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## **Salt in Cheese: A Review**

Mamdouh El-Bakry

Department of Dairy Science and Technology, Faculty of Agriculture, Cairo University, Giza, Egypt

*Corresponding Author: Mamdouh El-Bakry, UCD Food and Health Institute, University College Dublin, Dublin 4, Ireland*

### **ABSTRACT**

High salt, sodium chloride (NaCl), intake has been linked with diseases and strokes. Processed foods to which cheese belongs highly contribute to the dietary salt intake, in industrialised countries. Therefore, it might be of interest to reduce salt in cheese. The aim of this review is mainly to outline recent approaches used to reduce salt in cheese. Salt acts as preservative and flavour enhancer in cheese. In addition, salt has a main role in the functional properties of the cheese. Accordingly, there is a challenge in reducing salt without affecting the cheese quality. The reduction of salt was achieved through the decrease of its content used and replacement by potassium chloride. In natural cheese, these approaches adversely affected the cheese properties, particularly the characteristic flavour. In processed cheese, these approaches were more promising than those in natural cheese, as most of the properties were not substantially affected. This might suggest that further research has to be done on reducing salt in natural cheese products.

**Key words:** Cheese, salt, sodium, potassium chloride, processed cheese

### **INTRODUCTION**

There is considerable evidence that high salt (sodium chloride) intake has been linked to health complications, such as stomach cancer, kidney stones and diabetes (Sultanpur *et al.*, 2011). In addition, high dietary sodium chloride increases the urinary loss of calcium and therefore may play a role in the progress of osteoporosis (Adeniyi and Fasanmade, 2006). Most importantly, excess sodium intake is associated with high blood pressure and increased risk of heart attack and strokes (Salahdeen and Alada, 2007). The efficacy of reducing sodium intake in lowering blood pressure is well established. The recommended maximum daily intake for sodium is about 2.4 g. However, the daily sodium intake in industrialised developed countries is usually about 5 to 6 times higher than the maximum recommended daily intake (WHO, 2010). Therefore, dietary guidelines advise that sodium intake be reduced.

It has been reported that almost all of the dietary sodium comes from processed foods, to which various types of cheese belong, consumed in Western countries. Cheese is a versatile, nutrient-dense dairy food, however, it is perceived as containing high levels of fat and sodium (Ali and Abdel-Razig, 2011; Salih *et al.*, 2011). The traditionally common salt (sodium chloride, NaCl) is the main source of sodium in cheese, which is the main dairy product that involves the use of salt in its manufacture protocols. The aim of this paper is to provide a concise review on salt in different cheeses, with an emphasis on its content and role and approaches used for the reduction of salt content.

## **SALT AND SODIUM CONTENT OF CHEESE**

In general, salt content in different types of cheese has a very broad range (Guinee and Fox, 2004). The salt concentration in natural cheese, which is usually made from milk by acid and/or rennet-coagulation, ranges from approximately 0.7 to 4 g/100 g cheese. Processed cheese, which differs from natural cheese in that it is made from natural cheese or casein that is blended with emulsifying salts at high temperatures to form a homogeneous product, has a salt content of 1 to 2 g/100 g. The highest content of salt is found in pickled cheeses such as Domiati and Sikma cheese, natural hard cheeses that are highly consumed in Egypt and Turkey, respectively, which contains up to 7 g salt/100 g (Ceylan *et al.*, 2003; Elsanhoty *et al.*, 2009).

The total sodium content in cheeses has a broad range which varies from ~40 to 800 mg sodium/100 g of most types of natural cheese, where salt is the only source of sodium (McCance and Widdowsons, 2002). Processed cheese contains a higher level of sodium (~1500 mg/100 g) overall cheese types. There is an additional source of sodium beside salt due to the essential use of the so called emulsifying salts, such as sodium citrates or phosphates, in the manufacture (El-Diam and El-Zubeir, 2006). The main role of the emulsifying salts is to sequester the calcium present in the milk protein used-mainly casein- and accordingly facilitate its hydration and conversion to an active emulsifier, which allows for the emulsification of fat and formation of a stable homogeneous end-product.

## **ROLE OF SALT IN CHEESE**

Cheese is considered as being the most important dairy product involving the use of salt (sodium chloride) in the manufacture. The primary role of salt is to act as a preservative due to its ability to reduce the water activity that prevents the growth of most of undesirable microorganisms (Aly and Galal, 2002; Abdalla and El-Zubeir, 2006). In addition, its chloride ion also inhibits the germination of microbial spores. Salt is usually added to control the growth of lactic acid bacteria and to prevent undesirable microbial growth by killing or limiting the growth of foodborne pathogens and spoilage microorganisms. The secondary role of salt in cheese includes the contribution to taste, both directly-as salt is a component of the expected taste of the cheese- and as a flavour enhancer. The taste of salt is highly appreciated by many consumers and saltiness is regarded as one of the basic flavours in food due to the sodium, giving the desired characteristic taste to cheese products. Finally, salt interacts with major components in the cheese and thereby affecting the functional characteristics (Floury *et al.*, 2009). Salt has an essential function in the protein hydration and the modification of the water binding capacity of casein within the cheese matrix and viscosity, which affects the stability and textural properties.

