

Lactic acid fermented vegetable juices

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ABSTRACT: Vegetable juices processed by lactic acid fermentation bring about a change in the beverage assortment for their high nutritive value, high content of vitamins and minerals. Starter cultures of the genus *Lactobacillus* are added into juices to achieve their desirable properties. This review describes the manufacture of lactic acid fermented vegetable juices and beneficial effects of the lactic acid bacteria (mainly antimicrobial and anticancer effects). A separate part of research is devoted to nutrition aspects of lactic acid fermentation and to the occurrence of biogenic amines in lactic acid fermented vegetables and vegetable juices.

Keywords: fermentation; vegetable juices; lactic acid bacteria; manufacture; nutrition

Fermented foods are food substrates that are invaded or overgrown by edible microorganisms whose enzymes, particularly amylases, proteases and lipases, hydrolyse polysaccharides, proteins and lipids to non-toxic products with flavours, aromas and textures pleasant and attractive to the human consumer (STEINKRAUS 1997).

The lactic acid fermentation of vegetable products, applied as a preservation method for the production of finished and half-finished products, is considered as an important technology and it is further investigated because of the growing amount of raw materials processed in this way in the food industry. The main reasons for this interest are the nutritional, physiological and hygienic aspects of the process and their corresponding implementation and production costs (KAROVIČOVÁ et al. 1999).

While there are 21 different commercial vegetable fermentations in Europe along with a large number of fermented vegetable juices and blends, the most economically relevant of them are the fermentations of olives, cucumbers (pickles) and cabbage (sauerkraut, Korean kimchi) (CAPLICE, FITZERALD 1999).

Typical lactic acid fermented vegetables

Examples of lactic acid fermented vegetables produced in different regions of the world are shown in Table 1 (LEE 1997). According to KIM et al. (2000) the Chinese cabbage, cabbage, pH adjusted tomato (to pH 7.2), carrot and spinach media gave relatively higher fermentability than other vegetables because they have more fermentable saccharides than other vegetables.

The classic lactic acid vegetable fermentation is sauerkraut. Fresh cabbage is shredded and 2.25% salt is added (STEINKRAUS 1997). Sauerkraut production typically relies on a sequential microbial process that involves heterofermentative and homofermentative lactic

acid bacteria, generally involving *Leuconostoc* species for the first group and *Lactobacillus* and *Pediococcus* for the second. The pH of final product is from 3.5 to 3.8 (GARDNER et al. 2001). At this pH the cabbage or other vegetables will be preserved for a long period of time (STEINKRAUS 1997). Sauerkraut brine is an important by-product of the cabbage fermentation industry and can be used as a substance for the production of carotenoids by *Rhodotorula rubra* (SHIH, HANG 1996) or for β -glucosidase production by *Candida wickerhamii* for commercial applications (SIM, HANG 1996).

As a group of traditional vegetable foods in Korea, kimchi is known to be the product of natural mixed fermentation carried out principally by lactic acid bacteria. *Kimchi* is characterised particularly by its sour, sweet and carbonated taste and differs in flavour from sauerkraut and pickles that are popular fermented vegetables in the West (HONG et al. 1999). Raw materials for *kimchi* are divided into three main groups. Korean cabbage and radish are the major materials, and minor ingredients include garlic, red pepper, green onion, ginger and salt (LEE 1997). Optimum taste of *kimchi* is attained when the pH and acidity reach approximately 4.0–4.5 and 0.5–0.6, respectively. Vitamin C content is maximal at this point. As the fermentation temperature increases, the ripening time decreases: *kimchi* ripens in 1 week at 15°C and 3 days at 25°C. Low temperature is preferred in *kimchi* fermentation to prevent the production of strong acid and over-ripening and to extend the period of optimum taste (LEE 1997).

Manufacture of lactic acid fermented vegetable juices

In many countries the consumption of lactic acid fermented vegetable juices increases (KOPEC 2000). Lactic acid fermented vegetable juices are produced

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Table 1. Examples of lactic acid fermented vegetables produced in different regions of the world

Product name	Country	Major ingredients	Microorganisms
Sauerkraut	International	cabbage, salt	<i>Leuconostoc mesenteroides</i> , <i>Latobacillus brevis</i> , <i>Lactobacillus plantarum</i>
Kimchi	Korea	Korean cabbage, radish, various vegetables, salt	<i>Leuconostoc mesenteroides</i> , <i>Latobacillus brevis</i> , <i>Lactobacillus plantarum</i>
Dhamuoi	Vietnam	cabbage, various vegetables	<i>Leuconostoc mesenteroides</i> , <i>Lactobacillus plantarum</i>
Dakguadong	Thailand	mustard leaf, salt	<i>Lactobacillus plantarum</i>
Burong mustala	Philippines	mustard	<i>Latobacillus brevis</i> , <i>Pediococcus cerevisiae</i>

mainly from cabbage, red beet, carrot, celery and tomato (KAROVIČOVÁ et al. 2002).

