According to its average composition whey is approximately 93% water and contains about 50% of total solids present in the milk of which lactose is the main constituent. Whey proteins constitute less than 1% of dry matter (Beucler et al., 2005).

Minerals and milk fat are also present but in less amounts. However, whey composition is very variable and significantly depends on the technology of whey production.

Most compositional differences are in contents of calcium, phosphates, lactic acid and lactate which are present in much higher amounts in acid whey (Table1).

On the other side, sweet whey contains besides whey proteins also glycomacropeptide (GMP) which is obtained by enzymatic hydrolysis of casein. Moreover, whey protein content is quite lower in whey obtained in the process of cheese manufacture from ultrafiltered milk or from milk processed at high temperatures (Jelen, 2003).

However, in processes of traditional cheese manufacture, regardless of casein coagulation process, almost all whey proteins cross into the whey due to their insensitivity to enzyme activity and acids (Tratnik, 1998). Thereat whey proteins are the constituents which put whey into spotlight on the diary products market.

Whey proteins include several thermosensitive fractions like ß-lactoglobulin, α-lactalbumin, bovine serum albumine, immunoglobulins and termostable fraction of proteose peptones. Due to the high content of essential aminoacids (notably lysine, cysteine and methionine) and cystin, whey proteins are one of nutritionally most valuable proteins.

Due to such aminoacid composition whey proteins have much higher biological value (but also other parameters that determine nutritional value) in comparison with casein or other proteins of animal origin, including egg proteins which have been considered for a long time as referent proteins.

Protein utilization in human organism is tightly related to cystine/methionine ratio which is about 10 times higher in whey proteins than in casein.

Therefore, it is not surprising that thermally denaturated lactalbumns are being almost totally (100%) absorbed in the digestive system while this ratio is significantly lower (about 75%) regarding casein absorption.

Whey protein content is similar in sweet and acid whey. Nevertheless, it is important to mention free aminoacid content which varies a lot and is mostly dependant on the level of casein hydrolysis in cheese making process.

Thereby, free aminoacid content is about 4 times higher in sweet whey and about 10 times higher in acid whey than in milk (Tratnik, 1998).

Table 2: Content of aminoacids (mg/L) in whey (Tratnik, 1998)

Tablica 2: Udjel aminokiselina (mg/L) u sirutki (Tratnik, 1998.)

Whey Sirutka	Free aminoacids Slobodne aminokiseline		Aminoacids in proteins Aminokiseline u proteinima	
	Total Ukupne	Essential Esencijalne	Total Ukupne	Essential Esencijalne
Slatka Sweet whey	132.7	51.0	6.490	3.326
Kisela Acid whey	450.0	356.0	5.590	2.849

Recommended daily intakes of most essential aminoacids can be satisfied by consumption of 1.5 liters of whey or 0.5 liters of milk (Popović-Vranješ and Vujičić, 1997).

Besides that, whey proteins have excellent functional properties like good solubility, good viscosity, good emulsifying and gelation abilities. Therefore whey protein concentrates are largely used in food industry. Due to the fact that whey proteins have much higher digestibility than casein, they are often used in production of infant formulas and to improve the nutritional value not only of diary products but also of many other food products. Also, it is important to mention immunoglobulins and other glycoproteins (lactoferrine, transferrine) and enzymes (lysozime, lactoperoxidase) which are very notable factors of immunactive system of whey. They have antimicrobial properties and have the ability to reduce or even inhibit allergic reactions (Tratnik, 2003).

However, lactose is the main constituent (about 70%) of the whey dry matter and is a very important source of energy, but it has several roles. Some of beneficial effects of lactose are stimulation of peristaltic activities in the digestive tract, alleviation of calcium and phosphor absorption, establishment of lightly acid reaction in the gut which inhibits the growth and expansion of pathogens. Furthermore, lactose also assures the optimal amount of magnesium and improves digestion of milk fat and other nutrients in human organism and it does not participate in plaque formation. Heat treatments of whey cause transformation of certain amount of lactose into lactulose which is bifidobacteria growth promotor (Tratnik, 2003).

