Putting salt on the agenda

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Dietary salt has never received the attention it deserves. Consumer organisations, NGOs, government and industry have focused their attention primarily on fats (saturated and trans fats) and, of course, on the trend towards obesity.

This also explains why salt is known as the "silent killer" [1] – an "assassin" which, as it is low on the social agenda, sneaks into the body unnoticed via processed foods. What this means in concrete terms is that excessive consumption of salt – or, to be precise, its sodium component (see inset panel below) – leads to higher blood pressure, which in turn increases the risk of cardiovascular disease.

"No salt" Indian culture

Numerous studies have now been performed that have revealed this risk. One of the first studies of this kind, conducted in the 1970s, showed a low frequency of hypertension among a tribe of Brazilian Indians, the Yanomamo, who did not use salt in their diet [2]. Even later in life, no significant increase in blood pressure was identified.

Essential

Sodium is an essential mineral which performs various functions in the body [3]. Together with potassium, sodium assists in the establishment of a stable fluid balance and regulates the transport of nutrients and other molecules into and out of the cells. Furthermore, it plays a role in the conduction of nerve impulses and in muscle contraction. Finally, sodium helps to maintain the acid-base balance in the body. There is no definitive minimum standard for sodium intake. Estimates range from 1 gram of cooking salt (consisting of 400 mg sodium and 600 mg chloride) to 2.4 grams of cooking salt [4] per day.

In the 1980s the findings among the Yanomamo tribe were also included in an international study entitled Intersalt [5], encompassing 32 countries, which established the correlation between salt intake and hypertension. Apart from studies on the relationship between salt intake and hypertension, studies have also emerged over the years which state that too much salt can lead to bone decalcification [6], stomach cancer [7] and obesity in children (by increasing consumption of sugary soft drinks) [8].
There is now so much clinical scientific evidence for the relationship between sodium intake and hypertension (see also the studies by Cook [9] and He & McGregor [10]) that politicians, industry and NGOs have moved salt higher up the agenda.

WHO raises the alarm

In 2003 the World Health Organisation published its Independent Expert Report on Diet and Chronic Disease [11], which stated that diets that are low in salt, saturated fat and sugar help to combat chronic conditions such as cardiovascular disease (CVD). According to the WHO, the burden of chronic diseases, which are to a significant extent diet-related, is rapidly increasing worldwide. At present, non-communicable diseases such as CVD and cancer are responsible for nearly 60% of the 57 million total reported deaths in the world. The WHO maintains that many of these deaths are due to just a handful of risk factors, citing high cholesterol levels and high blood pressure among the "usual suspects".

Health Council recommends a 6 g limit

In the Netherlands, the starting gun for the offensive against salt was sounded by the Health Council in 2006. In its "Guidelines for a Healthy Diet" the Council advocated not using more than 6 grams of cooking salt (2.4 grams of sodium) per day [12].

In the previous Guidelines, which were published in 1986, the recommended ceiling was set considerably higher at 9 grams of cooking salt (3.6 grams of sodium).

In view of the salt intake in the Netherlands, the 6 gram threshold is quite ambitious. According to Dutch Consumer Association calculations, average salt intake is between 10 and 12 grams of cooking salt per person per day. Marianne Geleijnse of Wageningen University and Research Centre (WUR) estimates salt intake to be in the region of 10 grams per person per day.

A recent survey of 333 people conducted in Doetinchem by the National Institute of Public Health and the Environment (RIVM) [13] indicates that average intake is 8.8 grams. It is striking that intake varies markedly from one target group to another. Men aged between 19 and 49 are reckoned to consume 10.1 grams of salt per day, whereas women aged 50-70 consume appreciably less (7.5 grams). The limitation of this sample survey lies in the fact that the people of Doetinchem are not necessarily representative of the population as a whole. Furthermore, there is likely to be greater awareness of salt consumption in Doetinchem than elsewhere in the Netherlands precisely because of the survey.

A challenge for industry

In other words, salt intake must be reduced by at least 30%. Because consumers derive around three-quarters of their daily salt intake via processed foods, the food industry has a decisive role to play. Certain companies, such as Unilever [14] and Hak [15], have already made specific reductions in the levels of salt in their products, but many more need to follow their example. Because salt is an inexpensive commodity, many companies will find it difficult to make the transition.

"Salt is, naturally, an attractive ingredient for product developers because it is cheap and enhances flavour", says Kees den Uijl, who is business development manager at Euroma and an innovation consultant with Food Nutrition Delta.

But industry is likely to find that its hand is forced. With increasing pressure being applied by government and such bodies as the Dutch Consumer Association (Consumentenbond) [16], salt – or, to be more precise, salt content – is an issue that the food industry cannot shy away from. Nor does it want to, judging by the initiatives that have been undertaken in the recent past by Unilever, HAK and other companies.

Bread, meat products, soups

It goes without saying that not every branch of the Dutch food industry needs to commit the same level of resources to this matter. Practice has shown that salt content can vary considerably within different product categories. It is logical that those manufacturers which produce foods that make a significant contribution to salt intake will face the greatest challenge. According to the 1998 Dutch food consumption survey, bread, cheese, meat products and soups are collectively responsible for half of per-capita salt intake via processed food.