Lactic acid fermented vegetable juices can be produced by two procedures: the vegetable is fermented in a usual way and then it is processed by pressing the juice (manufacture from sauerkraut) or the vegetable is processed to mash or raw juice at first and it is consecutively fermented. There are 3 types of fermentation of vegetable juices: spontaneous fermentation by natural microflora, fermentation by starter cultures that are added into raw materials and fermentation of heat-treated materials by starter cultures (HAMMES 1990).

At the manufacture of lactic acid fermented vegetable juices, the pressed juice can be pasteurised at first and consecutively it is inoculated by a culture of selected lactic acid bacteria (KOPEC 2000) at a concentration from 5×10^6 to 1×10^7 cfu/ml (ŠULC 1984).

For fermentation of juices, of the highest importance are commercially supplied strains such as *Lactobacillus plantarum*, *Lb. bavaricus*, *Lb. xylosum*, *Lb. bifidus*, *Lb. brevis* (ŠULC 1984). The desirable properties of fermented vegetable juices can be achieved by choosing *Lactobacillus* strains suitable for the lactic acid fermentation of individual raw materials. The criteria used for finding out suitability of a strain are as follows: the rate and total production of acids, change in pH, loss of nutritionally important substances, decrease in nitrate concentration and production of biogenic amines (KAROVIČOVÁ et al. 1994, 1999), ability of substrate to accept a starter culture, type of metabolism and ability of culture to create desirable sensory properties of fermented products (HOLZAPFEL 2002). Bacteriocin-producing starter cultures were suggested as a mean to obtain more controlled and reproducible vegetable fermentations (AUKRUST et al. 1994; AUSCO et al. 1998).

Enzyme mash treatment is a well-known modern process to gain more juice from vegetable (DEMIR et al. 2001). The enzyme decomposition is applied before the lactic acid fermentation of products to achieve a concentration of compounds that commonly remain in the pomace. It refers especially to some mineral compounds, including calcium, phosphorus and magnesium (KOPEC 2000).

Fermentation takes place at the temperature of about 20–30°C (ADAMS, NICOLAIDES 1997). For an optimal course of lactic acid fermentation, the content of sugars in raw materials must be sufficiently high (at least 40 g/kg) and the content of proteins that neutralise emergent acids must be minimal (KOPEC 2000). During fermentation, the pH of juices decreases from 6–6.5 to 3.8–4.5 (ADAMS, NICOLAIDES 1997). A rapid decrease in pH at the beginning of fermentation is of great importance for the quality of the end product (VIANDER et al. 2003). A rapid increase in acidity minimises the influence of spoilage bacteria. In the slowly acidified environments the lactic acid fermentation can be suppressed by butyric bacteria (KYZLINK 1980). The acidity below pH 3.6 is undesirable from the sensory aspect (LOPATNÍKOVÁ 1992). By fermentation, the juices obtain pleasant acid taste and characteristic aroma (BIACS 1986). After fermentation, the juices can be filled into bottles and pasteurised or aseptically filled into bottles after previous filtration (BIACS 1986).

Beneficial effects of lactic acid bacteria

By definition, lactic acid bacteria are bacteria that ferment a sugar (e.g. glucose) predominantly to lactic acid (LIU 2003).

Lactic acid bacteria have strong inhibitory effects on the growth and toxin production of other bacteria. This antagonistic activity can be the result of:

- competition for available nutrients,
- decrease in redox potential,
- production of lactic acid and acetic acid and the resulting decrease in pH,
- production of other inhibitory primary metabolites, such as hydrogen peroxide, carbon dioxide or diacetyl,
- production of special antimicrobial compounds such as bacteriocins and antibiotics.

Each of these properties and especially the combination of some of them can be used to extend the shelf life and safety of food products (KALANTZOPOULOS 1997).