Water soluble vitamins present in the milk also pass into the whey, but their amounts are very variable and highly dependant on the storage conditions of whey. Thereby riobaflavine, folic acid and cobalamine are present in significant amounts. The latter ones are bounded to whey proteins and mostly remain in whey after cheese manufacture. It is interesting that whey

can contain higher amounts of riboflavine than milk, due to the activity of some lactic acid bacteria used in cheese manufacture. Due to relatively high content of riboflavine, whey has a characteristic yellow-green colour (Popović-Vranješ and Vujičić, 1997; Tratnik, 1998).

Mineral composition in whey dry matter is the variable (7-12%) and depends on the technological process of cheese production (Popović-Vranješ and Vujičić, 1997). Whey contains almost all soluble salts and microelements present in the milk, but also salts added in the cheese manufacture process. Thereby calcium and phosphates are partially remaining bounded in the casein contained in cheese, and their contents are much higher in acid whey because of much higher solubility in acid medium (Tratnik, 1998).

How to produce a tasty beverage from whey?

Whey can be utilized in different ways in food industry, but it is mostly being dehydrated to whey powder or used for manufacture of whey protein concentrates and isolates of lactose or proteins.

Processing of whey to beverages began in the 1970-ies, and one of the oldest whey beverages is *Rivella* from Switzerland. Until today a large scale of different whey beverages has been developed, which are produced from native sweet or acid whey, deproteinized whey, fresh diluted whey, fermented whey or powdered whey.

There are also alcoholic whey beverages like whey beer or wine and beverages with low alcohol content (less than 1.5%).

Several difficulties occur during the processes of whey beverage production. First of all, the high water content makes fresh whey very pervious to microbial spoilage whereby heat treatments are needed. On the other side, whey proteins are thermosensitive and start to denature at temperatures above 60 ºC (Tratnik, 1998) whereby a certain amount of present proteins precipitate after the usual thermal treatment of whey (72 ºC/15 - 20 sec.). Therefore a lot of efforts are made in studying the implementation of ultrasound or membrane processes like microfiltration instead of thermal treatments. Ultrasound can also improve solubility of whey proteins (Režek-Jambrak et al., 2008) and in that case the amount of sediment formed during storage of whey beverages can be reduced. Besides that, acidification of whey down to pH < 3,9 causes whey proteins to become thermoresistant and do not precipitate even during UHT sterilization treatments (Jelen, 2003).

Relatively high content of minerals in the dry matter of whey presents the next problem in whey beverage production because these minerals are responsible for undesired salty-sour

flavour of whey. This problem is especially bold in acid whey due to higher amount of lactic acid whereof the content of minerals (mostly Ca-phosphates and Ca-lactates) is also higher due to better solubility. That causes redundant acidity and appearance of clots in the final product and also formation of higher amounts of sediment during heat treatments (Tratnik, 2003).

However, despite of all difficulties, fresh whey processing has proved to be the most economical technological solution. Therefore many efforts have been made in development of beverages with addition of fruit concentrates in order to produce a drink with acceptable sensory properties especially regarding flavour (Koffi et al., 2005).

Nonalcoholic whey beverages

In recent two decades numerous patents containing recipes for production of whey beverages with addition of fruit concentrates with variable fruit dry matter amounts (5-20%) have been registered. Thereby citrus-flavoured drinks and drinks with addition of other tropical fruit aromas like mango, banana or papaya have been most frequently suggested, since they have proved to be very efficient in covering up the undesirable odour of cooked milk and salty-sour flavour of fresh whey (Đurić et al., 2004).

Besides that, addition of many other fruits like concentrates of apple, pear, peach, apricot and cherry has also been applied. The addition of berries which are known as a good source of iron and antioxidants have proved to be very useful. That is especially important in production of whey beverages with improved nutritional value. Best example for supporting this thesis is Brazilian group of scientists who have developed a whey drink flavoured by addition of strawberry concentrate and fortified with ferrous bisglycinate. They have proved that long-term consumption of this drink had an impact on reduction in the prevalence of anemia in children and adolescents (Miglioranza et al., 2003).

