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SALT AND ITS SIGNIFICANCE IN CHEESE MAKING

Discussion groups - applied cheese technology

Authors:
Daniel Goy. Jean-Pierre Häni, Patricia Piccinali, Karin Wehrmüller, Ernst Jakob, Marie-Therese Fröhlich-Wyder, Revision 2012: Walter Bisig
Agroscope Liebefeld-Posieux Research Station ALP, CH-3003 Berne

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Contents

Summary

The use of salt is widespread due to its flavour-enhancing effect. Salt (NaCl) is essential in human nutrition but its consumption needs to be controlled. An insufficient or excess amount can have a negative effect on health.

For cheese, it is possible to replace a maximum of one third of NaCl (sodium chloride) with KCl (potassium chloride). Larger amounts of KCl produce an unpleasant bitter taste. The necessary labelling of KCl as an additive is a disadvantage. Because of the fact that potassium in human nutrition may in rare cases have an impact on health, the use of KCl is not actively encouraged by many food authorities.

The use of salt is indispensable in cheese production. It is imperative to respect the desired content of the different types of cheese.

Salt plays a versatile role. Salt influences the following characteristics and processes in cheese:
- Ripening
- Preserving against pathogenic bacteria and against spoilage bacteria
- Development of microflora
- Stabilising the surface and rind formation
- Consistency and structure of the cheese
- Taste and aroma

The currently used salt contents in cheese, e.g. 13 to 16 g/kg for Gruyère cheese, have an inhibitory effect on propionic acid bacteria (PAB), which are considered to be spoilage bacteria in many cheese varieties. For brine salted Gruyère type cheese, a salt content of 3.5% in moisture (≈ 1.2% in cheese) had a reducing effect on PAB, 5% salt in moisture (≈ 1.7% in cheese) completely inhibited growth of PAB. In curd salted cheese, a salt content of 12 g/kg (3% in moisture) was sufficient already to keep propionic acid below the critical 2 mmol/kg limit in 6 months old cheese. The inhibiting effect of the currently used salt contents on the growth of propionic acid bacteria is too low to completely protect the cheese against unwanted propionic acid fermentation. It is therefore necessary to make sure to keep the contamination of the milk with propionic acid bacteria to a minimum (< 20 cfu/g).

The use of cooking salt with added iodine and fluorine in the production of cheese is no longer recommended due to legal requirements in a number of export countries.

1. Introduction

Salt has been known for its qualities as a seasoning and preservative in food since early history. It has a flavour-enhancing effect, which explains its widespread use in cooking. Salt is also an indispensible element in the production of cheese in terms of taste and quality.

The following article looks at salt from a number of angles and deals with its significance in nutrition and the technology of cheese making.

2. Influence of salt on the sensory quality of food

Nowadays, salty is considered to be a basic taste in the same way as sweet, sour, bitter and umami (sodium glutamate is an example of a carrier of the umami taste). The tastes arising from the dissolving of molecules in saliva are identified by human beings via taste buds in the oral cavity. The mechanisms responsible for recognising tastes have been the subject of scientific research for decades. There is relatively good information available on the recognition of sweetness and bitterness, whereas many questions remain unanswered regarding the perception of salinity. The human perception of salt is normally related to the sensory perception of sodium chloride (NaCl). It appears the sodium ions penetrate the sensory cells of the taste buds via ion channels found in the membrane. Exactly how the receptors of the taste cells convert the chemical information of the sodium ion into electrical nerve impulses, is a puzzle that still remains to be solved.

Salt, or to be more precise sodium, has two different characteristics in terms of taste. The first, and most well-known, is its ability to cause a salty taste. Most adults and children like salty things. This is an innate reaction that probably reflects the fact that salt is essential to the human diet. And then there is a liking for salty things that human beings primarily develop during their childhood, which leads to a salt intake over and above the required daily amount.

The second characteristic of salt is its interaction with the components of flavours, which we understand as a combination of taste, aroma and the so-called trigeminal perceptions (hot, burning, cooling etc.). We use this interaction to improve the sensory qualities of food. Salt is a powerful suppressor of numerous bitter substances and in certain food it intensifies the taste of sugar to a certain extent. Moreover, salt has a flavour-enhancing effect. For this reason, salt is systematically added to processed food.

Current research work is focussed on the characteristics of the ion channels, which probably consist of three to four subunits. The need to solve the puzzle of the perception of salinity has gained considerable significance given the relationship between health problems and excessive salt intake.

3. Salt in the human diet

3.1 The function of salt (NaCl)

Cooking salt is the chemical combination of the elements sodium (Na) and chlorine (Cl), which perform important functions in the human body. Sodium is responsible for the regulation of the water balance and osmotic pressure in cells and is also involved in the regulation of the acid-base balance. Sodium is also important for the stimulation of muscles and nerves. Chlorine also plays a significant role in the acid-base balance. The physiological salt requirement in human beings has not been precisely defined. The minimum sodium and chlorine requirements in adults are 550 mg and 830 mg respectively, which is equivalent to 1.4 g of cooking salt.

3.2 Consumption and recommendations

Salt consumption in Switzerland is between 7 and 13 g per day per person and according to official recommendations this should be reduced to 6 g in the long term. When reducing salt intake, it should be borne in mind that salt is one of the most important sources of iodine in Switzerland.

Bread, cheese, soups, ready meals and meat products are food groups that contribute most to the daily consumption of salt. However, it is difficult to estimate how much individual foodstuffs contribute to salt consumption. Previous calculations are based on consumption figures; some 70-80% of salt consumption comes from processed food, approx. 15-20% from the natural salt content of food and the rest from salt added to food at mealtimes.

