

## POSSIBILITIES TO REDUCE THE SALT CONTENT IN DAIRY PRODUCTS

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**Andreja Čanžek Majhenič**, Doctor of Biotechnological Sciences,  
Associate professor, Head of the Chair of Dairy Science  
University of Ljubljana, Biotechnical Faculty,  
Department of Animal Science, Chair of Dairy Science  
1230 Domžale, Slovenia

### Correspondence:

Andreja Čanžek Majhenič  
E-mail: [andreja.canzek@bf.uni-lj.si](mailto:andreja.canzek@bf.uni-lj.si)

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**Abstract.** Salt application in milk processing refers mainly to cheeses, processed cheeses and dairy spreads. Although salt is technologically unavoidable in these dairy products, there are some possibilities to reduce salt content, but only maximally to the technologically acceptable levels. Because cheeses are very popular, most discussions on how to reduce salt content were oriented to this area, and special emphasis is rendered to salt utilization in cheese-making technology. But limitations are discussed as well. Processed cheeses demand melting salts for proper melting, and these salts became a part of the dairy product. Therefore, when consuming processed cheeses, these salts contribute to elevated levels in our body, and as such have adverse effects on cardiovascular potential, hypertension. But fortunately, processed cheeses are not consumed in large quantities and there is still some maneuverable space to reduce melting salts content, without any harm to technological process. Dairy spreads, either milk or cheese, natural or supplemented with diverse mixtures of herbs, spices, meat, garlic et al. technologically do not need salt, but they are still salted. Salt is added only as taste enhancer, to improve taste. So, salt can be completely avoided from spreads, but consumers probably will not agree to remove salt completely. Therefore, detailed consumer research should be made to establish what is the minimum salt content in spreads, they tolerate. And finally, salted variety of butter is discussed as well. Butter is one of the dairy products, that is least loaded with additives. Only beta-carotene and/or salt are allowed. Beta-carotene is used to unify seasonal discolorations and salt to produce salted varieties of butter. Although not popular locally, some attention is focused to salt in butter as well, and possible reductions. Hereforth, decrease of salt application in certain dairy products is discussed.

**Keywords:** salt, cheese, processed cheese, dairy spreads, butter.

### Introduction. Formulation of the problem

For normal functioning, the human body requires essential compounds such as vitamins, minerals, micronutrients, some amino acids and fatty acids. Among the various minerals, sodium, magnesium, calcium, potassium, iron, iodine, fluor, zinc and selenium are the most important [1]. At the same time, the amount of intake is very important since one that is too low or one that is too high can cause some negative effects on our health.

One such vital substance is sodium, a micronutrient, which is necessary for the functioning of cells and the entire organism. For easier understanding, instead of sodium, the term table salt is used, which is the most commonly used term for NaCl [2]. Table salt or NaCl is composed of 40% sodium and 60% chloride and provides about 90% of the sodium in the human diet [3]. It is crucial in maintaining the membrane potential of cells and in the absorption of nutrients in the small intestine. In addition, it affects extracellular fluid volume, thereby maintaining blood volume and blood pressure [4].

Sodium homeostasis is regulated by a complex system of membrane transporters and neuro-hormonal factors, and insufficient or excessive sodium intake can lead to various medical conditions such as high blood pressure (hypertension), stroke, cardiovascular diseases, stomach cancer and metabolic syndrome, among which high blood pressure and its consequences are one of the main causes of death [5]. Sodium, which is found everywhere in nature, mostly in the form of NaCl or table salt, is mainly introduced into the body via salt, and is excreted from the body via urine, feces or via perspiration through the skin [1]. Salt intake, being a self-evident and everyday condiment, has for some time, especially in the developed world, considerably exceeded the recommended values, which is reflected in the direct connection between excessive salt consumption and the increase in the aforementioned diseases, where Slovenia is of no exception [6] and is at the very top of the European Union (EU) in terms of the prevalence of hypertension [4]. Some dairy products, especially cheese, processed cheese and dairy spreads, are main sources of salt and as such, are

discussed of how much they contribute to the recommended daily salt intake.

**Analysis of recent research and publications**

Adults in Slovenia still exceed the recommended daily salt intake by more than 130 % on average. As evident from Fig. 1, the largest source of salt intake is bread and bakery products, followed by meat products, pickled vegetables, cheeses, and semi-processed and processed food products [1,4]. It is therefore no coincidence that many European countries include in their public health programs activities to reduce salt consumption among all age groups of the population, where Slovenia participate as well [1]. Thus, in 2008, the EU also launched the National Salt Initiatives campaigns, the aim of which was to reduce the salt content by 16 % in all food categories in four years, thereby achieving the World Health Organization (WHO) recommendations of a daily intake for healthy adults of up to 5 g of salt/day or up to 2 g sodium/day. A promising discovery was the fact that in years between 2007 and 2012, men's salt intake decreased by just under 10% [1]. WHO member governments have committed to reduce salt intake by 30 % globally by 2025, which would mean 1.65 million fewer deaths each year as well [3].