Besides fruits, some scientist have applied the addition of other flavouring agents like chocolate, coca, vanilla, cereals (mostly rice, oat and barley), honey, etc. Addition of cereals, especially bran, seems to be very interesting and is resulting in production of a beverage fortified with dietary fibers, essential fatty acids (with addition of oat) and hypoallergenic proteins what makes these beverages suitable for consumption by allergic population and children. In order to prepare a hypoallergenic beverage, the addition of other vegetable sources of proteins like isolates of potato or soy proteins may be used. Thereby, oatmeal

addition is preferred because it not only enhances the low allergenic protein content, but also adds to the taste of the resulting product (Girsh, 2001).

Since bran is a very good source of dietary fibers it is very important to choose carefully the source of bran to be added because many fibers have very low solubility or are not soluble at all. Stabilized rice bran has shown to be one of the best choices in this category of flavouring agents since it has the proper balance of soluble and insoluble dietary fibers, there is almost no sediment formation during storage of rice bran fortified beverages and it does not contain allergy causing proteins. Addition of honey to such beverage instead of sugar or other sweeteners results in fortifying it with numerous other nutrients like vitamins, minerals (Hammond, 1992) and fytochemicals which are not naturally present in whey.

However, the main problem occurring in all these recipes (especially when adding fruits like apples, pears and bananas) is the formation of sediment due to the high amount of fruit dry matter and interactions of proteins with components in fruit dry matter.

The sediment arises with time and consequently such whey beverages do not perform well on the market. On the other side, if the amount of fruit dry matter is not high enough, the end product does not have good sensory properties like colour, flavour and odour (Koffi et al., 2005; Đurić et al., 2003).

Therefore it is a very big challenge to find the optimal recipe for mixing fruit concentrate and/or other additives with fresh whey in order to produce a beverage with acceptable sensory properties.

For this purpose many studies were carried out what resulted in a whole scale of possible solutions which could be applied in order to produce a beverage with as few lacks as possible. Thereby some authors propose the addition of metal gluconate (Remer, 1982), citric acid and diverse sweeteners like fructose, succrose or lactose hydrolysates for adjusting odour and flavour.

Nowadays some authors have suggested the addition of CO_2 combined with fruit add-ins to overcome the undesirable flavour and odur of cooked milk (Sherwood et al., 2007).

One of better options for beverages with acceptable sensory properties manufacture is production of **fermented whey beverages**. For whey fermentations mainly starter and probiotic cultures of lactic acid bacteria are used, while in case of alcoholic fermentations mostly yeast specie *Kluyveromyces* is used.

In this way fermented whey beverage with desirable nutritive and sensory properties is produced, without implementation of complicated and expensive technologies like

ultrafiltration and evaporation which are being used in case of processing whey protein isolates or concentrates or powdered whey to beverages.

There are even some indications that fermentation of whey using yoghurt culture (*Lactobacillus delbrueckii* ssp. *bulgaricus* and *Streptococcus termophilus*) produces a more intense yoghurt flavor compared to the one obtained when skim milk is fermented.

This suggests the possibility of producing beverages from whey with similar sensory profiles to those of fermented milk drinks or with some flavor attributes of drinking yogurt, following manufacturing procedures conventionally used for milk (Gallardo-Escamilla et al., 2005).

In this category of products big attention has been paid to development of probiotic whey beverages, since beneficiary effects of probiotic strains on human health like lowering cholesterol level in blood, improving lactose metabolism, lowering blood pressure, anticancerogenic properties and immune system stimulation are known for a long period of time (Shah, 2007).

One of the most important factors is the chosen probiotic strain since it determines the unique flavor and texture of the end product. In the past few years many studies regarding fermentations with probiotic strains *Lactobacillus reuteri* and *Bifidobacterium bifidum* have been made whereby Mendoza et al. (2007) managed to produce an acceptable probiotic whey beverage with addition of sugar and pectins.

Drgalić et al. (2005) studied survival and growth of probiotic strains *Lactobacillus acidophilus* La-5, *Bifidobacterium bifidum* Bb-12 and *Lactobacillus casei* Lc-1 in reconstituted whey for 28 days of cool storage. All strains have shown good survival during storage time of fermented beverages. The beverage fermented by probiotic strain Bb-12 obtained lower sensory score than the other two beverages fermented by strains La-5 and Lc-1.