3.3 Diseases associated with high salt consumption

Salt is often primarily associated with high blood pressure (hypertension). Hypertension is probably the most well known but not the only issue relating to salt and health. Other diseases have also been connected with excess sodium intake. However, further scientific investigations are required to produce more authoritative evidence. Negative effects on health are mostly ascribed to salt per se rather than individual foodstuffs containing salt.

In Switzerland, approx. 40% of men and 25% of women have high blood pressure with the incidence increasing with age. Hypertension is a significant risk factor for cardiovascular diseases, which, as well as being the most common disease of civilisation, is also the most common cause of death in Switzerland. The causes of hypertension are complex and involve the over production of certain hormones, changes in the vascular system, diabetes, being overweight and various dietary factors. Excess weight and diet are influences that can be modified and therefore provide a starting point (alongside medical treatment) for reducing blood pressure. A diet high in sodium (e.g. salty foods) and low in potassium (e.g. fruit and vegetables) and calcium (e.g. dairy products) increases the likelihood of high blood pressure according to individual disposition. However, not everybody reacts in the same way to high or low salt intake. Patients sensitive to salt react to increased salt intake with an increase in blood pressure, whereas that is not influenced in people who are not sensitive to salt. However, there is no general definition of what constitutes sensitivity to salt and the mechanisms involved remain to be explained. It is estimated that around 15% of people with normal blood pressure are sensitive to salt while the proportion with patients suffering with hypertension is around 50 – 60%. Based on decreasing kidney functions, it is highly likely a large part of the elderly population (approx. > 65 years) is sensitive to salt. That means "only" patients sensitive to salt will benefit from a reduction in salt in their diets. The contention that a reduction in salt consumption across the population will bring health benefits is unproved and a matter of debate amongst experts. But there do appear to be certain sections of the population (e.g. people suffering from hypertension who are sensitive to salt) where a reduction in salt can have a positive effect.

Population studies on the connection between salt intake and high blood pressure have provided contradictory results.

There are other salts, such as potassium chloride, which is present in unrefined table salt, which can be used as alternatives to cooking salt to avoid excess consumption of sodium. Unfortunately, these salts are not widely available and they are more expensive and also have additional disadvantages (see Section 4 below).

Excess potassium may also cause hyperkalaemia (abnormally high level of potassium in the blood leading to cardiac arrest) which is why many authorities do not recommend the use of potassium chloride as a salt substitute (John et al. 2011).

4. Possibilities for reducing the sodium content in cheese

The use of salt substitutes makes it possible to produce cheese suitable for people who have to follow a low-salt diet for medical reasons. The food industry most commonly uses potassium chloride for this purpose. However, potassium chloride not only tastes salty but is also perceived to be bitter or metallic.

ALP tests have shown that salt (NaCl) in cheese can be partly replaced by potassium chloride (KCl); the NaCl content of cheese sinks proportionately with the increase in the amount of KCl in the brine. Table 1 shows the analysis results for the cheese used in the test.

Table 1: Composition of mature Raclette cheese brined in a solution of NaCl and partly KCl

Variants (n=4)	Fat	Water	pH value	NaCl	Sodium	Potassium
	[g/kg]	[g/kg]		[g/kg]		
Control (NaCl only)	259.75	465.88	5.37	23.95	9.41	0.82
KCl 10%	259.13	465.13	5.33	20.90	8.22	2.53
KCl 20%	260.38	461.75	5.46	17.41	6.84	3.97
KCl 30%	254.38	470.88	5.36	16.47	6.47	5.88
p value (variants)	n.s.	n.s.	*	* * *	* * *	* * *

* p ≤ 0.05; * * p ≤ 0.01; * * * p ≤ 0.001; n.s. = no significant influence of variants

It was possible to replace a maximum of 30% of the salt (NaCl) by potassium chloride. With the increase of the proportion of KCl, bitterness increased (figure 1). If the ratio was increased above 30%, the cheese became too bitter.

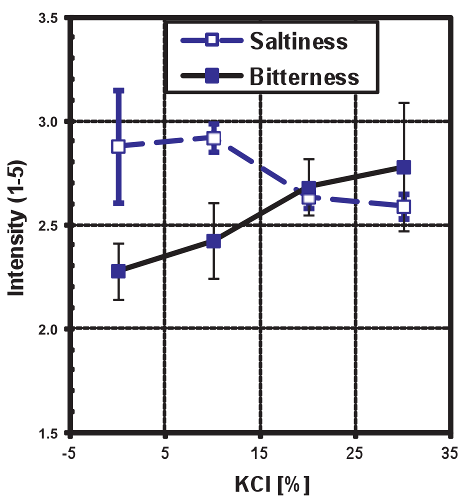


Figure 1: Saltiness and bitterness in mature Raclette cheese depending on the part of salt replaced by KCl in the brine

Important information
Where potassium chloride (KCl) is used in part to replace cooking salt (NaCl), then the salt content in the cheese has to be determined by analysing the sodium content. The standard determination of cooking salt content using chloride analysis leads to false, i.e. excessive results. Labelling of KCl as an additive would be necessary.

5. The salting of cheese

5.1 Salt absorption in cheese

A test aimed at the improved identification of salt absorption in Appenzeller showed this was influenced by the length of time the cheese spent in the brine, the salt content of the smearing water and the water content of the cheese before brining. It also confirmed that the salt content after brining can be balanced by the use of more or less salted smearing water.

In terms of taste, it is generally the case that a salt concentration of 3.5 to 4.5% in the moisture phase of the cheese is ideal.