Usually, sodium is expressed in mg/100g, while table salt is expressed in g/100g. However, according to the WHO recommendations for healthy adults (a tolerable salt intake up to 5 g per day), this value is still above the physiologically recommended value for salt intake, which is 1.4 g. That means that foods with more than 1.5 g of salt/100 g or more than 0.6 g Na /100 g are still not the most beneficial to our health. Thankfully, we will be on the safe side for our health if we strive for foods with up to 0.3 g of salt /100 g or up to 0.1 g Na/100 g. Moreover, even a brief look tells us what is the conversion of sodium into salt; value must be multiplied by 2.5[3,7].

The fact that the human organism adapts relatively quickly and without problems to a lower

amount of salt in the diet is very encouraging meaning that we could quickly reach the recommended daily salt intake [7]. Moreover, this would allow us to re-percept the various tastes of the basic ingredients of the dish [1].

It is also gratifying that the websites of credible portals such as Nutrition Institute [8], the National Institute of Public Health [1], the National Portal on Food and Nutrition [2] provide Slovenian consumers with reliable information about salt, its impact on health, which foods contain more salt, how various initiatives to reduce salt intake are progressing, etc. The website of the Nutrition Institute even informs us that the WHO presented a new global report to reduce sodium intake (by 30 % by 2025), and at the same time recommended how to achieve these goals [9].

From the technological point of view, salt application in dairy industry refers mainly to cheeses, processed cheeses and spreads, and to lesser extend to salted variety of butter.

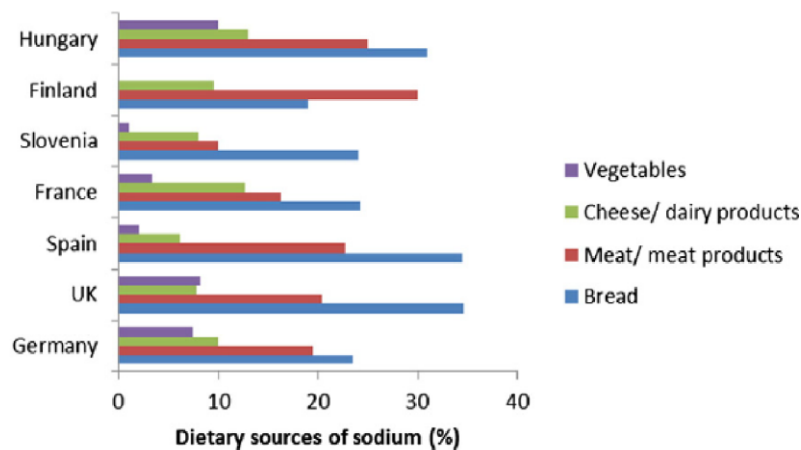
According to worldwide efforts to reduce the salt content in our foods and along with the perception that aforementioned dairy products contribute to high salt intake, ineligious, possibilities to reduce salt content in these dairy products are discussed.

Therefore, possibilities and obstacles on how to reduce salt content in certain dairy products is discussed in regard to follow technological aspect and WHO recommendations.

**The purpose** of the study was to determine how the nutrition and salt content in foods are related, with the stress on dairy sector.

**Research objectives:**

- to investigate the “salt” status in Slovenia, where consumers are quite aware of healthy food
- to investigate the “salt” status all-over the world, where the western diet is probably the most problematic regarding the salt
- to successfully combine technological processes with WHO recommendations and guidelines on reducing salt intake and how to achieve these goals



**Fig. 1. Dietary sources of sodium in selected European countries (%) [4]; CC BY- NC-ND 4,0.)**

### Salt and cheese

Salt is an important factor in the technological process of cheese production and affects cheeses from several aspects: [10-12]:

- prolongs the shelf life of cheeses;
- inhibits the growth and activity of unwanted microorganisms (MO);
- regulates enzymes activity;
- affects the amount of water in the cheese, syneresis,  $a_w$  value;
- affects the physical changes of proteins and thus the texture of cheeses;
- participates in the formation of the cheese rind;
- and at last, but not least, it affects the taste of cheeses.

Salting is carried out in two ways, namely [13,14]:

- wet salting in brine;
- dry salting, where salt can be rubbed on the surface of an already formed cheese, or the cheese grain is salted during the formation of the cheese curd, or briefly matured and ground cheese curd (cheddar) is salted.

The specialty in salting is Domiati cheese, in which the cheese-milk is already salted [11,15].

Let us discuss the effects of salt on the amount of water in the cheese, on the syneresis activity, and on the  $a_w$  value.