Logic dictates that a significant reduction in salt levels within these product categories will deliver considerable health benefits. The fact remains, however, that producers of other, less salty product categories (and those companies manufacturing products that are less widely consumed) can hide behind the backs of those supplying the front-line producers.

Salt intake by product category	
Bread	28 %
Chees	11 %
Meat & meat products	10 %
Soups	7 %

Source, Dutch food consumption survey of young adults, 2003

FNLI: concerted effort required

According to Christine Grit of the Federation of the Dutch Food and Grocery Industry (FNLI): "The sector as a whole must really get to grips with the salt problem. Ultimately, consumers must get used to food that tastes less salty, so that this becomes the norm. This process will be most effective if every producer joins in."

The question that remains is: how can the food industry tackle the salt problem? In this report we review the different approaches that can be adopted. In some cases it will be enough simply to reduce salt without any other measures. In the majority of cases – and certainly if a substantial reduction is made – the sodium will need to be replaced by all manner of auxiliary agents.

Clearly, the first step, a reduction by 10-15%, is relatively straightforward. It is the second step that is likely to take a lot more thought ...

Chapter 2

Salt reduction:
a host of possibilities

2.1 The role of salt

Before we examine the possible alternatives to salt, it is useful first of all to briefly consider the functions that salt serves in a food product. "It goes without saying that salt affects flavour", says Kees den Uijl. "Obviously, salt tastes salty, but it also enhances other flavours [17]. In addition, it suppresses bitterness." [18] Salt also determines texture. Take meat and meat products, for example. If you lower the salt content in a frankfurter [19], the texture will change. This is because salt has a binding effect on proteins. Because salt facilitates protein binding, the product will have a particular, characteristic "bite".

Shelf-life less of an issue

A further important function of salt in certain product categories relates to shelf-life, with the main consideration being the regulation of water activity. "In meat products, you cannot simply reduce salt and yet maintain the same shelf-life", says Den Uijl. "Obviously, shelf-life will vary from product to product."

"For example, in Dutch rusks, which have a relatively low water activity, salt has no influence at all on shelf-life", adds Sonneveld's Innovation and Development Manager Peter Weegels.

A fresh product such as bread will last for between four and five days. Then it is not actually stale, but the taste and texture are such that it can no longer be eaten. In this case, salt has little bearing on shelf-life, but has a major role in determining the baking qualities.

'Hurdle' technologies

"Nevertheless, salt plays only a limited role in maintaining microbial safety and thus shelf-life in the majority of food products – exceptions being such items as anchovies and Roquefort", according to Professor Marcel Zwietering of the Food Microbiology Department at Wageningen University & Research Centre. "For example, reducing NaCl by 30% will not lead to a commensurate reduction in shelf-life, but rather a reduction of only a few percentage points. This will depend on the amount of salt that the product contains and relevant micro-organisms. This reduction in shelf-life can still be offset by tweaking other parameters – for example by reducing the pH, or adjusting the processing or chilling temperature (transportation, storage, Ed.). Needless to say, other salts can take over the antimicrobial role of NaCl. But potassium chloride is heavier than NaCl, so you cannot simply replace a given weight of NaCl with the same weight of KCl. Relatively more KCl will need to be added, unless the other 'hurdles' are used to compensate." The difference in molar mass between potassium and sodium is approximately 16 g/mol.

Processing aid

Finally, salt is also used as an aid in fermentation and baking processes. For example, cooking salt inhibits the growth of unwanted bacteria during the fermentation of sauerkraut. It also strengthens the gluten structure during the bread-baking process. If the glutens do not remain intact, the dough becomes sticky and the baker is left with an unsaleable product.

2.2 Various options

There are various ways to reduce the sodium content in food. In this chapter we weigh up all of these options.

In theory these are separate measures, but in practice they are often combined. They can be regarded as tools in a salt reduction "toolbox". The simplest method is to remove a certain amount of sodium without replacing it. A distinction needs to be made between radical and gradual reduction. The latter approach involves replacing the sodium with other types of salt, or with salt blends. Another option is to use herbs or spices.

Flavour enhancers

The use of flavour enhancers is a further option. These do not actually taste salty, but intensify other flavours, including saltiness.

Physical distribution is a method based on uneven stimulation of the taste receptors. By varying intensity (both in terms of time and saltiness), it is possible to enhance the perception of salt. Another option is to improve the solubility of salt, and thus availability in the mouth.

Finally, there is the multisensory approach. Although still in its infancy, this technique already appears to be yielding promising results. So-called cross-modal interaction involves engaging other senses apart from taste in order to increase salt perception.

2.3 Simply less salt

The easiest way to remove sodium is simply by using less salt, but without adversely affecting taste, texture and shelf-life. That this should be a viable option for many manufacturers is evident from survey findings published by the Dutch Consumer Association in 2007 [20]. This survey reveals major differences in salt content within the same product categories. In some cases – such as white bread, rice/noodles and garden peas, for example – these differences can exceed 50% (see table).