Based on the absolute salt and water content of the cheese, it is possible to calculate the salt concentration in the aqueous phase (normally called salt in water) according to the following formula:

$$\text{NaCl in the aqueous phase [g/kg]} = \frac{\text{Salt content in cheese [g/kg] x 1000}}{\text{Water content of cheese[g/kg]}}$$

Sample calculation for a hard cheese:

NaCl content in cheese:	15 g/kg
Water content:	359 g/kg
Salt concentration in the aqueous phase:	41.7 g/kg

Table 2: Ideal salt content for different types of cheeses produced in Switzerland

Type of cheese	Absolute salt content [g/kg]
Sbrinz AOC	from 16 to 20
Gruyère AOC	from 13 to 16
Emmentaler AOC	from 3 to 5
Tête de Moine AOC	from 17 to 21
Tilsit	from 14 to 16
Appenzeller®	from 14 to 18
Raclette Suisse®	from 15 to 19
Vacherin fribourgeois AOC	from 15 to 18
Vacherin Mont-d'or AOC	from 12 to 15
Reblochon	from 14 to 17
Camembert	from 15 to 18

The range shown in Table 2 is narrower than the content range shown in the product specifications of the different types of cheese. However, these content levels are ideal in terms of the quality of the cheese.

Table 3: Salt and water content of different types of cheeses produced in Switzerland (average values from ALP database of samples from industry)

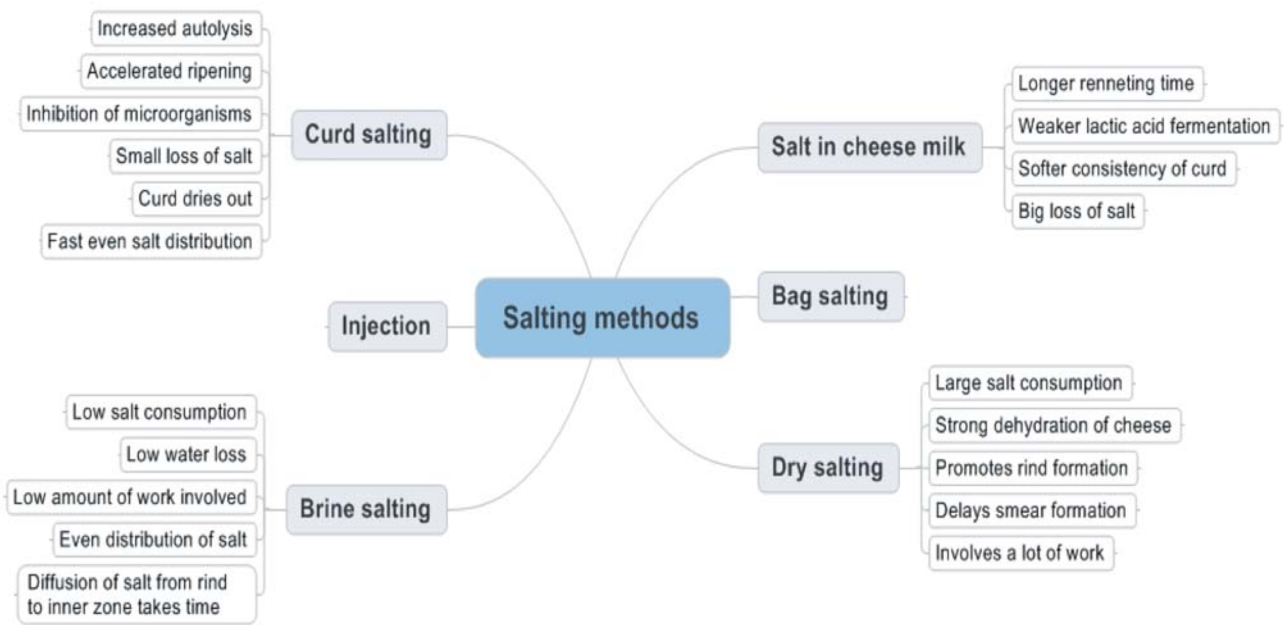
Type	NaCl		Water		Salt in water	Salt intake per 50 g of cheese
	[g/kg]		[g/kg]		%	% of RDA*
Emmental	4.29	± 0.76	350	± 8	1.2	4%
Cottage cheese	8.17	± 1.11	786	± 19	1.0	8%
Brie	12.76	± 1.59	514	± 27	2.5	13%
Vacherin fribourgeois	12.76	± 1.94	423	± 29	3.0	13%
Tilsit pasteurised	13.87	± 2.02	420	± 22	3.3	14%
Gruyère	14.88	± 2.27	359	± 11	4.1	15%
Appenzeller	15.3	± 2.02	396	± 13	3.9	15%
Vacherin Mont-d'Or	17.07	± 4.06	568	± 16	3.0	17%
Tilsit made of raw milk	17.4	± 2.02	396	± 16	4.4	17%
Sbrinz	17.9	± 2.77	319	± 09	5.6	18%
Tomme	18.13	± 2.87	550	± 38	3.3	18%
Raclette pasteurised	18.36	± 1.49	414	± 20	4.4	18%
Limburger	19.14	± 6.88	559	± 18	3.4	19%
Reblochon	20.17	± 4.82	517	± 34	3.9	20%
Appenzeller ¼-fat	20.43	± 5.04	482	± 17	4.2	20%
Camembert	22.47	± 12.5	521	± 31	4.3	22%
Tête de Moine	23.43	± 2.87	352	± 22	6.7	23%

*Recommended daily amount = Ideal value of 5 g NaCl per day according to WHO recommendations

5.2 Salting methods

Different types of salting are used in industrial dairy processing:

The most commonly used salting method in Switzerland is brining. Additional salt is added during the ripening process with the smearing water.



5.3 Salt diffusion

The salt only diffuses slowly towards the centre of the cheese wheel. For example, 90 days are needed with Gruyère to allow the salt to be distributed evenly within the whole cheese. Gruyère absorbs approximately 50% of the salt during its time in the brine, 30% from the cheese smearing solution in the first ten days and the rest from the smearing solution applied for up to 3 months.