## **STRATEGIES FOR REDUCING SALT IN CHEESE**

Strategies for reducing “salt” in cheese include mainly the reduction of the salt sodium chloride (NaCl) and its replacement by potassium chloride (KCl). However, these strategies present many challenges, such as adverse effects on flavour, microbiological stability and functional properties of the final product. When salt content is simply reduced in natural cheese, proteolysis, water activity, acidity and bitterness all increase, while hardness decrease. In addition, irregular fermentations could occur which may alter the desired characteristic taste of the cheese, e.g., development of a bitter unacceptable flavour.

In cheddar cheese, which was extensively studied in respect to salt reduction, analysis showed that reducing NaCl resulted in unpleasant aftertaste and bitterness. Within a range of 0.5 to 3%

salt, at salt levels below 1.5% compared to higher levels of 1.8 to 3%, an increase in the growth of undesired non-starter bacteria occurred that caused bitter flavours due to excessive proteolyses (Rutikowska *et al.*, 2008). In addition, high salt cheeses showed the highest desirability due to the high cheddar intensity flavour and lack of an unpleasant aftertaste. In low fat cheddar cheese, Banks *et al.* (1993) reported that a high salt content of ~1.8% was necessary to show the desired flavour, as lower salt levels of ~1.2% resulted in a bitter taste with less cheddar flavour. All of these factors make it difficult to reduce the salt content in cheese without substantially adversely affecting the quality.

In pickled cheeses, which are typically characterised by their high salt content, a decrease in the typical salt concentration led to undesired properties. For instance, reducing the salt concentration from 6 to 4 g/100 g in Herby cheese, a traditional cheese manufactured from sheep and cow milk in Eastern Turkey, led to an increase in the number of lactic acid bacteria that resulted in increased acidity (Tarakci *et al.*, 2004). In addition, a decrease in the consumers' acceptability in terms of appearance, colour and texture was observed. In processed cheese, a recent approach showed that the manufacture of the cheese at highly reduced concentrations of NaCl was successful (El-Bakry *et al.*, 2011a). All the cheese properties, except the microbiological stability, were not adversely affected by the reduction of salt up to a concentration of 0 g salt/100 g cheese.

Substitution of salt (sodium chloride) with other salts has been considered as an alternative approach to reduce sodium in cheeses. In general, KCl has been recognized as a potential salt to substitute NaCl in various food stuff, mainly due to the similarity between the cation of these two salts (Kaur *et al.*, 2011). This approach to reduce sodium gives an additional benefit, from a nutritional perspective. Potassium is known to have a significant effect of reducing the blood pressure and hence, reducing the risk of cardiovascular diseases (Doyle and Glass, 2010). A mixture of sodium chloride and potassium chloride has been successfully used in various cheeses without substantially affecting the properties of the cheese, such as Cheddar, Ras, Kefalograviera and Halloumi cheese (Guinee and Sutherland, 2011). However, the level of substitution of NaCl by KCl is limited by the bitter undesired taste that might be produced by KCl. In mild flavoured cheeses, such as white soft unripened cheeses, at levels of replacements up to 50%, the bitterness is well masked by the remaining NaCl (Breslin and Beauchamp, 1997). This replacement might give the perception of saltiness without undesired flavours. However, this level of replacement may not provide desired characteristic flavours of other types of cheese. In cheddar cheese, cheeses with a level of substitution of 50% exhibited an unacceptable crumbly texture due to the presence of KCl, whereas cheeses that contained lower levels of substitution (~25%) of NaCl by KCl were preferred by the panellists (Fitzgerald and Buckley, 1985).

In processed cheese, the replacement of NaCl by KCl have been reported in various research work (Guinee and Fox, 2004; Guinee and Sutherland, 2011). Most of the functional and microbiological properties of the cheese were not substantially affected as a result of this replacement. Recently, processed cheese was successfully manufactured at full replacement of NaCl by KCl (El-Bakry *et al.*, 2011b). There were no adverse effects on functional properties of the cheese, which included textural, rheological and microstructural properties. However, the microbiological stability over refrigerated storage was substantially reduced.

## CONCLUSION

The reduction and replacement of salt (NaCl) by KCl in cheese faces a lot of challenges that make it difficult to reduce salt without affecting the overall desired quality of the food stuff.

However, approaches to reduce salt used in the manufacture of processed cheese seemed to be more promising than those used for natural cheese. The reduction of salt in processed cheese did not affect all, but microbiological, cheese properties. Therefore, it is suggested to focus on the reduction of salt in natural cheese in future research. It might be also useful to further investigate approaches for reducing salt in processed cheese that do not alter the microbiological properties. Furthermore, reducing other low sodium salts-mainly sodium emulsifying salts-used in the manufacture of processed cheese might be of high interest, from a nutritional viewpoint, towards the production of healthy low sodium' cheese products.

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