After molding and pressing, Gouda cheese contains approximately 46.5% water. During salting, the amount of water is further reduced to approximately 41.8%, while in Edam, cheese's water content decreases from 51.5% to around 44.7%. Although salting does not decrease the water content drastically, the microbiological conditions ( $a_w$  value) change significantly. The new conditions prevent the growth of lactic acid bacteria (LAB) in general, but promote the actions of the microbiota that participates in the cheese ripening. For example: 2% salt in cheese containing 40% water means a 5% aqueous solution of salt in cheese, which is sufficient to inhibit LAB, but not coliform MO. Inhibiting latter, a 12% aqueous salt solution is needed. In brine, the concentration of salt on the cheese surface is 16 to 18 %, which results in the formation of a cheese rind. Rind formation prevents any microbiological activity except for the bacteria of the red smear, *Brevibacterium linens*, which are characteristic for the original Tilsit, Romadur, etc. [11,12].

All cheeses with a smooth, closed rind, such as Emmental, Gouda, Edam, Sbrinc, etc., are salted in brine, where the salting mechanism of whey and brine exchange takes place according to the laws of diffusion – salt into cheese, and osmosis - whey from cheese. Regardless of the salting method, whether it is wet or dry, the salt concentration is the highest in the outer layers of the cheese. Brine is a 16 to 22% aqueous solution of table salt with a temperature of 12 to 14 °C and an acidity of 10 to 25 SH. Large concrete

basins, usually 90 cm deep, are filled with this aqueous salt solution, where cheeses float freely. During the salting, which most often lasts for 2 to 5 days, e.g. Parmesan 14 days, depending on the type of cheese, the cheeses should rest [16]. Thus, salting in the brine requires extremely large capacities, which are provided by large basins. However, thinking of cooling, cleaning, disinfection, and as well as of periodically changing of the brine, it is clear that this process is extremely expensive. However, in the 1960s and 1970s, there was a shortening of the salting time, which was not related to any nutritional requirements, but was simply a result of the market's requirements, which demanded an increase in cheese production every year. It was possible to purchase bigger milk tanks and cheese machines and thereby up-scale cheese production, while the concrete basins for brine remained the same size. The shortening of the salting time led to a decrease in the salt content of cheeses which could result in unhealthy and sensorially unacceptable cheeses. Although shortening of the salting time in this case happened for economic reasons, influenced the technological process as well; but certainly not nutritional or health aspect. Therefore, intensive work on milk quality and the introduction of a cold chain from milk production to the consumer successfully compensated for the reduction of salt in cheeses.

During salting, the cheese rind is finally formed. When salting is finished, the cheeses are drained and dried, and transferred to the ripening rooms or ripening chambers, where they need to be treated. This means regular care for the cheeses, at the beginning of ripening on a daily basis and later weekly. The elements of cheese treatment include the turning of the cheese wheels, brushing and washing with a warm, slightly wet cloth, antifungal application, painting, cutting into wedges, and displacement. It must be stressed out that the classic treatment mode includes all the elements of automated treatment, except that the classic treatment is done manually. In the ripening room/ripening chamber, the appropriate temperature (10 to 14°C) and relative humidity (75 to 85%) must be guaranteed so that the cheeses ripen normally and do not dry out. In the last thirty years, many producers have decided to wrap up the cheeses in the shrink foil immediately after salting, draining and drying (especially semi-hard cheeses). In that way the salting time of the cheeses was shortened because the function of the rind was taken over by the foil. It is therefore necessary to maintain only the appropriate temperature during the ripening; there is no need for regular treatment of the cheeses, and even relative humidity is no longer so important. Shortening of the salting time and therefore reducing the amount of salt in the cheeses resulted in faster ripening of the cheeses and the overall time of cheesemaking was reduced. From an economic point of view, the technological process has become shorter and cheaper. The salt content,

especially in semi-hard cheeses, has significantly been further decreased to a technologically acceptable level [12].

**Table 1 – Sodium content of milk from various species and cheeses (summarised by [17])**

Milk	mg/100 ml
Cow milk	49
Goat milk	50
Sheep mlk	44
Cheese	mg/100 g
Of swiss type (Emmental)	90
Brie	629
Cheddar	644
Mozzarella	682
Gruyere	714
Gouda	819
Camembert	842
Feta	917
Parmigiano Reggiano	1376
Roquefort	1809