The characteristic products of lactic acid fermentation are lactic and acetic acid (ADAMS, NICOLAIDES 1997).

Table 2. Content of biogenic amines in sauerkraut and sauerkraut brine

Amine	Sauerkraut (mg/kg)	Brine (mg/dm ³)
Putrescine	100–200	442–678
Histamine	42–52	143–174
Cadaverine	53–71	178–237
Spermidine	3–8	10–76
Spermine	1–2	3–5

The antimicrobial action of these acids is related to the ability of the undissociated acid molecules to penetrate through the bacterial plasma membrane as a function of their diffusion constant. In the cytoplasm, the acid dissociates to release protons and conjugate bases with higher pH, this disrupts the membrane proton-motive force, thus disabling the energy-yielding and transport process dependent upon it (SAVARD et al. 2002). Lactic acid also forms the natural protection of the body against various infections, increases immunity and acts as a physiological disinfection agent, improves digestion and acts at liver diseases (ŠULC 1984).

Acetic acid is more inhibitory than lactic acid and can inhibit yeasts, moulds and bacteria (CAPLICE, FITZERALD 1999). Although lactic and acetic acid in fermented products have antimicrobial effects, high acetic acid concentrations are not typically desirable from sensory and quality aspects (LEE et al. 1999).

The combination of acids and alcohol is conducive to the formation of esters that impart desirable flavours (LEE 1997).

Carbon dioxide can directly be produced an anaerobic environment and is toxic to some aerobic food microorganisms through its action on cell membranes and its ability to reduce internal and external pH (CAPLICE, FITZERALD 1999). Produced carbon dioxide replaces the air and provides anaerobic conditions favourable for the stability of ascorbic acid and the natural colour of vegetables (LEE 1997).

Lactic acid bacteria lack true catalase to break down hydrogen peroxide generated in the presence of oxygen. It is argued that hydrogen peroxide can accumulate and be inhibitory to some microorganisms. Inhibition is mediated through the strong oxidising effect on membrane lipids and cell proteins (CAPLICE, FITZERALD 1999).

Bacteriocins produced by lactic acid bacteria are peptides or small proteins that are frequently inhibitory towards many undesirable bacteria, including food-borne pathogens (e.g. *Listeria monocytogenes*) (LEROY et al. 2002). Bacteriocins from lactic acid bacteria can be subdivided into four classes. Class I of bacteriocins consists of lanthibiotics. These are small and heat-stable peptides that contain thioether amino acids such as lanthionine (MESSENS, DE VUYST 2002). Class II is divided into three sub-groups of which Class IIa is the most common. This group is composed of pediocin-like bacteriocins with anti-listerial activity. Pediocins are produced by *Pediococcus* spp. and while they are not very effective against spores, they are more effective

Table 3. Proposed health and nutritional benefits of *Lactobacillus* species

Proposed health and nutritional benefits of <i>Lactobacillus</i> species
Enzyme (lactase) presentation
Colonisation and maintenance of normal microflora
Competitive exclusion of undesirable microorganisms
Microbial interference and anti-microbial activities
Pathogen clearance
Immuno-stimulation and modulation
Cholesterol reduction/removal
Deconjugation of bile acids
Anticarcinogenic and antimutagenic activities
Reduction of endotoxaemia from alcoholic liver disease

than nisin in some food systems. Class III comprises large heat-labile proteins and class IV a complex of bacteriocins with glyco- and/or lipid moieties.

An advantage of bacteriocins over classical antibiotics is that digestive enzymes destroy them. Bacteriocin-producing strains can be used as part of or adjuncts to starter cultures for fermented foods in order to improve safety and quality (CAPLICE, FITZERALD 1999).

Lactic acid bacteria are considered to have several beneficial physiological effects such as antimicrobial activity enhancing the immune potency (KULLISAAR et al. 2002) and to prevent cancer and lower serum cholesterol levels (KAUR et al. 2002). Proposed health and nutritional benefits of *Lactobacillus* species are presented in Table 3 (KLAENHAMMER 1995). Because lactic acid bacteria prohibit colonisation by the invader and control the intestinal pH through the release of acetic and lactic acids, these bacteria could effectively prevent constipation and diarrhoea caused by lactose intolerance or pathogenic bacteria. A synergistic effect of dietary fibre and lactic acid bacteria for the improvement of the large intestinal health of the host may be achieved by providing fermented fibre-rich natural plants to the host (KIM et al. 2000).