In some recent studies whey was fermented by using following strains *Lactobaciluus acidophilus*, *Lactobacillus delbrueckii* sbsp. *bulgaricus*, *Streptococcus thremophillus*, *Lactobacillus rhamnosus* and *Bifidobacterium animalis* subsp. *lactis*. Thereby the most successful ones proved to be fermentations with yoghurt culture (*Streptococcus termophillus* and *Lactobacillus delbrueckii* sbsp. *bulgaricus)* and co-culture *Streptococcus termophillus–Bifidobacterium animalis* subsp. *lactis* (Almeida et al, 2008).

Pescuma et al. (2008) obtained similar results by using co-culture *Streptococcus termophillus* and *Lactobacillus delbrueckii* sbsp. *Bulgaricus,* proposing to be a high potential culture for whey fermentation.

Lactobacillus rhamnosus belongs to one of frequently used strains, but it does not have the ability of fermenting lactose due to the lack of enzyme ß-galactosidase. Therefore it is necessary to hydrolyze lactose before starting the fermentation process. One of the most famous whey beverages obtained by fermentation with *Lactobacillus rhamnosus* is «Gefilus» which is being produced in Finland using demineralized whey or whey protein concentrates with prior lactose hydrolysis. This beverage is mostly being flavored by addition of fruit juices or fruit aromas and fructose as sweetening agent (Tratnik, 1998).

Due to the low total solid content (6-7%) of liquid whey consequently the mouth feel of fermented whey beverages is poor and watery in comparison with fermented milk. Therefore it is required either to use exopolysaccharide-producing probiotic strains or the addition of hydrocolloids. When added in relatively low amounts hydrocolloids enhance viscosity of the product and prevent sedimentation of dispersed particles.

Therefore choice of the proper type and level of hydrocolloid used is one of the most important factors in the manufacture of fermented dairy products. In fact, it is very important that added hydrocolloids do not mask natural flavour of the product and that they are effective at the typical product pH range, i.e. 4.0-4.6. Suitable for use in fermented whey beverages production are carboxymethyl cellulose (CMC), pectin, alginate and xanthan gum (XG) since their addition significantly enhances mouth feel of the end product (Gallardo-Escamilla et al., 2007).

Dietetic beverages, beverages with hydrolyzed lactose, beverages similar to milk and powder drinks also belong to the category of nonalcoholic whey beverages.

Due to the composition and related properties, whey is a very good raw material for simple production of dietetic beverages by addition os some sweetening agent (most often saccharin and cyclamate), fruit bases of apple or some tropical fruits and stabilizing agent. These beverages have very low energy value (104-113 kJ/100 mL) what makes them suitable for consumption by large group of consumers.

However, a potential problem that occurs here is application of sweetening agents which are related to some indications of toxicity. Thereby it is rated to develop recipes for dietetic whey beverages without using sweetening agents.

Lactose hydrolyzation results in production of glucose and galactose - monosaccharides with much higher sweetness, better solubility and better absorption ability than lactose. In that way, sweetness of whey is being enhanced by production of natural «sweetening agents» what enables the use of such whey for production of low-energy beverages including the above mentioned dietetic drinks.

Besides that, whey with hydrolyzed lactose is suitable for consumption by consumers with partial or complete lactose intolerance, but also for fermentations by strains with lack of enzyme ß-galactosidase (e.g. production of the above mentioned beverage Gefillus by using strain *Lactobacillus rhamnosus*).

Production of *milk-like beverages* includes mixing liquid or powder whey with skim or whole milk, buttermilk, some vegetable oils, hydrocolloids and emulsifiers. Thereby milk is added in order to improve stability and density of the beverage. One of the most famous products in this category is *Way-Mil* with very similar appearance to milk, specific taste and can contain add-ins like chocolate or fruits. *Way-Mil* contains approximately 2-4% milk fat, 1-1.5% proteins, 4-5% lactose, 0,7% minerals and water soluble vitamins (Popović-Vranješ and Vujičić, 1997).