In order to gain more information on the diffusion of salt, nine wheels of Gruyère produced in winter and nine in summer were tested at ALP. A sample of each was taken after 3, 10, 30, 60, 90, 120, 150 and 180 days of ripening. The samples were processed in such a way that they represented the three zones shown in figure. 2 (0.5 cm of the rind was removed). The water and salt content in the different zones were analysed, revealing the salt diffusion from the rind to the centre of the cheese.

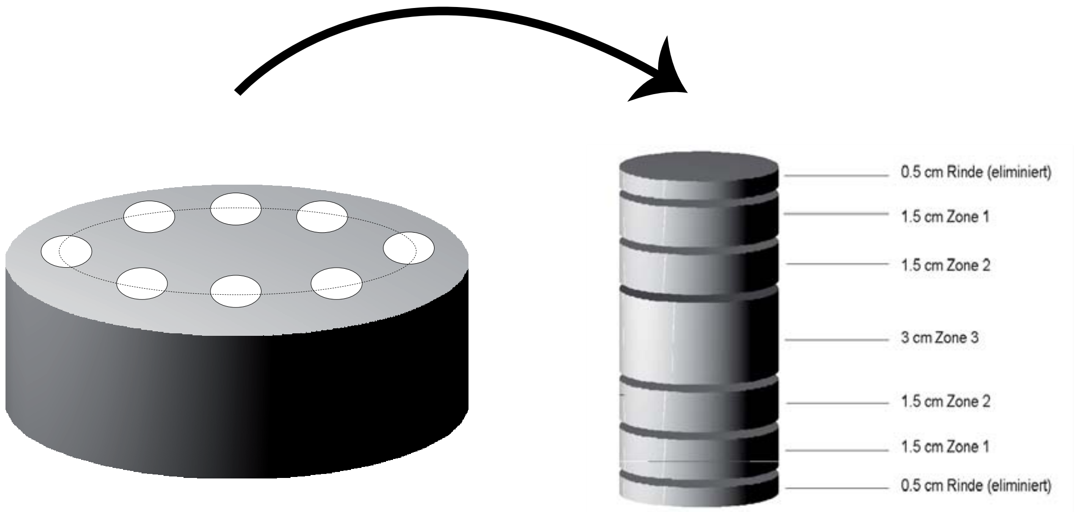


Figure. 2: Sampling in salt diffusion test in Gruyère (Rinde = rind; eliminiert = removed).

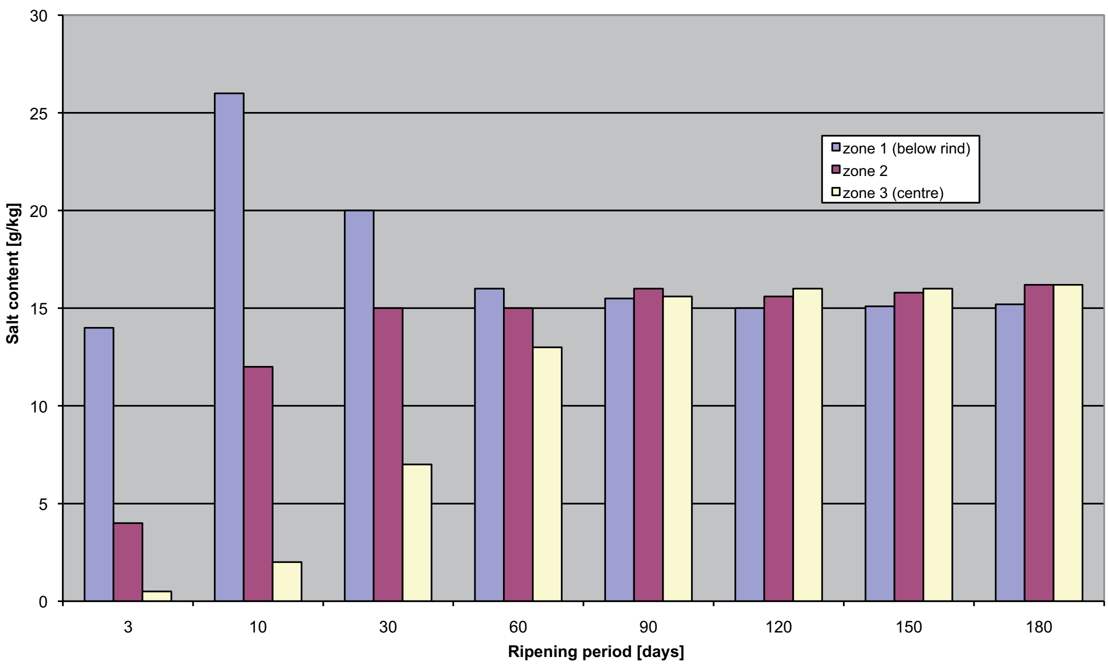


Figure. 3: Salt diffusion in the different zones of a Gruyère cheese wheel.

A close examination of the amount of salt used for cheese brining and smearing revealed that there were no seasonal differences in the amount of salt absorbed in the 18 cheese wheels tested.

The salt diffused into the centre of the wheels very slowly. Approximately 90 days were required to achieve a similar concentration in all 3 zones (figure 3).

The effect of the salting can be easily seen in zone 1 from the start of the maturing process. On the other hand, this zone contains less salt than the other two zones at the end of the ripening process. This phenomenon is explained by the cheese being treated with pure water (without added salt) in the later phase of the ripening process.

Conclusions from the test
Salt is not always absorbed in the same way in cheese. The factors that influence the speed of diffusion of salt are as follows:
- Slow acidification (high pH value after 2 and 4 hours) –> quicker diffusion of salt
- High lactic acid content after 24 hours –> quicker diffusion of salt
- High water content, low fat mass content, high wff –> quicker diffusion of salt
- Height of wheels

Cheesemakers can control the exact salt content of the cheese if they adhere to the following points:
- Even distribution of water content in cheese
- Consistent acidification
- Even height of cheese wheels
- Optimum duration of time spent in the brine
- Degree of dry salting
- Knowledge and maintenance of salt content in the smearing solution

The duration of the salting in the brine varies considerably and depends on the following factors:
- Salt concentration of the brine (recommended concentration 22° Bé)
- Stirring of the brine.