Product	Lowest (g salt/ portion)	Highest (g salt/ portion)	Difference % lower
White bread	0,29	0,6	-52
Cheese 48+	0,32	0,68	-53
Pizza *	2,93	9,16	-68
Rice/noodles	1,72	6	-71
Garden peas (can/jar)	0,3	1,05	-63

Source: Dutch Consumer Association, 2007

* Unknown whether the pizza topping was the same.

In other words, there are quite a few products whose sodium content can be lowered. It should be noted, however, that the lowest values are not indicative; i.e. even though the products may be from the same category, they probably have different recipes.

HAK slashes salt

There are now a number of producers that have cut salt content without compensation. HAK, for example, last year cut the salt content of its canned vegetables by 25% in one fell swoop [21]. "The reduction varies from vegetable to vegetable", explains senior product manager Erik Pijnenburg.

A few examples: HAK's reduced-salt kale contains 0.10 gram of sodium, while its haricot beans contain 0.15 gram and its beetroot 0.21 gram.

Pijnenburg is candid about the method used. "During the product development phase we kept on lowering the salt and therefore also the sodium content until the consumer panels found the taste to be ideal."

According to Pijnenburg, the reason consumers found the less salty variants tastier was that they tasted more vegetables. "That may also be true. Although salt is a seasoning, it also has a levelling effect on the other flavours."

Slow versus radical

It is actually remarkable that the consumer panels found HAK vegetables with less salt tastier than the old variants. The reason? Habit. According to Beauchamp [22], this is an important factor in determining the preferred level of salt. If consumers are accustomed to a certain level of salt in food, this is the level that they will find ideal.

If manufacturers reduce salt content too abruptly, consumers may turn away from these products. Another danger, and one which the Dutch Consumer Association, among others, has warned about [23], is that consumers will start to compensate for reduced salt levels by reaching for the salt cellar more at home.

Reaching for the salt cellar

Research [24] has shown, however, that a fairly abrupt reduction in sodium (by around 50%) over a period of 13 weeks did not lead to excessive use of the salt cellar.

According to Beauchamp, the 11 experimental subjects only compensated for 20% of the "shortfall" of sodium that they obtained via processed food.

On the other hand, manufacturers cannot afford to lose consumers by slamming on the salt brakes too quickly. Ultimately, the intention is that consumers should get used to a new, lower preferred salt level almost without noticing it. This was also found to work in Beauchamp's study [22], which shows that a gradual reduction in cooking salt leads to a different preferred level. The question is: exactly how low is this level?

Research by Beauchamp's group also shows that habituation to lower salt levels is product-dependent. "For example, habituation did occur for the soup whose salt content was reduced in the study, but the preference for salt in other products did not change", says Jojanneke Busch, Flavour Manager at Unilever R&D in Vlaardingen.

Trial and error

Striking this balance is a question of trial and error. The determination of a minimum level is dependent on the specific product and process in question. As HAK has already demonstrated, it is possible to achieve an abrupt reduction of 25% in canned vegetables. Australian researchers maintain that a 25% salt reduction in bread, over a period of six weeks, has no consequences for consumer acceptance [25].

Just to be perfectly clear, what we are talking about here is a salt reduction without any replacement or other measures. It appears that a 25% reduction is too ambitious for many product categories. A straw poll conducted among experts and a number of companies (producers and suppliers) indicates a potential scope for reduction without compensation of between 10 and 15%. In other words, if the food industry wants to remove at least a third of the salt from its products, the reduction-without-replacement approach will prove inadequate. Manufacturers will then have to dig deeper into their box of tricks.
And there is another problem, namely that salt also makes up a significant proportion of the dry matter in some products (especially solid ones). In these cases the industry will have to use other, often more expensive, ingredients.

2.4 Other salts and salt blends

There are numerous salt substitutes on the market that can pave the way for higher levels of sodium reduction. Ingredient suppliers at home and abroad have ready-made mixes with which the food industry can achieve significant reductions (ranging from 25 to 50%). Broadly speaking, the range of products on offer fall into two categories: mixes that still consist partly of sodium chloride and those that contain no NaCl at all.
First of all, it is appropriate to briefly outline the most widely used salts. Then we shall review the advantages and disadvantages of these products. Finally, we shall give an overview of what the suppliers have to offer. Given the wide range of products available, this will not be an exhaustive list.