Exopolysaccharides produced by lactic acid bacteria are sugar polymers that improve the rheological and textural properties of food products (LEROY et al. 2002).

Anti-cancer effects of lactic acid bacteria: Several research studies confirm the ability of lactic acid bacteria to reduce the mutagenicity of intestinal contents by suppressing the levels of specific bacterial enzymes that promote the activation of procarcinogenic compounds (DALY et al. 1998). Lactobacilli have been periodically associated with anti-carcinogenic, anti-mutagenic and anti-tumorigenic activities. These activities may occur via the following:

- binding, inhibition or inactivation of mutagens *in vitro*,
- reductions in carcinogen-generating faecal enzymes *in vivo*,
- stimulation of the immune system,
- suppression of tumour formation (KLAENHAMMER 1995).

Nutritional aspects of lactic acid fermentation

The nutritional value of a particular food depends on its digestibility and its content of essential nutrients. Both digestibility and its nutrient content may be improved by fermentation. During fermentation the enzymatic activity of microbial culture may predigest the macronutrients (KALANTZOPOULOS 1997). The different ways by which the fermentation process can affect the nutritional quality of foods include improving the nutrient density and increasing the amount of and bioavailability of nutrients. The latter may be achieved by degradation of anti-nutritional factors, pre-digestion of certain food components, synthesis of promoters for absorption and by influencing the uptake of nutrient by the mucosa (SVANBERG, LORRI 1997).

The lactic acid fermentation enhances protein solubility and the availability of limiting amino acids in some cases by as much as 50%. The micronutrient availability is also enhanced because of significant reductions in phytates. Tannins are reduced by as much as 50% and oligosaccharides by as much as 90% (NOUT, NGODDY 1997).

The nutritional impact of fermented foods on nutritional diseases can be direct or indirect. Food fermentations that increase the protein content or improve the balance of essential amino acids or their availability will have a direct curative effect. Similarly fermentations that increase the content or availability of vitamins such as thiamine, riboflavin, niacin or folic acid can have profound direct effects on the health of the consumers of such foods (STEINKRAUS 1997).

It was shown that lactic acid fermentation increased the utilisation of iron from food by breakaway of inorganic iron from complex substances under the influence of vitamin C (SIEGENBERG 1991; VENKATESH 1998).

Fermentation may reduce the content of non-digestible material in plant foods such as cellulose, hemicellulose and polygalacturonic and glucuronic acids. Breakdown of these compounds may lead to the improved bioavailability of mineral and trace elements (KALANTZOPOULOS 1997).

Fermented foods may reduce the serum cholesterol concentration by reducing the intestinal absorption of dietary and endogenous cholesterol or inhibiting cholesterol synthesis in liver (KALANTZOPOULOS 1997).

Lactic acid fermentation imparts attributes of robust stability and safety to the product, and thereby pre-empts disease infections such as diarrhoea and salmonellosis (NOUT, NGODDY 1997).

Occurrence of biogenic amines in lactic acid fermented vegetables and juices

Biogenic amines (BA) are low-molecular-mass amines having a recognised biological activity and which may occur naturally in food and beverages (KIRSCHBAUM et al. 2000). A scale of symptoms is produced following an excessive oral intake of BA. They cause mainly psychoactive and/or vasoactive effects (KALAČ et al. 1999).

The amount of BA usually increases during controlled or spontaneous microbial fermentation of food or in the course of food spoilage (KIRSCHBAUM et al. 2000). There are many factors that affect biogenic amine formation such as temperature, pH value changes, oxygen access or sodium chloride content (SILLA-SANTOS 1996).

Sauerkraut, shredded white cabbage preserved by lactic acid fermentation, has been popular in many European countries due to its sensorial properties and favourable nutritional value (KALAČ et al. 1999). The manufacturing of sauerkraut takes place in three steps characterised by active microorganisms that produce BA (KOLEŠÁROVÁ 1995):

- *Leuconostoc mesenteroides*, producing putrescine in a concentration of about 250 mg/kg,
- *Lactobacillus* sp., producing putrescine and tyramine,
- *Pediococcus cerevisiae*, producing histamine in a concentration of about 200 mg/kg.