Cheeses with normal salt content have a better taste. This effect is not only due to the saltiness of the salt, but salt apparently activates microbiological enzymes that cause the formation of characteristic aromatic components in cheese. Therefore, there is no need to wonder why today's cheeses no longer taste like they used to. Table 1 shows the sodium content of some types of milk and cheese. We see that in cheeses with high sodium content (2.5–3.5%), such as Camembert, feta, parmesan, sodium (salt) contributes to the flavor of cheeses, and in some cases even creates suitable conditions for the growth of desirable, noble molds such as, for example, *Penicillium roqueforti* and simultaneously inhibits the growth of salt-sensitive and other unwanted MO. On the other hand, for cheeses with a low salt content (0.9-1.2%), such as Swiss cheeses (Emmental), mozzarella, it is considered that we do not expect a very salty taste, since high salt contents would have a negative effect on development of the cheese's characteristic taste and other properties. Thus, the eyes formation in Swiss types of cheese is the result of lactate metabolism and the subsequent formation of CO<sub>2</sub> by propionibacteria, the growth of which is inhibited by high salt concentrations. Also, a delicate, milky and sweet taste is desired in fresh mozzarella, which is mainly contributed by milk, while high salt content would give this cheese an unwanted salty note [17].

In cheesemaking, salt is significant part of the technological procedure and as such cannot be excluded under any circumstances. Namely, salt has many very important technological functions in cheeses (preservation, strengthening of the cheese surface and rind formation, the influence on the

consistency and structure of the cheese curd, the influence on the development of microbiota and, last but not least, the influence on the taste and aroma of cheeses) [18].

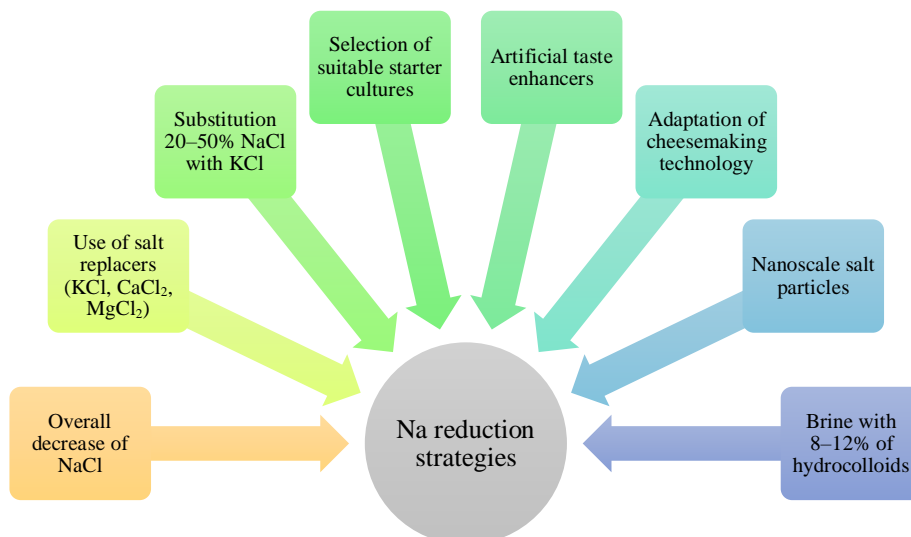
According to some authors [11,18] there are some measures in cheesemaking that control Na, namely:

- maintaining the lowest possible but constant salt concentration in the moisture of the cheese, which also enables optimal cheese quality. Cheddar cheese is such an example, in which the goal is achieved by introducing a more standardized technology;

- flavor enhancers, which if added even in low concentrations, can provoke a salty taste. However, at the same time, this measure can have adverse effects as well, as the added flavor enhancers can simultaneously provoke negative aftertastes (burnt, smoked, as meat broth). Having this in mind, as well as legislation regarding flavor enhancers, this salt reduction approach has limited chance of being generally implemented: i) simple salt reduction, which is added during the cheesemaking process, which, in turn, risks increased growth of unwanted bacteria (spoilage, pathogens). In this situation, milk's own salts are count on, like calcium, phosphorus, potassium. This can be achieved by the use of cheese milk with a higher protein content; ii) partial or complete replacement of salt with substitutes that have reduced or no sodium content (MgCl<sub>2</sub> KCl, CaCl<sub>2</sub>), but taste similar to NaCl. KCl is the most common used substitute for NaCl. However, this approach somehow was avoided due to reports of taste deterioration, mainly due to the appearance of bitterness. Attempts to replace table salt with substitutes, such as potassium and calcium chloride, respectively, had some adverse effects, where potassium chloride resulted in a distinctly bitter taste, while calcium chloride resulted in a hard and stringy texture of the cheeses. Regarding the shelf life or conservation, the aforementioned salts are comparable to table salt, while regarding cheese technological acceptance it was established that potassium or calcium chloride can replace a maximum of 50 % of table salt.

As early as 1982 [19] it was reported that consumers recognized and preferred fuller salty taste of cheese with higher sodium chloride concentrations (1.75% salt), over by cheeses with a reduced salt content (1.5% and 1.25% salt) and even over by cheeses where NaCl was partially replaced by KCl, that were scored worst. Replacing NaCl with MgCl<sub>2</sub>, KCl or CaCl<sub>2</sub> in cheddar cheese [20] resulted in highly unacceptable cheeses, often with a bitter and metallic taste and a crumbly texture. Proteolysis and lipolysis were also more intense in these cheeses.