Potassium chloride

It goes without saying that sodium chloride is not the only type of salt on the market. There are various compounds which, when used in combination, perform almost the same functions in food products as sodium chloride. Which particular combination is chosen will depend on the type of product concerned and what functions it needs to perform (food safety, for example).
Potassium (K) [26] is a mineral that occurs naturally in the body and is involved in the regulation of cardiac function and blood pressure, etc. It is the most widely used alternative to salt in the food industry. Either too much or too little potassium chloride in the blood (E508) can be dangerous (as will be discussed in more detail later).
Potassium sulfate (K_2SO_4; E515) [27] is a white crystalline powder with a bitter, salty taste. It is freely soluble in water. Potassium sulfate is synthesised by allowing sulfuric acid to react with potassium hydroxide or other potassium salts. It is naturally present in certain mineral waters.
Magnesium sulfate ($MgSO_3$ and $MgSO_4$; E518) [28] is a natural salt consisting of sulfuric acid and magnesium salts. Often referred to as Epsom salt, it is also used as a firming agent in processed vegetables and fruit.
Calcium carbonate ($CaCO_3$; E170) [29] occurs abundantly in nature in the form of the mineral, calcite. It is used domestically as a descaling agent to remove the calcium deposits that accumulate on heating elements. Calcium carbonate is used as a filling agent in some chewing gums. In the meat industry the salt is also used for the white "mould" on dry sausages.
Ammonium chloride (NH_4Cl; E510) [30] is the ammonium salt of hydrogen chloride. This white crystalline powder, also known as sal ammoniac, is used as an acidity regulator in baking products, etc.

Bitter taste

The biggest disadvantage of the above-mentioned salts (potassium chloride, for example) is their bitter aftertaste. Sensitivity to this bitter taste varies from person to person. "These flavour anomalies can lead consumers to stop buying these products", says Albert Zwijgers, innovation consultant at Food Nutrition Delta. "If similar products are available that do not have this flavour anomaly, manufacturers may lose market share."

However, studies have been performed in which the use of substances such as potassium chloride did not, in fact, lead to reduced consumer acceptance. This is not only the case following minimal reductions, but also when salt content has been lowered significantly. For example, a group of South African researchers reduced the sodium content in brown bread by 32.3% and replaced it with a blend of potassium chloride, magnesium chloride and calcium chloride [31]. According to these authors, both the taste and the other quality parameters (including texture) were "acceptable". It remains to be seen whether manufacturers will find this satisfactory.

In a German study [32], a comparison between sodium levels following incorporation of mineral salt and common salt in a number of meat products revealed significant reductions, ranging from 35% for turkey meatballs to 50% for minced meat and liver sausage. In a further comparative study, scores recorded for products with reduced NaCl content were 0.4% points lower than those for the control products when rated on a scale from zero to five. This was not only the case in relation to taste, but also for odour and texture.

Masking

There are ways of masking this bitter taste. For example, one supplier uses L-lysine, an amino acid that neutralises the bitter taste and thereby increases the likelihood that consumers will accept the product.

Another masking agent is trehalose. This is a non-reducing sugar which can be used not only as a sweetener but also as a stabiliser and flavour enhancer. Trehalose, which is also found in natural products such as lobster and prawns, is sold on the European market by Cargill under the brand name Ascend.

Finally, some flavour houses have developed aromas that partly mask the bitter taste.

Texture

The implications of sodium substitution would appear to be less significant for texture. In the South African study [31] no difference in texture was noted, whereas the German researchers did identify a difference, as has been stated.

Another study [33], which investigated cheddar cheese, showed that a partial replacement of sodium with potassium had no impact on texture.

As mentioned previously, salt does not play a decisive role in microbial safety for the majority of products. Exceptions are meat products, cheese, margarines and mayonnaises. Ultimately, it will be necessary to consider each individual product in order to determine the extent to which NaCl can be replaced with potassium chloride or other salts.

The effects on taste, texture and shelf-life depend on various product-specific factors such as pH, the addition of other preservatives, et cetera.

Labelling

Another disadvantage of potassium chloride and the other salt substitutes is that these additives must be specified on the label as E-numbers. There is also the option of not declaring these substitute products as additives (and therefore as an E-number). The disadvantage of this approach is that "potassium chloride" still sounds more chemical on the label than "salt" or "cooking salt".

Nowadays, the food industry is more inclined to remove as many E-numbers as possible from its products. Influenced by this trend for "clean label" foods [34], producers aim to include as many "natural" ingredients and additives – like cooking salt, for example – as possible on the label. It is therefore not surprising that the industry, represented by the FNLI, has argued in Brussels [35] that E-numbers should be abandoned for these salts. The industry association is receiving support from the Dutch Consumer Association in this campaign. For the time being, industry will have to continue declaring the salts as E-numbers.

Health issues

Research has shown that potassium, a substance that needs to be in equilibrium with sodium in the body, has an antihypertensive effect [36]. Intake of potassium, which occurs naturally in dairy products, vegetables, fruit, etc., is known to be relatively low in the Netherlands. The average potassium intake in the Netherlands is 3.6 grams per day. The 1997/98 Dutch National Food Consumption Survey (VCP) indicated that 45% of the Dutch population did not even consume this amount [37].

In other words, potassium could make a positive contribution to public health. However, adverse health effects may occur within a small risk group (kidney patients), who may develop hyperkalaemia, a condition whereby the kidneys are unable to remove potassium from the body quickly enough. The result is severe muscle weakness, heart problems and kidney failure.