The stirring of the brine has two advantages: Even temperatures in the brine and minimisation of the lower salt boundary-layer between cheese and brine.
- Volume of cheese wheel (ratio of surface and weight of cheese)

The volume and the surface directly in contact with the brine are very significant for the salt absorption of the cheese: Appenzeller cheese absorbs approximately 10 g of salt per kg of cheese a day in the brine, whereas Gruyère only absorbs 7 g of salt per kg of cheese in the same length of time.

It can be seen that the osmosis is very intensive immediately after the cheese is placed in the brine. This process slows down once the rind has hardened through dehydration.

The amount of salt increases slightly if the cheese is in the brine for more than a day.

Additional salt is often required during the smearing process to achieve the desired salt content.

The correct amount of salt has to be added during smearing of the cheese to control the salt content.

5.4 Possibilities for speeding up cheese salting

With large cheese wheels that have to be salted to the centre quickly, such as Sbrinz, a range of variants for speeding up the salting were investigated. Salting the curd during moulding did not provide the desired result. Either most of the salt was lost with the whey or the salt had a negative effect on the acidification and draining of the cheese.

Stirring the brine generally speeds up the absorption of salt.

6. Significance of salt in cheese technology

In cheese technology salt affects the following product characteristics and processes:
- Taste and aroma
- Surface and rind
- Consistency and structure of the cheese
- Development of microflora and proteolysis

6.1 Influence on taste and aroma

Too little salt in the cheese leads to unpleasant perceptions of taste. The taste is bland, less developed, atypical and other off-tastes such as impurity and bitterness become often evident. Salt has the ability to mask unpleasant aromas. This is well-known with bitter tastes. In contrast, salty cheese has well-developed aromas, which are not just based on saltiness but also on the effect of salt as a flavour enhancer.

With frozen cheese curd, sensory analysis shows that salting speeds up the oxidation of fat. It is therefore essential to avoid salting cheese curd intended to be frozen.

6.2 Influence on the surface, rind formation and the smear flora

Salt draws moisture from the surface of the cheese, which leads to the formation of the rind.

Results from a test on Appenzeller showed that the wheels, which had spent 18 hours in the brine and had been smeared with unsalted or lightly salted water, often had faults such as rough, spotted surfaces or a rind with swellings. In contrast, cheese that spent three days in the brine and was then treated with very salty smear water (15% NaCl) produced a sticky cheese smear that did not dry out in between the individual treatments.

Finally, salting affects the surface flora of the cheese.
In general, the growth of bacteria is most restricted by salt as they require higher moisture levels for growth (optimum aW-value > 0.98). Geotrichum candidum also does not tolerate too high salt concentrations (aW value > 0.94 = 9% NaCl), while many other yeasts and moulds are not completely inhibited at salt concentrations of 20%, i.e. an aW value of 0.84. Dry salting of the surface thereby primarily inhibits the bacteria of the smear flora.

The growth of beneficial moulds such as P. camemberti is inhibited by salt. The growth threshold is approximately 20% salt in an aqueous environment. Growth is delayed by a week at levels above 10%. On the other hand, salt promotes the spread of fungal mycelium on the surface. In an unsalted environment, most strains hardly spread whereas half of the strains spread with concentrations compatible with cheese technology.

6.3 Cheese consistency and structure

The texture of hard cheese and semi-hard cheese becomes more crumbly with increasing salt content. This occurs through the displacement of calcium in the casein-calcium phosphate complex by sodium.

6.4 Weight loss

The duration of brining and the salt concentration of the smearing water influence the weight loss of semi-hard and hard cheese.

The longer the time spent in the brine, the greater the weight loss measured after brining. However, the overall weight loss is lower in the same cheese towards the end of the ripening period. As a result, the cheese loses less weight overall.

Similarly, tests showed that cheese smeared with very salty water (15% NaCl) looses less weight than cheese treated with less salty water (from 0 to 10%).

6.5 Development of microflora in curd

As mentioned above (6.2), there are salt-sensitive, salt-tolerant and salt-loving microorganisms. They all require freely available water measured by the aW value. The aW value conforms to the relative humidity formed in the headspace of a closed vessel after the introduction of a sample (e.g. salt solution). Pure water produces a relative humidity of 100% and its aW value is therefore 1.0.

In general, bacteria can only grow with aW values above 0.92, which is equivalent with a maximum salt concentration of approximately 12%. Above this salt level there is a lack of freely available water, which inhibits growth.

An increasing salt concentration in cheese reduces the proteolysis speed as the microbial and enzymatic activities decline. As a result the speed of the ripening process also declines. This means that the salt concentration plays a decisive role in the microflora as well as in the ripening and development of taste in cheese.

Propionic acid bacteria are severely restrained with a 4% and above concentration of salt in water. They stop growing at a NaCl concentration of 5.5%. Brown spots that form in cheese are colonies of propionic acid bacteria. The experience of ALP and people involved in this sector tends to indicate that salt content influences the appearance of these brown spots. A high salt content reduces their appearance but also affects the consistency and structure of the cheese.

ALP has carried out two tests (ALP Intern 2007 no. 320 and no. 326) aimed at determining the threshold of salt tolerance of propionic acid bacteria in cheese.