As presented in Fig. 2, some authors discuss [21] even more sophisticated strategies of salt reduction in cheese.



**Fig. 2.** Some strategies investigated to reduce Na content in cheeses (summarised by [21], with authors' permission)

One of the possible alternatives for reducing salt content in cheeses (Fig. 2), even below the technological minimum, is the selection of suitable starter cultures, protective or bacteriocinogenic. Latter compensate for the antimicrobial effect of less salt with their antibacterial action against harmful and/or pathogenic bacteria. This strategy is already used in practice [22] tested the effectiveness of three different staphylococci in three different cheese matrices (NaCl 100 %, NaCl/KCl 75/25 % and NaCl/KCl 50/50%). At various reduced NaCl contents in cheese, lysostaphin proved to be the most effective. Therefore, this bacteriocin offers both, the possibility of being used to prevent staphylococcal infection in Minas cheese, and simultaneously provides cheese with 50% less Na, which is in line with health standard guidelines. In this way, the amount of salt in cheeses is reduced without technological effects on taste, texture and shelf life. At the same time, the salt in the cheese is primarily connected to flavor and as such would be minimized without consequence. As recommended by English Food Standards Agency (FSA) additional 29% salt reduction for cheese should be applied. An excellent example is Cheddar cheese, a typical English cheese, which even today contains approx. 1.8% salt. LAB that produce bacteriocins are the subject of intensive research around the globe. However, the activities of reducing the salt/sodium content are not only focused on the dairy industry, but it is an acute problem in the entire food chain of processed foods [23].

Normal or even increased amount of salt in cheese decreases the rate of proteolysis, slows down microbiological and enzymatic activity in general and thus provides distinctive and normal conditions for cheese ripening. These conditions give the optimal possibilities and enough time for the development of the aromatic substances. Therefore, salt also has a crucial influence on the development of the cheese flavor [18].

By lowering the salt content below the technologically acceptable minimum and comparing such

cheeses with "normal" could lead to changed, new criteria regarding the technological processes of cheese production and the varieties of cheeses themselves, the taste of cheeses, new guidelines regarding the texture of cheeses, which is not in interest of dairy sector [11].

As already mentioned, in the last 30–40 years, the decreased salt amount in cheeses was mainly due to economic parameters. At the same time, during this period, a lot of effort was invested in the quality of the milk, in the strict maintenance of the cold chain from the cow to the consumer, and a lot of money was invested in the technological equipment in the cheese plants.

On the other hand, salt is an essential element in cheesemaking. The exception is fresh cheeses. In the production of rennet cheeses, the salt decrease was greatly influenced by the increase in production, technological progress and the transition to an industrial, large-scale production method with minimal costs. The salt decrease was adopted even when the taste and texture of the cheese deviated from the traditional ones. It is clear that there are strives and desires to produce cheeses with a reduced amount of salt, but this effort must not lead to lower quality criteria for cheeses. Table 2 shows the salt content decrease in some cheeses, that were mostly produced in Slovenia, over the last 60 years.

In Slovenia, nutritional experts recommend that children aged 2 to 8 should consume up to two, and adolescents and adults two to four nutritional units of milk or dairy products per day. One nutritional unit means 2 dcl of semi-skimmed milk, a pot of fermented milk (yoghurt, sour milk, kefir), 50 g or 3 large spoons of low-fat fresh cheese, 40 g or half a slice of low-fat cheese. Nutritional units are calculated in accordance with Recommended Dietary Allowance (RDA) where "Average daily level of intake is sufficient to meet the nutrient requirements of nearly all (97–98%) healthy individuals" [34]. So, these nutritional units cover most of the daily needs for calcium. For children until they enter

school, they should consume whole milk and dairy products from whole milk [35].

**Table 3 – Average consumption of milk and dairy products per capita in Slovenia [33]**

Dairy product	Consumption		
	Per year	Per week	Per day
Milk (l)	61.0	1.15	0.168
Fermented products (l)	25.0	0.47	0.07
Fermented milk (yoghurt, l)	18.0	0.33	0.05
Cream (l)	6.0	0.11	0.016
Cheese and curd together (kg)	15.0	0.28	0.041
Butter (kg)	1.0	0.02	0.002

High salt intake is a major cause of high blood pressure (BP), which increases the risk of cardiovascular diseases (CVD) such as stroke, heart disease and heart attack, the leading cause of death worldwide. A moderate reduction in salt consumption causes a significant reduction in BP and is associated with reduced CVD events. In response to such findings and on the basis of clear, high-quality evidence, WHO issued a guideline on sodium intake for adults (less than 2 g sodium/day or 5 g salt/day) and for children (maximum of 2 g sodium/day). Subsequently, the European Union (EU) High Level Group on Diet, Physical Activity and Health developed a Framework for National Salt Initiatives, approved and adopted by EU Member States. It encouraged countries to adopt salt reformulation targets to help them achieve the WHO target of salt intake [3]. That means that cheeses contribute to 1% of daily salt intake. Based on the daily consumption of 0.041 kilograms of cheese per inhabitant (Table 3), the daily salt intake is about 0.5–0.3%. However, it is assumed that the average salt intake in Slovenia today is still much higher, namely 10–15 g per day.