Very large group of products make *powder whey drinks* which need to have good instant properties, a long shelf life and good solubility. They can be fortified with vitamins and minerals.

Compared to liquid beverages, these products are much easier to transport and store what is very important in nourishment of population in case of hard surviving conditions and lack of protein sources.

Production of whey powder drinks includes mixing whey usually with soy, powdered fruits, concentrated fruit juices or whey protein concentrates.

Thereby it is very important to adjust the whey composition before dehydrating it, while the process of mixing powder whey with other components varies and depends on the type of add-ins. If liquid concentrated fruit juice is being added, powder whey must be previously reconstituted with water. When adding crystallized fruit juices or powder fruit bases, there is no need for whey reconstitution (Popović-Vranješ and Vujičić, 1997).

Some of the most famous European nonalcoholic whey-based beverages, including their composition, are listed in Table 3.

Table 3: Overview of some whey based beverages in the European market (Popović Vranješ et al., 1997)

Tablica 3: Pregled nekih sirutkinih napitaka na europskom tržištu (Popović-Vranješ i sur., 1997.)

Name of the product Naziv proizvoda	Country of origin Zemlja porijekla	Characteristics/composition Karakteristike/sastav
Frusighurt	NJEMAČKA GERMANY	Sirutka uz dodatak baze jabuke/citrusa Whey with addition of apple/citrus extract
Big M		Aromatizirana sirutka obogaćena vitaminom E Aromatized whey enriched with vitamin E
Mango Molke-Mix		Sirutka uz dodatak mango-voćne baze i kulture bifidobakterija Whey with addition of mango extract and bifidobacteria
Frucht-Molke (Immensee)		Sirutka uz dodatak baze crnog ribizla ili 25% mješavine voća iz 10 vrsta voća (naranča, ananas, marelica, jabuka, banana, egzotično voće, mango, šljiva i citrusi) Whey with addition of black currant extract or of 25% fruit mixture consisting of 10 fruit extracts (orange, pineapple, apricot, apple, banana, exotic fruits, mango, plum and citrus)
Kur-Molke		Sirutka uz dodatak baze jabuka ili naranča/marakuja Whey with addition of apple or orange/maracuja extracts
Molken Frucht Nektar		Sirutka+25% naranča/marakuja koncentrat Whey+25% orange/maracuja concentrate
Multivitamin-Molke		Sirutka+dodatak voćnih baza

		od 10 vrsta voća +10 vitamina Whey + addition of 10 fruits extracts +10 vitamins
Rivella Surelli Fit	ŠVICARSKA SWITZERLAND	Voda, sirutka, ugljična kiselina, šećer, prirodne arome, sredstvo za zakiseljavanje (L(-) mliječna kiselina)*/Water, whey, carbon acid, sugar, natural aromas, acidifying agent (L-lactic acid)* 35% bistre deproteinizirane, CO_2 gazirane sirutke 35% of clear, deproteinised, carbonated whey Napitak sličan Rivelli, ali karbonizirana sirutka + 15% voćne kaše ili mango baze Beverage like Rivella, but with carbonated whey+15% fruit paste or mango extract
Nature s Wonder	ŠVEDSKA SWEDEN	50% egzotično voće, ananas ili narančin koncentrat, obogaćen mliječno-proteinskim koncentratom, hidrolizirana laktoza 50% of exotic fruits, pineapple or orange concentrate, enriched with milk-protein concentrate
Latella	AUSTRIJA AUSTRIA	Sirutka + mango + marakuja i voćna kaša/baza citrusa Whey+mango+maracuja and fruit paste/citrus extract
Morea	FRANCUSKA FRANCE	Sirutkin koncentrat + 40% baze pomiješane iz manga, kivija i egzotičnog voća Whey concentrate+ 40% extract from mango, kiwi and exotic fruits