The data in Table 2 show that BA, especially putrescine, accumulated in sauerkraut brine (HALÁSZ et al. 1994). KALAČ et al. (1999) examined the content of biogenic amines in 121 sauerkraut samples. The mean concentrations were 174, 146 and 50 mg/kg for tyramine, putrescine and cadaverine, respectively. Histamine levels were below 2 mg/kg in 44% of samples and above 10 mg/kg in only 19% of samples. KIRSCHBAUM et al. (1997, 1999) found extremely high amounts of putrescine in bottled and pasteurised sauerkraut juices from Germany (up to 229 or 694 mg/dm³). KALAČ et al. (2000a) determined 44.1–387 mg/kg of tyramine, 21.9 to 260 mg/kg of putrescine, 12.4–59.6 mg/kg of cadaverine and 2.4–22.2 mg/kg of spermidine in different laboratory prepared sauerkrauts after 6 months storage. In lactic acid fermented cabbage juices from Germany KIRSCHBAUM et al. (2000) found 38.3–62.9 mg/dm³ of histamine, 37.1–73 mg/dm³ of tyramine, 83.5–366 mg/kg³ of putrescine and 18.9–59.4 of cadaverine. Cadaverine, histamine, putrescine, spermidine and tyramine were found in lactic acid fermented vegetables (such as carrot and red beet) in concentrations ranging from 1 to 15 mg/kg (HORNERO-MÉNDEZ, GARRIDO FERNÁNDEZ 1997).

For the preparation of sauerkraut with lowered biogenic amines content the initial fermentation should run at a temperature of 15–20°C and bacterial activity can be suppressed by pasteurisation as soon as total acidity reaches the value 9–10 g (as lactic acid) per kg or at the pH value 4.0–3.8 (KALAČ et al. 1999). Some researchers found out that an increase in histamine concentration went parallelly with pH values below 3.8–3.6 and therefore suggested to stop the fermentation process by pasteurisation when pH decreased below 4 (HALÁSZ et al. 1999) because in this stage the activity of the yeasts *Pediococcus cerevisiae* started that can produce histamine at a concentration of about 200 mg/kg (KOLEŠÁROVÁ 1995). KALAČ et al. (2000b) reported that sauerkrauts inoculated by *Lactobacillus plantarum* or a mixed culture of *Lactobacillus plantarum*, *Lacto-*

bacillus casei, *Enterococcus faecium* and *Pediococcus* spp. had significantly lower concentrations of tyramine, putrescine and cadaverine.

An important factor for a decrease in BA levels during sauerkraut production seems to be the prevention of initial contamination by amine-producing bacteria from cabbage, shredding machines, transporters and silos. The amine-negative inoculants should also be resistant to contamination (KALAČ et al. 2000b).

Current situation in lactic acid fermented vegetables or vegetable juices

In recent years, several authors dealt with the lactic acid fermentation of vegetables or vegetable juices:

DE CASTRO et al. (1998) performed the controlled fermentation of peeled, blanched garlic, using a starter culture of *Lactobacillus plantarum* and compared it with that of unblanched garlic. Blanching was carried out in hot water (90°C) for 15 min. The starter grew abundantly in the case of blanched garlic, producing mainly lactic acid and reaching pH 3.8 after 7 days. The fermented blanched garlic was microbiologically stable during storage at 30°C in an acidified brine.

AUKRUST et al. (1994) used *Lactobacillus sakei* for fermentation of carrot slices that produces the bacteriocin sakacin A. Carrot contained proteinase which was eluted into the brine during fermentation. The results indicated that sakacin A was inactivated by the carrot proteinase.

MONTAÑO et al. (1997) used a mixed culture of *Lactobacillus plantarum* and *Saccharomyces cerevisiae* and a single culture of *Lactobacillus plantarum* for fermentation of lye-treated carrots. After fermentation, the samples were preserved by addition of sorbic acid, benzoic acid or pasteurised at 80°C for 10 min. The controlled fermentation with the mixed culture resulted in higher utilisation of fermentable material than with the single culture. The flavour of carrots fermented by the mixed culture was significantly preferred to that of carrots fermented with the single culture (probably due to the formation of more flavour compounds). The pasteurised samples were microbiologically stable during the storage period (9 months and storage at 30°C) while lactic acid bacteria grew in the samples with preservatives.

KUCHTA et al. (1994) fermented vegetables (gourd, cabbage, celery) by *Lactobacillus plantarum*, *Lb. brevis* and *Lb. pentosus*. The gourds were fermented for 4 days, cabbage for 7 days and celery for 9 days.