If cheese spreads and processed cheeses are added to the cheese group, we estimate that dairy products nowadays contribute no more than 2 to 3% of daily salt intake.

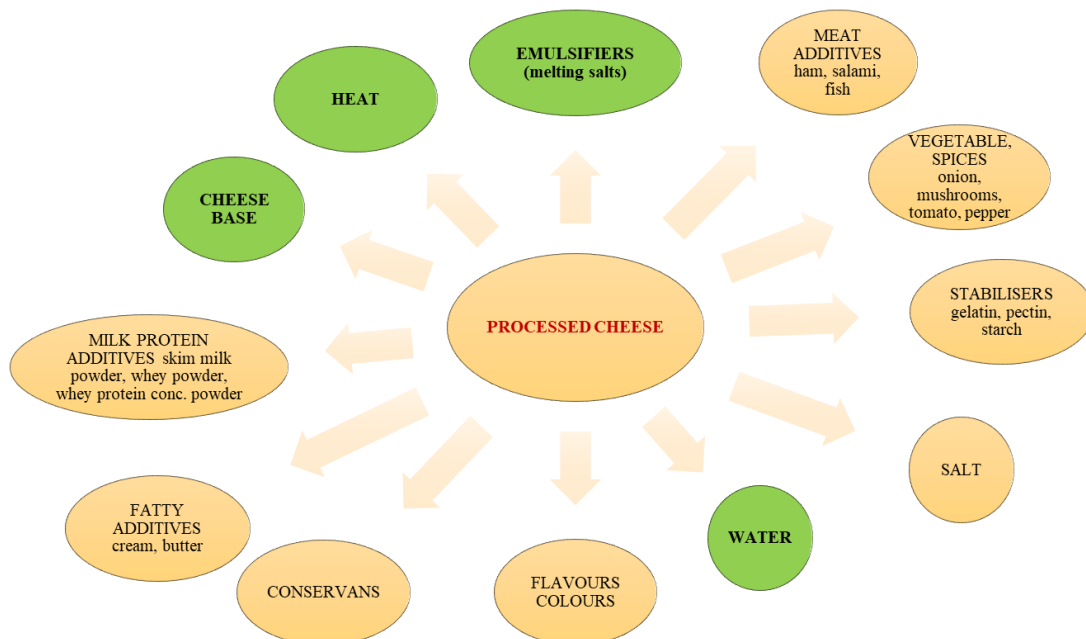
**Salt and processed cheese**

The basic raw material for the processed cheeses production is a mixture of different types of cheese. Only one type of cheese is never melted because then the melted product has a bland, empty, indistinct taste. A mixture of different ripened cheeses is recommended [36].

When melting the basic raw material, 3 % of melting salts should be added (Fig. 3). Sodium polyphosphates are mostly used, as they have the best technological properties. As evident from Fig. 4, the reaction between the protein-bound calcium in the cheese base and the sodium from the melting salt occurs only if mixture is diluted with water (40%) and heated (more than 75°C) [13,36].

The cheese base can consist of one type of cheese, but usually consists of a mixture of different cheeses of different tastes, consistency, and maturity. For the cheese base, "offcuts" of cheeses can be used (when round cheese-wheels are made into square sales units) or cheeses with minor defects in appearance (cheese-wheel of irregular shape, "crumpled" cheese-wheel) or in color (discoloration, uneven color), but never cheeses with microbiological defects (sporogenic, gas-forming MO). But if cheese base consists of ≥ 75 % of one type of cheese, the processed cheese is named after that cheese (e.g. processed Emmental cheese) [10].

Processed cheese is therefore Na-paracaseinate (Fig. 4). All protein-bound divalent calcium is replaced by monovalent sodium or potassium from the melting salt. After cooling, the processed cheese comes from sol to a gel state - processed cheese.