Djoez Taksi	NORVEŠKA NORWAY	80% sirutka + 12,8% voćni koncentrat + aroma 80% whey + 12,8% fruit concentrate + aroma 85,3% sirutka + 6,3% voćni koncentrat + boja 85,3% whey + 6,3% fruit concentrate + coloring agent
Hedelmatarha	FINSKA FINNLAND	Sirutka kojoj je laktoza hidrolizirana + voće (mango ili mješavina tropskog voća) Whey with hydrolyzed lactose + fruits (mango or mixture of exotic fruits)
Fanna-fitt	MAĐARSKA HUNGARY	80% UF-permeata slatke sirutke, fermentiran i nakon 2. ultrafiltracije pomiješan sa voćnom bazom (mango, ananas, jagoda) 80% UF permeate of sweet whey fermented and mixed with fruit extracts(mango, pineapple, strawberries) after 2. ultrafiltration
Lambada**	SLOVENIJA SLOVENIA	Pasterizirana sirutka uz dodatak 3% voćnog sirupa te šećera i limunske kiseline po potrebi. Dostupan u 8 različitih voćnih okusa (egzotik, kivi, marelica, ananas, limun, naranča, mango i marakuja). Pasteurized whey with addition of 3% of fruit syrup, sugar and citric acid if necessary. Available in 8 different fruit flavours (exotic, kiwi, apricot, pineapple, lemon, orange, mango and maracuja).

* http://www.dooyoo.de/nichtalkoholische-getraenke/rivella-rot/1065545/

**Jarc et al., 1994

Alcoholic whey beverages

Since lactose is the main constituent (70%) of whey dry matter, whey is a very good material for production of alcoholic beverages. Alcoholic whey beverages are divided to beverages with low alcohol content (≤ 1.5%), whey beer and whey wine. Production of *whey beverages with low alcohol content* includes deproteinizing whey, whey concentration, fermentation of lactose (usually by yeast strains *Kluyveromyces fragilis* and *Saccharomyces lactis)* or addition of succrose until reaching the desired alcohol content (0.5 - 1%), flavoring, sweetening and bootling. Thereby, a certain amount of lactose is being transformed to lactic acid which gives a refreshing sour taste to the end product, while the rest ferments to alcohol. Some of noted beverages belonging to this category are «Milone» obtained by fermentation with kefir culture and whey sparkling wine «Serwovit» produced in Poland.

Whey beer can be produced with or without addition of malt; it can be fortified with minerals or can contain starch hydrolyzates and vitamins. Some of problems that can occur here are presence of milk fat since which can cause loss of beer foam, undesirable odour and taste due to low solubility of whey proteins and inability of beer yeasts to ferment lactose.

Whey wine contains relatively low alcohol amount (10-11%) and is mostly flavored with fruit aromas. Production of whey wine includes clearing, deproteinazation, lactose hydrolysis by ß-galactosidase, decanting and cooling, addition of yeasts and fermentation, decanting, aging, filtering and bottling (Popović-Vranješ and Vujičić, 1997).

Regarding everything mentioned above, there are numerous possibilities to prepare whey based beverage, but the ideal recipe has not been found yet. Despite huge efforts that were made, scientists are still searching with many difficulties. Nevertheless, whey is a too valuable source of nutrients to be given up from trying to utilize it in the food industry.

Who can consume whey based beverages?

Whey based beverages target a large scale of consumers - from old people to little children.

Because of its health benefits, it was used to treat some illnesses, such as tuberculosis and skin and digestive tract diseases, since the time of Ancient Greece. In the 18th century there were specialized institutions built for curing illnesses with whey which designated the start of detailed studies of nutritional and therapeutic properties of whey. These so called „whey cures“ were usual in countries like Switzerland, Germany and Austria at that time. Whey were

also successfully applied for treatments of diarrhea, bile illness, skin problems, scales in the urinary tract and some intoxications. (Popović-Vranješ and Vujičić, 1997).

Due to high amount of proteins with high nutritional value these beverages are ideal source of energy and nutrients for athletes. Whey proteins are a rich source of branched chain aminoacids (BCAA) like isoleucine, leucine and valine. BCAAs unlike other essential aminoacids are metabolized directly into the muscle tissue and are first amino acids used during periods of exercise and resistance trainings. (Sherwood et al., 2007).