The role of potassium in salt substitutes is minor, however, compared with other sources of potassium such as vegetables and fruit.

The market

It comes as no surprise that salt suppliers and other commercial operators have responded en masse to the demand for solutions that lower sodium content. As was stated previously, there are products on the market that contain sodium and other products that are sodium-free. An example of the latter category is Alsosalt, from the US supplier of the same name.

Alsosalt

According to the supplier, Alsosalt – a blend of potassium and the amino acid, L-Lysine – does not have a bitter aftertaste due to the patented production process [38]. The product is marketed as a table salt and as a salt substitute for industry use. On its website the supplier proudly announces that Heinz's No Salt Added Ketchup now contains Alsosalt. A brief glance at the label reveals that the ketchup contains 125 milligrams of sodium (5 milligrams per portion). The website does not indicate the extent to which AlsoSalt can reduce sodium.

It is clear, however, that Alsosalt cannot be used in every food product. In bread and meat products, for example, Alsosalt is unable to perform the same functions with regard to texture and shelf-life.

Pansalt

Pansalt [39] was developed by a Finnish Professor, Heikki Karppanen, and Dr Mildred Seelig from the US. Available both in the form of table salt and as an industrial salt, Pansalt contains 56-57% sodium chloride and 28% potassium chloride, its remaining ingredients being magnesium sulfate, lysine and iodine. It offers the potential to reduce sodium levels by between 40 and 45%.

The website of the manufacturer, Oriola Oy, states that the product is currently used in Finland, Germany and the Philippines. On the domestic market, Pansalt is already used in large restaurants and all McDonald's outlets. Snacks, dairy products, hamburgers and bread are some of the product categories that have been seasoned with Pansalt.

Flavomare

Another salt replacer originating from Finland is Flavomare [40], a salt blend that contains potassium chloride and flavonoids (among other ingredients). The producer, Selako, claims that Flavomare allows for a sodium reduction of between 25 and 50% without producing "off" tastes. According to Selako, Flavomare offers additional benefits in relation to shelf-life. The flavonoids serve to reduce oxidation (and resultant loss of quality) during processing and storage.

Selako also claims that the acrylamide content in certain products (such as chips) is reduced by 50%. Flavomare is used in meat seasonings, meat products, ready meals, bouillons, dressings, etc.

Sub4Salt

Sub4Salt, from Jungbunzlauer of Switzerland, was named "Ingredient of the Year" in 2008 by market researchers Frost & Sullivan [41]. According to the company, this product is capable of reducing the sodium content of processed foods by 25 to 50%. Whereas 1 gram of sodium chloride contains 0.4 gram of sodium, 1 gram of Sub4Salt contains 0.26 gram of NaCl.

Interestingly, Jungbunzlauer does not reveal what other ingredients its salt substitute contains. It is clear, however, that Frost & Sullivan is extremely impressed with Sub4Salt. "There is no other product on the market that can compete with Sub4Salt in terms of price and effectiveness. It does not have a bitter, metallic aftertaste [see the earlier comments on the side effects of potassium chloride], nor does it have the bouillon-like taste that can accompany MSG and yeast extracts", says Frost & Sullivan analyst Natasha Telles.

SaltWise

This is a relatively new salt substitute, introduced by Cargill in 2007. According to the supplier, SaltWise (recipe unknown) can reduce the amount of salt in products by 25 to 50% without flavour being sacrificed [42]. Furthermore, Cargill notes in the brochure that its product delivers "full parity liking" (i.e. a comparable taste to fully salted products) at 33% reduced sodium.

The salt substitute can be used in deep-frozen products, soups, sauces, dressings, meat, chicken, salty snacks, etc.

SaltPrint

This salt substitute from Firmenich Inc (US) contains neither sodium nor potassium chloride. It is therefore strictly speaking not a salt replacer but an aid in masking the bitter aftertaste of potassium chloride. According to the supplier, SaltPrint can be used in products containing varying proportions of NaCl and KCl. SaltPrint increases saltiness and other tastes, claims Firmenich. No percentages are given with regard to sodium reduction.

Suprasel

Suprasel from AkzoNobel is a blend of NaCl and KCl in varying proportions. The company is currently working on a mix which, it claims, delivers a better flavour perception than existing products. "The product is based on the same principle as that employed in standard low-sodium products, whereby sodium is partly replaced by other elements such as potassium. Thanks to the new technology, we are able to combine this with a significantly better taste", says a spokesperson for the multinational.

AkzoNobel maintains that the new mix allows for reductions in NaCl of up to 50%, depending on the product. Dr Johanneke Busch of Unilever Food and Health Research Institute qualifies this claim (and the claims of other suppliers), however: "Manufacturers' salt-reduction recommendations for the above salt substitutes frequently exceed the level that can actually be achieved in commercial products by a considerable margin."

2.5 Flavour enhancers

Flavour enhancers do not themselves taste salty, but they do result in a more intense, salty, taste and odour. The principle underlying flavour enhancers is based on stimulating the taste receptors in the mouth and throat. These receptors keep the sodium channel in the open position for longer, so that salt perception is increased [43].