7. Salt as "inhibitor" for propionic acid bacteria

7.1 Inhibition of propionic acid fermentation in curd salted cheese using NaCl

Propionic acid bacteria may cause spoilage such as undesired eye formation, cracks and undesired flavour formation in many cheese varieties such as Gruyere, Sbrinz, Appenzeller or Tilsiter. The aim of this experiment was to establish evidence on the effectiveness of salt relating to the inhibition of propionic acid bacteria and to be in a position to provide practical recommendations. The experiment – using curd-salting known from Cheddar technology for a faster equal distribution of the salt in the cheese – involved adding certain amounts of salt to the curd. Concentrations of 3 to 6% salt should be achieved in the aqueous phase. The milk was pasteurised. The vat milk was inoculated with 200 to 300 propionic acid bacteria per ml (cfu/ml) (table 4).

The propionic acid content was low with all salt concentrations after 3 months (figure 5). On the other hand, after 6 months, propionic acid fermentation could only be inhibited sufficiently (< 2 mmol/g propionic acid) with a salt concentration of more than 3% in the aqueous phase.

Table 4 Salt added per 10 kg of cheese in curd salted cheese experiment

Version	% salt desired in water in cheese	Salt intake per 10 kg of cheese	% salt achieved in water in cheese
1	3.00	190 g	2.01
2	4.00	250 g	2.41
3	5.00	310 g	2.78
4	6.00	370 g	3.32

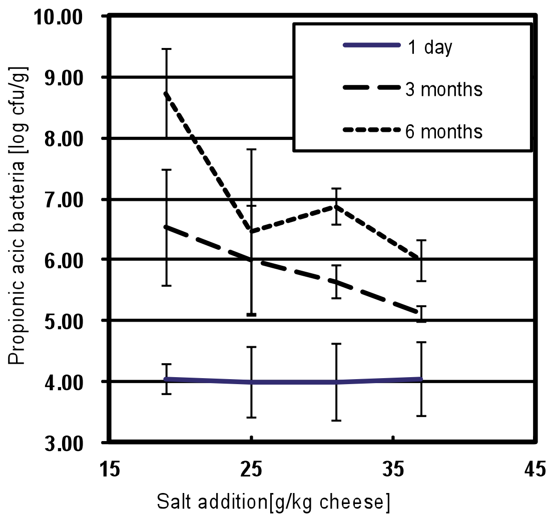


Figure. 4:
Growth of propionic acid bacteria in curd salted cheese depending on the addition of NaCl (–1 day, – – 3 months, --- 6 months)

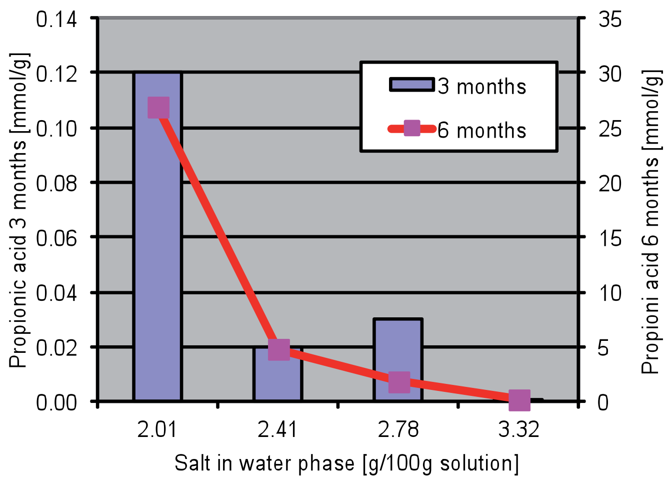


Figure. 5 :
Propionic acid formation in test Cheddar depending on the salt concentration in the aqueous phase.

7.2 Inhibition of propionic acid bacteria using NaCl in a model Gruyère

This experiment was carried out to potentially reduce the recommended salt content in cheese without promoting the undesired fermentation of propionic acid bacteria. It is known that that salt has an inhibiting effect on the growth of propionic acid bacteria (PAB).

The following three factors were varied and their effect examined in the experiment:

Factor 1: Strain of PAB:	Strain A Strain B
Factor 2: Duration of brining:	1 day (control) 3 days
Factor 3: Smearing water:	Salt content 2.5% Salt content 6% (control) Salt content 22%

There were 2 x 2 x 3 = 12 variants. The variants with the normal content in the smearing water (6%) were produced in double. A total of 16 cheeses were produced.

The vat milk was inoculated with 200 to 300 cfu/ml of propionic acid bacteria. The tolerance value for Gruyère is < 20 cfu/ml.

The effect of the salt both due to the duration of brining and to the salt concentration of the smearing water was evident for up to 3 months. But the propionic acid bacteria count increased during the period 3 to 6 months without being seriously inhibited by the salt (figure. 6). Also the propionic acid content of the cheese increased in the period from 3 to 6 months (figure 7) for all the salt treatments, but still less for the treatments using more salt.

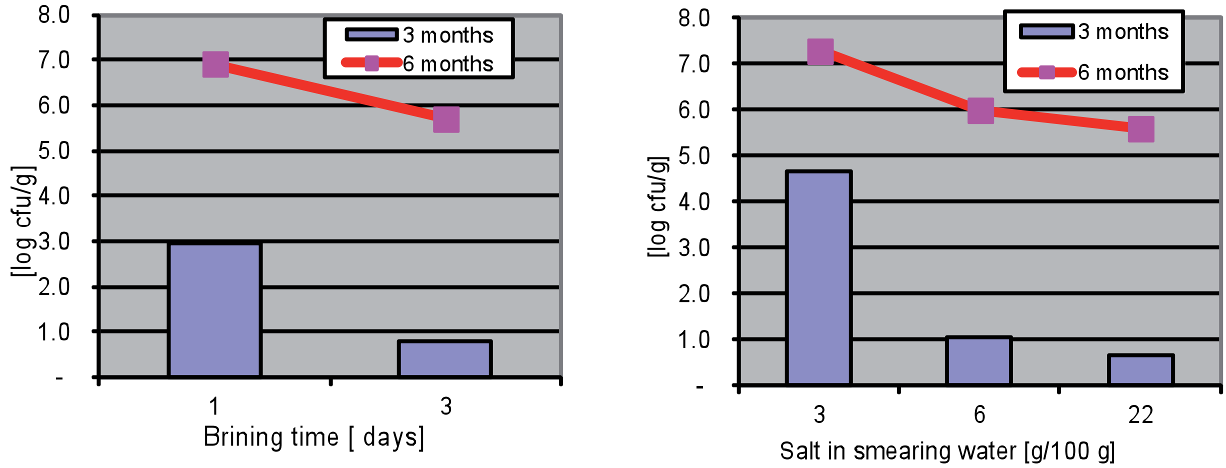


Figure 6: Growth of propionic acid bacteria in model Gruyère depending on the duration of brining (left) and salt concentration of the smearing water (right).