**Fig. 3. Ingredients in processed cheese production (summarised by [13], with publishers' permission HMU). Required components for processed cheese production are marked green, optional are yellow**

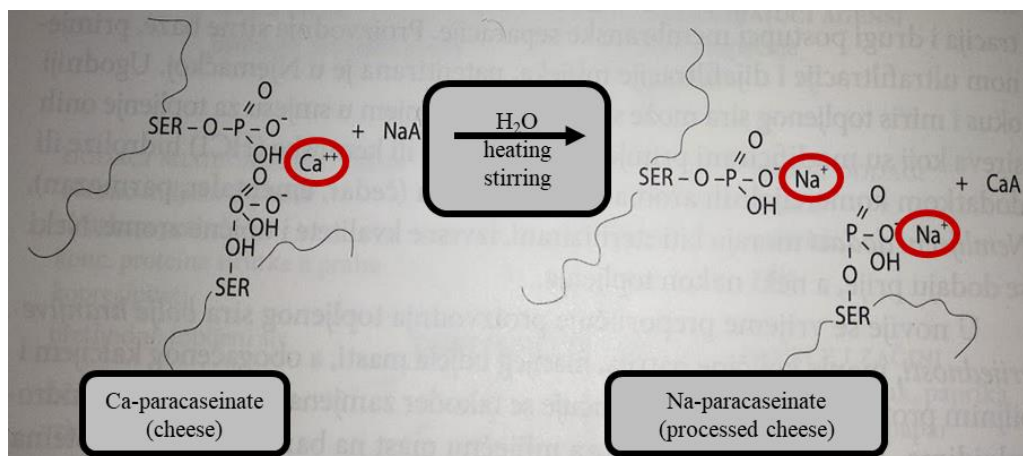


Fig. 4. The chemistry reaction during cheese melting (summarised by [13]; with publishers' permission HMU)  
NaA: emulsifying salt

From briefly described technology it is obvious that the processed cheeses contain in total as much salt as the basic raw material, and melting salts, respectively, such as sodium polyphosphate. But still, there are some possibilities to reduce the amount of salt in processed cheeses. Namely, instead of adding the technologically recommended 3% of melting salts, this can be reduced and added only 2%, without any adverse effect to the final product, but this is in direct correlation with the Ca amount in the cheeses composing basic raw material. To prepare basic raw material with a lower amount of salt, cheeses without/low salt content are selected (e.g. 50% fresh cheese (curd) and 50% Emmental cheese, which is generally known a very low-salt cheese, as larger amounts of salt inhibit the action of propionibacteria). Fresh cheeses are not salted and at the same time they represent the unripened component of the cheese mixture, while Emmental cheese contains 0.4% NaCl and represents the matured component. Since fresh cheese does not contain protein-bound calcium due to acidic coagulation, we need about 1 % of melting salt for the Emmental component. In the final product, there is 0.2% NaCl from Emmental cheese and 1% sodium from sodium polyphosphate.

In processed cheese technology, it is possible to reduce the amount of salt, where the final product is not impoverished, both in terms of sensory properties and the technological process.

#### Salt and butter

In Slovenia, there is no tradition to consume salted variety of butter. Therefore, dairy sector does not salt it.

But, in some countries, butter is salted, where butter with 2 % salt and extra-salted variation with 3 to 4 % salt are on market. The salt extends shelf life and impacts the flavor. Regardless to all the recommendations of decreasing salt intake, salted butter is still manufactured in the EU, but the consumer's demand for salted butter is decreasing. However, there is no longer any need for salting in

terms of shelf life, which is ensured by a consistent cold chain. At the same time, EU dairy industry is more and more oriented in production of unsalted butter from sweet cream; such butter has a milder aroma and taste. Although butter from sour cream is fuller and more aromatic, the demand for its production is decreasing. Buttermilk is the major byproducts generated from the churning. When butter is made from sweet cream, "sweet buttermilk" is generated as a byproduct, which is used to produce various dairy products [13,37]. It is evident that EU consumers buy less and less salted butter, but more and more unsalted butter made from sweet cream, which indicates that they prefer the milder taste.

As salted butter has never been produced in Slovenia, and there was no import of it until recently, consumers did not get used to it. Since the quality of butter in Slovenia in the last thirty years has been exceptional good from both, a technological point of view and in terms of sensory properties, salting was not necessary in order to extend its shelf life and cover sensory defects.

#### Salt and dairy spreads (milk/cream, cheese)

Dairy spreads can be defined as composites, where the raw material is either milk/cream or a fresh cheese (curd), usually from skim milk, which is mixed with dairy ingredients (yoghurt, butter, skim milk powder) as well as with non-dairy additives (vegetables, fruit (dry, fresh), spices, dried meat, fish, coffee, chocolate), which should not exceed 20 %, stabilizers (to improve texture), and finally everything is heat-treated. With spreads, the situation in terms of salt is different than with cheeses. Spreads on average contain 1% of added salt. The shelf life of spreads (with or without additives) is ensured with the final heat treatment and the addition of salt is technologically unnecessary. It is added exclusively for taste and harmony in relation to various additives. Reducing the salt addition or even completely eliminating it is possible without adverse technological consequences for the product [10].