Salty taste

The salty taste is generated by the fact that sodium ions pass through the ion channel on the salt receptor, whereupon a signal is sent to the brain. Various salts can also follow the same pathway. "As the ion mass of the metal in question increases, so the substance's power to activate the sodium channel diminishes," says Harold Bult of NIZO Food Research. "Potassium is capable of doing this and is used for this purpose. It is possible with smaller ions such as lithium, but this substance also has a pharmacological effect and is therefore unsuitable."
There are various types of flavour enhancer on the market, including hydrolysed vegetable protein, MSG (monosodium glutamate, also known as Ve-tsin), yeast extracts and ribonucleides.

Glutamates and non-glutamates

Broadly speaking, a distinction is drawn between flavour enhancers that contain glutamate as their principal active ingredient, such as MSG, and flavour enhancers that are glutamate-free, such as guanylic acid, disodium guanylate and calcium inosinate. The glutamate group consists of: glutamic acid (E620), monosodium glutamate (E621), potassium glutamate (E622), calcium glutamate (E623), ammonium glutamate (E624) and magnesium glutamate (E625). In addition, there are flavour enhancers such as natural yeast extracts and HVP. Although these products do contain glutamate, this is not the principal salt-replacing component, hence this categorisation. Yeast extracts naturally contain both nucleotides and glutamate, which enhance the taste of the ingredients (e.g. salt, cheese, tomato), and consequently the amount of salt can be reduced.
The "non-glutamates" have been allocated E-numbers E626 to E637. This group includes guanylic acid, dipotassium guanylate, inosinic acid and disodium ribonucleotides.
Just like the salt substitutes, flavour enhancers too have their advantages and disadvantages. These will be considered in this chapter, which also contains an incomplete list of commercial flavour enhancers.

2.5.1 Glutamates

Monosodium glutamate is possibly the best-known flavour enhancer on the market. In 2003 no less than 1.5 million tonnes of MSG was produced, 80% of it destined for the Asiatic market [44].
Monosodium glutamate (the mono-sodium salt of glutamic acid) – also known as Ve-tsin – is associated with the umami taste. This fifth taste – alongside sweet , sour, salty and bitter – can be likened to what we describe as savoury, for example, the taste of old cheese. Umami is also sometimes said to have a bouillon-like taste.

Commercial production of monosodium glutamate was started in 1909. Originally, it was manufactured by hydrolyzing natural proteins, such as wheat gluten and soybean flakes. Nowadays, the production of monosodium glutamate is carried out by means of bacterial fermentation. The bacteria (Corynebacterium glutamicus) are grown in a liquid medium containing sugars, molasses or starch as a fermentation substrate. They then synthesise the glutamic acid and excrete it into the medium. Glutamic acid thus accumulates in the medium and is later separated by filtration, purified and converted by neutralisation into monosodium glutamate. After additional purification, crystallisation and drying, the monosodium glutamate powder is ready to use. [45]

Glutamate occurs naturally in various foods such as tomatoes, fermented soya products, old cheese and yeast extract. Monosodium glutamate is increasingly used in meat products (notably sausage), all kinds of savoury snacks, cup-a-soups, etc. Concentrations of monosodium glutamate usually range from 0.1 to 0.8% of the food as it is served [46]. Higher concentrations do not lead to a more intensive taste, but rather have the effect of disturbing the flavour balance of the dish.

Kikkoman soy sauce

Recent research [47] shows glutamate to have major potential as a salt replacer, notably in the form of naturally brewed soy sauce. In this study, which was a collaboration between a team from Wageningen UR and the Japanese producer Kikkoman, soy sauce in powder form was found to be effective in various foods, without affecting the original taste.
Jos Mojet of Wageningen UR was closely involved in the study. "We chose to use a salad dressing, a soup and stir-fried pork. In these products we achieved NaCl reductions of 50, 17 and 29%, respectively." At these values, the study participants did not perceive any difference in taste, texture or odour compared with the standard products, according to Mojet. "In this study we have developed a method that can be used to calculate the optimum rate of exchange at which salt can be replaced with a salt replacer or some other substitute. Further research with repeated consumption should show whether consumer acceptance can also be maintained in the long term or whether it might even be possible to lower the concentration of salt even further through habituation. An additional advantage is the fact that soy sauce in powder form can be used in both dry and wet products. The only disadvantage is the brown colour. This is not a problem in bread or on chips, but a dressing will take on a dark colour similar to that of balsamic vinegar."
Kikkoman is now marketing a less salty soy sauce under the brand name Kikkoman Less Salt.