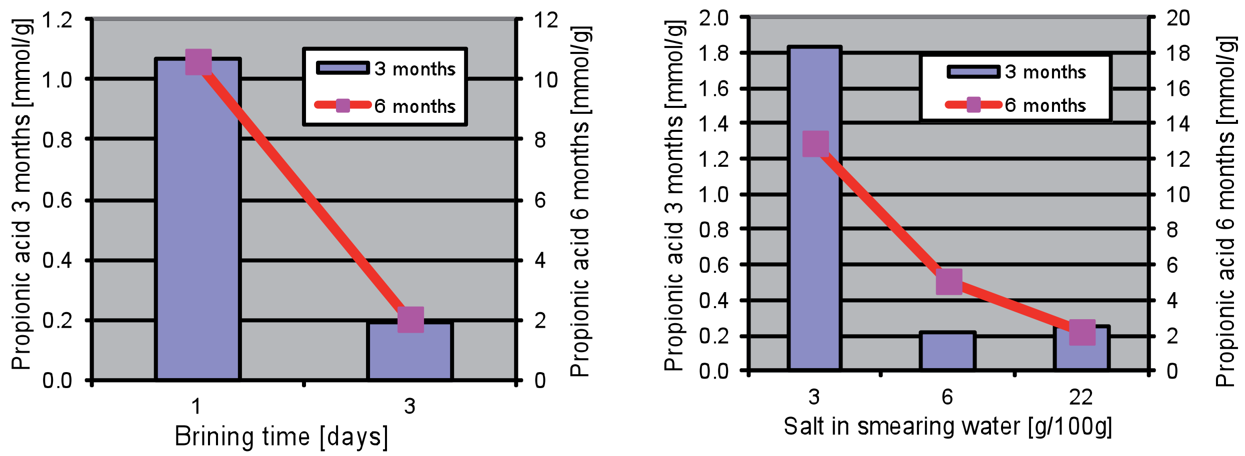


Figure 7: Propionic acid formation in model Gruyère depending on the duration of brining (left) and the salt concentration of the smearing water (right).

The propionic acid contents were still acceptable after 3 months. The concentration approached the tolerance threshold (≤ 2 mmol/g) with the use of smearing water containing 3% salt. After 6 months, cheese, which spent 1 day in the brine or which was smeared with water containing 3% salt, had a very high propionic acid content.

The following conclusions can be drawn from the two experiments:

1. Salt has an inhibiting effect on the development of propionic acid bacteria. For Gruyère-type cheese, the salt content in the aqueous phase must be 5% or more to completely inhibit the propionic acid bacteria (figure 8). A salt content of about 3.5% in the aqueous phase had a reducing effect already. Contamination of the vat milk with propionic acid bacteria must be kept to a minimum (e.g. < 20 cfu/ml for Gruyere) to avoid uncontrolled growth and to ensure the ability for full ripening.

2. In the curd salted Cheddar-type cheese, a lower content of salt was necessary to prevent PSB growth and propionic acid fermentation. A salt content of 12 g/kg (respectively 3 % in the water phase) was sufficient already to reduce the formation of propionic acid to a value lower than 2 mmol/kg in 6 months old cheese. As with curd salting, the salt was equally distributed in the cheese at a very early stage, the salt could prevent a propionic acid fermentation at a lower total salt level as in the brine salted Gruyere with additional salting through the smearing water (see figures 8 and 9).

3. The two tested PAB strains showed no difference in their sensitivity to salt.

4. Different surface treatments led to significant differences in the surface of the cheese. Only cheese smeared with water with a salt concentration of 22% had a good colour but it also had a slightly sticky cheese smear.

5. Too high a salt content had a negative effect on the cheese texture (cheese after 3-days of brining). From a technological point of view, this is the reason why the ideal salt content is considered between 13 and 16 g/kg (see table 2) or around 4.1% in the aqueous phase, which is below the 5% necessary in the aqueous phase for Gruyère-type cheese to completely inhibit PAB fermentation.

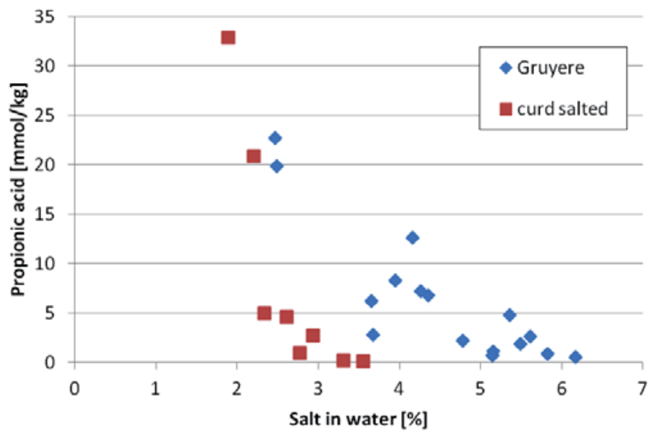


Figure 8: Propionic acid content in Gruyère type cheese and curd salted cheese as a function of the salt content in water (salt in curd salted cheese: 0.74% to 1.3%; salt in Gruyère-type cheese: 0.84 – 2.07%)