SANCHEZ et al. (2000) performed fermentation of green olives. It was found that in olives fermented by *Lactobacillus pentosus* the highest amount of lactic acid was produced in comparison with spontaneously fermented olives.

KAROVIČOVÁ et al. (1994) fermented carrot and capsicum by different lactic acid bacteria. It was shown that the best producers of lactic acid were *Lactobacillus* sp. and *Lactobacillus fermentum*.

LU et al. (2001) carried out fermentation of cucumber juices inoculated by *Lactobacillus plantarum*. The juices were fortified with glucose, fructose or a mixture of glu-

cose and fructose. When cucumber juice was supplemented with fructose and/or glucose, the starter culture continued to ferment fructose, but not glucose, resulting in an increase in lactic acid production and decrease in terminal pH.

GARDNER et al. (2001) studied various lactic acid bacteria for the fermentation of cabbage, carrot and beet-based vegetable products. It was found that a starter culture consisting of *Lactobacillus plantarum* NK312, *Pediococcus acidilactici* AFERM772 and *Leuconostoc mesenteroides* BLAC accelerated the fermentation process and prevented deterioration of fermented products for up to 90 days.

For the preparation of lactic acid fermented vegetable salads KAROVIČOVÁ et al. (1993) used green pea, carrot, celery and onion. The salads were inoculated by various *Lactobacillus* strains. The highest production of lactic acid was observed in the salad inoculated by *Lactobacillus* sp. S.

VIANDER et al. (2003) examined the impact of low NaCl and mineral salt concentrations on the spontaneous fermentation process of white cabbage into sauerkraut and sauerkraut juice. It was shown that sauerkraut and sauerkraut juice could be produced with a very low NaCl concentration as well as with a low mineral salt percentage. The sauerkraut juice fermented with 0.5% mineral salt was considered to have the best taste.

KAROVIČOVÁ et al. (2002a) performed spontaneous fermentation of cabbage juices, fermentation by *Lactobacillus plantarum* 92H and fermentation by a mixed culture of *Lactobacillus plantarum* and *Saccharomyces cerevisiae* C11-3. It was found that the highest amount of lactic acid was produced in juice inoculated by *Lactobacillus plantarum* 92H and the highest decrease in pH was observed in juice inoculated by the mixed culture. The spontaneously fermented juice had the highest intensity of harmonic taste, acceptance of taste, acceptance of odour and flavour.

DRDÁK et al. (1994) tested 16 strains of the genus *Lactobacillus* on samples of white fresh cabbage and of a mixture of sterilised cabbage and carrot juice. Fermentation lasted for 7 days at 27°C or 30°C. Three strains were acceptable on the basis of analytical criteria. These strains reduced the content of nitrates in the original samples.

KAROVIČOVÁ et al. (2001, 2002b) prepared cabbage-carrot juices fermented by *Lactobacillus plantarum* 92H during 150 hours at 24°C and cabbage juices with various concentrations of *Lactobacillus plantarum* 92H during 120 h at 28°C. The juices had the most harmonic taste and flavour in 72–96 h of fermentation.

CONCLUSION

The fundamental reason for the development and acceptance of fermented foods can be ascribed variably to preservation, improved nutritional properties, better flavour/aroma, upgrading of substrates to higher value products and improved health aspects (KALANTZOPOULOS 1997).

Publicity is a prerequisite of the higher consumption of lactic acid fermented food. An important factor is also the supply of lactic acid fermented vegetable juices with new quality characteristics, without application of preserving agents (KOPEC 2000).

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Mliečne fermentované zeleninové šťavy

ABSTRAKT: Mliečne fermentované zeleninové šťavy predstavujú zmenu v sortimente nápojov pre svoju vysokú nutritívnu hodnotu a vysoký obsah vitamínov a minerálnych látok. Pre dokonalé prekvasenie substrátu sa do štiav pridávajú štartovacie kultúry hlavne rodu *Lactobacillus*. V článku je opísaná výroba mliečne fermentovaných štiav a prospešné účinky baktérií mliečného kvasenia (najmä antimikrobiálny, antirakovinový účinok). Samostatná časť je venovaná nutritívnym aspektom mliečnej fermentácie a výskytu biogénnych amínov v mliečne fermentovanej zelenine a zeleninových šťavách.

Kľúčové slová: fermentácia; zeleninové šťavy; mliečne baktérie; výroba; výživa

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