Chinese restaurant syndrome

The reputation of monosodium glutamate has in the past been tainted by articles suggesting that it might cause health problems such as headaches. Because these symptoms have fairly often occurred after a visit to a Chinese restaurant, they have collectively been designated as "Chinese restaurant syndrome" [48].
There is now a scientific consensus [49] that MSG is not detrimental to health in the quantities that are used by the food industry. Consequently no ADI (acceptable daily intake) has been specified. This does not mean, however, that MSG is accepted unquestioningly by consumers. There is a certain analogy with the case of aspartame, an artificial sweetener which remains controversial despite a scientific consensus. MSG too is the subject of articles [50] posted on the internet which show the flavour enhancer in a bad light. Conversely, however, there are also websites [51] that present a more balanced picture of MSG.
As far as labelling is concerned, producers are required to indicate the presence of MSG by means of its E-number (E621). This applies only to prepackaged food, and not to food served up in restaurants – nor, of course, to those foods and food products that are naturally rich in MSG.

2.5.2. Yeast extracts/HVP

Yeast extracts are rich in glutamic acid, peptides, nucleotides, glutathione, vitamin B, minerals and other flavourings. The taste of yeast extracts varies according to which of the above components have been used. Marmite is a good example of the characteristic taste of yeast extract.

Yeast extract is also an effective salt and flavour enhancer. It naturally contains glutamate and nucleotides, and is principally used in savoury sauces, cheese and soups. Yeast extract can also be used to replace salt in bread. The capacity of yeast extract to replace NaCl is fairly high (40 to 50%).

Like other flavour enhancers, yeast extracts are used in relatively low concentrations (0.25 to 2%). Due to their high solubility and the previously mentioned broad range of flavours, yeast extracts can be used in a wide range of products. Yeast extract can be labelled as such. Yeast extract does contain a certain amount of natural glutamate, but it also contains other components. Although it generally enjoys a good reputation, some consumer groups put yeast extract on a par with MSG and therefore have a negative perception of it.

Hydrolysed vegetable protein (HVP)

HVP (hydrolysed vegetable protein) is obtained by means of a chemical or enzymatic process. HVP, which contains glutamate, has a slightly meaty aftertaste. It also has a flavour-enhancing effect. The taste profile of HVP can vary depending on the level of discolouration, protein source (soy, corn, wheat, canola), added ingredients, and the production and drying process [45].

It is incorporated in numerous products such as dry soups, bouillons, chips and ready meals. HVP is nearly 125 years old. Julius Maggi (the founder of the well-known brand, now owned by Nestlé) invented hydrolysed vegetable protein in 1886 [52].

Just like MSG, HVP has had to contend with bad press. Reports have focused on the fact that it may contain 3-MCPD (a chemical contaminant belonging to the chloropropanol family – see below).

3-MCPD

Initial reports suggested that HVP contained a relatively high dose of this carcinogen [53]. It was noted, however, that other foods (such as breads and smoked products) also contain 3-MCPD, albeit in lower concentrations. At present, there is a European Commission regulatory limit of 0.02 mg/kg for 3-MCPD in food products. Discussions are in progress within the Codex Alimentarius with a view to setting a higher maximum limit of 0.04 mg/kg [54]. Suppliers have now developed methods for minimising levels of this by-product in food.

2.5.3. Non-glutamates

As was stated previously, the second group of flavour enhancers are those that do not contain glutamate and are thus referred to collectively as non-glutamates. These additives are also known as high nucleotide enhancers because they contain a relatively high concentration of these molecules. Furthermore, they have a synergistic effect when combined with other flavour enhancers. For example, nucleotides provide a fuller umami profile in combination with MSG or yeast extracts.

Space constraints prevent us from discussing all 12 types of non-glutamates. Two of these substances – maltol and ethyl maltol – are in any case not relevant because they are sweetening agents. The remainder are, indeed, flavour and/or salt enhancers.

Guanylic acid (E626) [56]
White crystalline substance with flavour-enhancing properties that are many times stronger than those of glutamic acid. In liquid foods it gives the impression of increased viscosity. It is used in imported meat products, canned fish, sauces, canned vegetables, etc.

Inosinic acid (E630) [56]
Crystalline substance with a pleasant, sour taste. The taste perception is intensified 100-fold if a small amount of MSG is added. Inosinic acid is used in soups, spiced minced meat and meat products.

Calcium inosinate, Calcium-5'-inosinate (E633) [56]
Odourless, crystalline substance with a characteristic taste. Calcium inosinate has a synergistic effect when combined with salts of glutamic acid. It is widely used as a substitute for E632 (potassium inosinate) in such products as soups, stock cubes, beef and chicken stock.

2.5.4 The market

As with the salt blends, there are various companies at home and abroad that supply flavour enhancers, some of which are listed below.

Maxarome and Maxarite range (DSM)
Maxarome and Maxarite are two salt-replacement options from DSM Food Specialties for use in culinary (Maxarome) and bakery & dairy products (Maxarite). These two 5'-nucleotide yeast extracts have various functions. In addition to a flavour-enhancing (and therefore salt-reducing) effect, they also provide a umami taste and certain variants are able to provide a fuller mouthfeel (in low-fat applications, for example). Maxarome and Maxarite have the advantage of being clean label additives and consequently they do not require an E-number (see the earlier comments on the labelling of yeast extracts).

According to DSM, these yeast extracts have the capacity to reduce sodium by around 30%. The company even maintains that a 50% reduction is achievable if the products are used in combination with other salts. These claims have also been questioned by Johanneke Busch of Unilever.