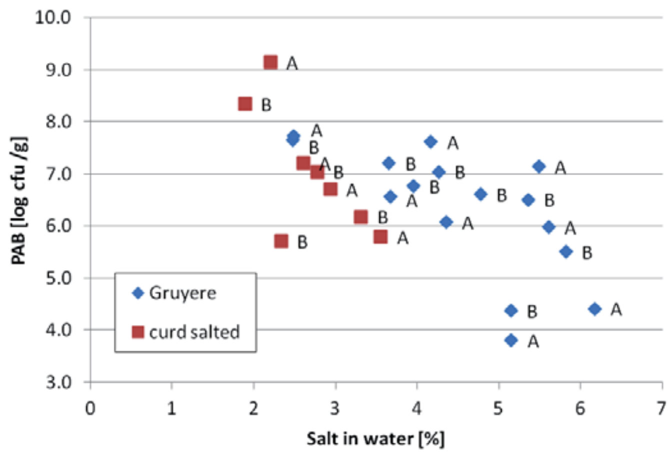


Figure 9: Logarithmic count of propionic acid bacteria in 16 Gruyere-type cheeses and 8 curd salted Cheddar-type cheeses inoculated with either PAB strain A or B, as a function of the salt content (same cheeses as in figure 8; salt in curd salted cheese: 0.74% to 1.3%; salt in Gruyère-type cheese: 0.84 – 2.07%)

8. Salts and additives currently recommended for cheese dairies

Saline du Rhin (Rhine saltworks) :
1473 JuraSel® table salt 25 kg (1471; 50 kg bag)
1545 JuraSel® table salt with iodine and fluorine 25 kg
5591 Cheese dairy salt

Saline de Bex :
1125 Dried fluoridated and iodised cooking salt
1225 Dried cooking salt
1725 Wet fluoridated and iodised cooking salt
1825 Wet cooking salt without iodine and fluorine

Separating agent = Anti-caking agent (E 536)
Iodine content: 0.002% = 20 g per tonne of salt
Fluorine content: 0.025% = 250 g per tonne of salt

Sample specification can be found in the attachment.

9. Use of iodised salt

The World Health Organisation (WHO) recommends a minimum iodine intake of 150 µg per day and a maximum level of 600 µg per day for adults. The iodine content of staple foods was recently analysed by the Swiss Federal Office of Public Health (FOPH) and it identified an average daily iodine intake of 140 µg per person. The Swiss Federal Dairy Research Station (FAM) information sheet no. 282 of February 1994 on the "Use of iodised cooking salt" revealed that 90% of cheese dairies used iodised cooking salt. FAM, now integrated into ALP-Haras, recommended the use of this salt as a preventive measure against goitre.

According to an ALP study, the diffusion of iodine to the centre of a cheese is relatively weak, i.e. the majority remains in the rind zone. With cheese that has a smeared rind, part of the iodine is removed with the rind, which is not consumed. The daily consumption of 50 g of cheese when iodised salt was used provided between 10 and 25 µg of iodine.

Three reasons led to the decision to stop using iodised salt for cheese manufacture in Switzerland:
1) The small diffusion of iodine into the cheese.
2) The necessary labelling of the use of iodised salt in many countries (see chapter 9.1) and
3) The ban of iodised salt for processed food in different export countries for cheese produced in Switzerland, e.g. in France. This ban in France is based on the "Development of nutritional effects of the introduction of iodised food components" report by the French food safety authority AFSSA (Agence Française de Sécurité Sanitaire des Aliments). This report declares that the systematic use of iodised salt in processed food exposes the population to the risk of exceeding the upper safety limit for iodine.

9.1 Labeling regarding the use of salt in Switzerland

Legislation in Switzerland does not currently require any labeling of salt in cheese. On the other hand, the use of iodised and fluoridated salt has to be labeled. Some retailers now also label the salt content of many foods as a contribution to the measures encouraged by the health authorities to reduce sodium intake of consumers. For cheese, many labels indicate the salt content now.

10. References

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Attachment : Specification

Specification:
Table salt, dried without iodine/fluorine

Salt is our history, our profession, our passion

Code: 1225

Characteristics	Consisting of sodium chloride, fine crystal structure, white and dried, food in accordance with the requirements of the Ordinance on Foodstuffs. The addition of a separating agent prevents the salt caking and enables optimum measurement of product. This salt is not enriched with iodine or fluorine (prevention of goitre, cretinism, tooth decay etc.) and is therefore unsuitable for use as cooking or table salt.
Use	Table salt for the industry if iodine and fluorine are not required as ingredients. This salt is not to be used in catering or as table salt as it is not enriched with iodine or fluorine.
Sensory aspects	Colour: White Odour: Odourless Taste: Purely salty as a solution of 1 to 6% in water (Detection limit: approx. 0.6‰ or 0.01M)
Composition	Sodium chloride min. 99.8 % NaCl Sulphates max. 0.2 % SO42- Calcium max. 80 ppm Ca2+ Magnesium max. 10 ppm Mg2+ Insoluble materials max. 0.01 % Separating agent max. 5 ppm E536 (K4[Fe(CN)6]) Humidity max. 0.2 % H2O
Physical characteristics	Specific weight: approx. 1.2 kg/dm3 Grain: 0.1- 0.5 mm Melting point: 801 Saturation point: 357 g/l water at 20°C
Storage conditions	Hygroscopic product: Can solidify in contact with water or if chilled. Store in a dry, closed room at more than 5 °C and a relative humidity of less than 70%. The product will not change under these storage conditions. The length of storage primarily depends on the environmental influences on the packaging and their conditions.
Packaging	25 kg polythene bags on 1,000 kg Euro pallets