### Salt and vegan cheese substitutes

Globally, in recent years, there has been an increasing concern for animal welfare, health and the environment, and therefore had been a loud appeal to exclude foods of animal origin from the diet and replace them/include foods of plant origin, not only among vegetarians and vegans, but also among other consumers. Therefore, more and more plant-based foods are available, which represents a substitute or a plant-based alternative to foods of animal origin (milk, meat, dairy and meat products) [38]. However, there has been an arising concern whether plant substitutes achieve the quality of foods of animal origin. In order to enlighten this concern, at least to some extent, [39] focused on the chemical and sensory quality of ten plant-based cheese substitutes labeled "classic"/"original" that are available on the Slovenian market. Chemical analysis included fat content, fatty acid composition, protein content, sodium and calcium content. Results were compared with the values on the label, and with the nutritional composition of a normal semi-hard type of cheese. The nutritional composition of plant-based cheese substitutes was very different from the usual semi-hard type of cheese, as they contained on average 60 times less protein, 8 times less calcium and as much as 50% more salt per 100 g. The protein content of plant-based cheese substitutes is quite problematic, as cheese is defined as a protein food. Imitating the functionality of casein with vegetable proteins is very demanding, so the market is full of vegetable substitutes for cheese, which compensate the protein deficiency with significant amounts of coconut, palm or other vegetable fats, which help manufacturers to partially obtain the consistency of cheeses) [40]. To get as close as possible to the desired consistency, different starches,

stabilizers, hydrocolloids, thickeners are added, proper aroma is obtained with the use of various aromas, color with the use of proper colors, while longer shelf life is obtained by the use of preservatives) [40,41]. Despite the functional role of protein in cheeses, many plant-based cheeses substitutes contain minimal or no protein. Those with proteins, however, contain them with the aim of improving the nutritional profile and not because of their functionality) [40].

When salt content was analyzed in plant-based cheese substitutes samples, it ranged from 1.44 g to 2.24 g/100 g, respectively (Fig. 5). As many as nine samples contained more than 1.5 g of salt/100 g. Samples with less salt (3, 5 and 9) were also evaluated worse sensorially, as their texture was plastic and crumbly, and the mouthfeel was empty and flavorless) [39].

However, if an adult consumes 55 g of plant-based cheese substitute (which is the recommended daily amount of cheese) with 1.99 to 2.24 g of salt (800 to 900 mg of sodium/100 g; samples 1, 4, 6, 7, 8 and 10) (Fig. 5), would cover most (80–90 %) of the physiological daily needs for Na or would cover 25% of the estimated value for the recommended maximum daily salt intake, which does not yet have harmful health effects.

It can be concluded that plant-based foods that are substitutes for foods of animal origin, such as plant-based cheese substitutes, still requires careful consumption, despite their sustainable orientation. In terms of nutritional quality, plant-based food substitutes can hardly come close to the original foods of animal origin, and quite often they even contain "unsuitable" ingredients, even in excessive amounts. Or they lack proper ones.

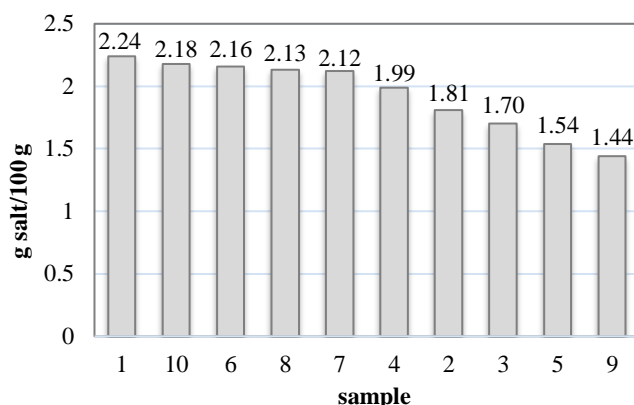


Fig. 5. Salt content in plant-based cheese substitutes (summarized by [40])

### Conclusion

Regarding salt intake, the most exposed dairy products are cheeses, cheese spreads and processed cheeses, but as evident, they are not the main source of salt or Na. At the same time, we do not consume enough of these products that they would significantly

contribute to salt intake. Nevertheless, there have been trends to reduce the salt content in foods in general, where dairy sector is of no exception, and especially "acute" dairy products such as cheeses, processed cheeses and cheese spreads are foods with certain maneuvers to reduce the amount of salts. However, salt in these products has its crucial technological

significance, so any "mindless" reduction of salt in these technologies could lead to health-adverse and sensorially unacceptable products. Regarding raw butter, the salted version has no tradition locally, so this dairy product is not problematic from the point of view of salt intake. To reduce salt intake the most can

be done by self-discipline, to avoid foods with a reputation of being "salty". For example, such are processed foods that have an attractive taste, but in forming this taste, many health detrimental ingredients participate, e.g. flavor enhancers (salt).

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