Whey protein fractions include also lactoferrin - an iron-binding protein, glycomacropeptide (GMP) which derives after cheesemaking using rennet and is naturally free of phenylalanine and alpha-lactalbumin which is a calcium-binding protein. That way, due to presence of lactoferrin whey beverages can be used as functional food intended to improve iron absorption from food and/or help to keep pathogens from attaching to the intestinal walls. That is very important for nutrition of little children and babies. Furthermore, these beverages may improve absorption of calcium what is very important for older population which is often suffering from osteoporosis. Besides that, a drink with addition of GMP isolate would be a very good source of energy and micronutrients for those suffering from phenylketonuria (Miller, 2005).

Beverages fortified with rice and oat bran or with isolates of soy and potato proteins are optimal for people allergic to milk proteins or suffering from celiac disease.

Many clinical studies have proved the antihypertensive effect of whey beverages.

They are also being used as meal replacement for people suffering from overweight problems, older population and athletes or as a healthy alternative to fast food. Food market studies have shown that fermented and/or fruit whey beverages are mainly consumed by health conscious women, children and working people who consume those beverages for breakfast or as a snack (Miller, 2005;Huth et al. 2006).

These are only some of possible uses of whey based beverages, but depending on the production technology there is a much wider range of applications. Therapeutic and health promoting properties of whey were accented already 460 b.C. by Hypoccrates - father of modern medicine (Popović-Vranješ and Vujičić, 1997; Tratnik, 2003). It seems that time has come when a modern man has also realized the importance of using whey in everyday nutrition.

NAPITCI NA BAZI SIRUTKE - NOVA GENERACIJA MLIJEČNIH PROIZVODA

Sažetak

Sirutka je sporedni proizvod koji nastaje u tehnološkom procesu proizvodnje sira, a sastav i svojstva ovise o tehnologiji proizvodnje osnovnog proizvoda te o kakvoći korištenog mlijeka. Prema prosječnom sastavu sirutka sadrži oko 93% vode, a u nju prelazi i oko 50% suhe tvari mlijeka. Najveći dio sirutke čini laktoza, manje od 1% proteini sirutke, a u manjim količinama prisutne su mineralne tvari i vitamini topljivi u vodi. Prerada sirutke u napitke počela je još u 70-tim godinama prošlog stoljeća, a do danas je razvijena čitava paleta sirutkinih napitaka, bilo da su proizvedeni od nativne slatke ili kisele sirutke, od deproteinizirane sirutke, zatim od svježe sirutke razrijeđene vodom, fermentirane sirutke, pa sve do napitaka u prahu uz dodatak raznih aroma. Bezalkoholni napitci od sirutke podrazumijevaju veoma šaroliku skupinu proizvoda dobivenih uglavnom miješanjem nativne slatke, rjeđe i kisele, sirutke s različitim dodacima, poput tropskog voća (ali i ostalog voća, kao npr. jabuke, kruške, jagodasto i bobičasto voće), žitarica i njihovih prerađevina (najčešće mekinja), izolata proteina biljnog podrijetla, CO_2, čokolade, kakao praha, vanilije i drugih aromatizirajućih dodataka. Posebna pozornost u ovoj skupini pridaje se razvoju proizvodnje fermentiranih napitaka pomoću probiotičkih sojeva, a tu je najvažnije odabrati adekvatnu kulturu bakterija kako bi se dobio visokovrijedan funkcionalan proizvod prihvatljivih senzorskih svojstava. Skupini bezalkoholnih napitaka od sirutke pripadaju još i dijetetski napitci, napitci s hidroliziranom laktozom, napitci slični mlijeku i napitci u prahu. Sirutka je veoma dobra sirovina za proizvodnju alkoholnih napitaka, obzirom da najveći dio suhe tvari čini laktoza (oko 70%). Alkoholni napitci od sirutke dijele se na napitke malog sadržaja alkohola (do 1,5%), sirutkino pivo i sirutkino vino. Sirutkini napitci namijenjeni su širokim skupinama potrošača - od onih najmanjih pa do najstarijih. Odlikuju se visokom hranjivom vrijednošću i dobrim terapijskim svojstvima.

Ključne riječi: sastav sirutke, alkoholni i bezalkoholni napitci, funkcionalni dodatci

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