HVP (Exter)
There are numerous suppliers of hydrolysed protein, especially in China. One supplier in the Netherlands is Exter (based in Zaandam), which acquired the Heinz HVP business in early 2009. According to Exter, its protein hydrolysate is allergy- and GMO-free.

Amplify (ConAgra)
Amplify is marketed as a salt enhancer that is based on peptide technology and a blend of ingredients that increase salty taste perception, according to SpiceTec, a subsidiary of ConAgra (US). SpiceTec claims that Amplify can reduce the sodium content in products such as soups, meats and snacks by 50% or more. Amplify is also stable at high temperatures and effective over a broad pH range.

SymLife Umami (Symrise)
Alongside SymLife Salt, a salt replacer, the German flavourings manufacturer Symrise also has a umami variant. This additive contains no MSG, yet has the same properties in terms of mouthfeel and taste. The advantage is that SymLife does not have to be labelled as an E-number.

2.6 Physical stimulation of taste receptors

Besides chemical stimulation, taste receptors can also be stimulated physically. It has already been demonstrated in the scientific literature [57, 58] that all senses are geared towards contrasts.

"A good analogy is a flashing light", says Gerrit Smit, Director of Flavour and Consumer Research at Unilever. "People are more likely to notice a flashing light than a constant one. The same applies to taste receptors. If you alternate peaks (in salt concentration, for example) with troughs, then a person will experience the peak more intensely. This means that you can actually produce a similar salt perception with a smaller amount of salt."

Salt pulse

A recent study [59] demonstrates that this mechanism also works with salt. Frequency, timing and differences in concentration are of critical importance here. The shorter and more intense the salt pulse, the greater the effect. "The important thing is that the boundary between the salt peaks and salt troughs is as sharply demarcated as possible", says Harold Bult. "This means that this method works best in solid foods with low water activity. After all, you don't want the salt to start migrating in the product. In processing terms too, it is more practical to introduce the salt into the product in different layers."

Less salty soup

A research group has now actually demonstrated [60] that salt distribution in a liquid matrix (soup) can also lead to increased salt perception. In this study, a soup in which the salt had been dissolved tasted less salty than a soup in which the salt was applied to pieces of chicken. "This method reduces the amount of salt that we need to use by around 15%", says Johanneke Busch. According to Dr Busch, the study participants did not perceive any significant differences in texture between the soup with extra-salty pieces of chicken and the standard soup.

Dutch sausage

The 15% figure given above is merely an indication of the scope that exists for reducing salt without any appreciable loss of flavour. It is, for example, possible to use around 25% less NaCl in meat products without impairing the flavour by distributing salt unevenly, claims Ronald Klont, R&D manager at Vion Food Group. This meat-processing company has now filed a patent application for the uneven distribution of flavourings (i.e. salt, but the principle also works for sweetening agents in other products) in food products .

The proof of concept for this patent has been demonstrated using a special boterhamworst (a Dutch-style smoked sausage made from pork and veal) which contains 2% salt [61]. The salt was not applied uniformly but in alternating "slices" containing 3.5% and 0.5% salt. "People who try this sausage experience less of a "low-salt" taste than with the sausage with a salt content of 2% that has been uniformly distributed", according to Klont. This study, a collaborative project between Vion and the Top Institute for Food and Nutrition (TIFN), is set to enter a new phase. "We have submitted the proof of concept for meat with boterhamworst. Precisely what commercial applications this may have will need to be finalised via an application phase."

2.6.1 Smaller crystals

Another potential way to increase salt perception in a physical manner is by adjusting the size and form of salt crystals. Because salt only works in a solution (such as saliva, for example), increased solubility may help to increase salt perception. According to Harold Bult, around 80% of NaCl disappears undetected by taste receptors in the human body. If you can reduce this percentage through improved bioavailability then you have struck it lucky.

Smaller-sized crystals might serve to enhance solubility [62]. The same applies to the form of the crystal. The larger the surface of a crystal, the quicker it will dissolve. In [45] it is reported that vacuum-granulated dendritic salt, consisting of macroporous crystals, dissolves twice as quickly as standard salt crystals. This principle is only relevant for "dry" product applications, such as chips, snacks and breads.

Saltesse salt substitute, manufactured by Symrise of Germany, is partly based on the principle outlined above. Available both as a table salt and as an industrial salt, Saltesse consists of minuscule salt crystals coated on to potato flakes. According to Matthias Hille, Category Manager at Symrise, Saltesse is capable of reducing salt intake by 50%.

The great advantage of Saltesse is that no taste anomalies occur that might need to be masked. Moreover, the solution is "E-number-free".

A disadvantage of Saltesse is its limited applicability. The product only works in a so-called "topical application", whereby it is applied directly on to the product (as in the case of chips or salty snacks).

2.7 Multisensory approach (cross-modal interaction)

This approach is based on the interaction between the different senses. This mechanism has now been demonstrated in several publications, including a paper by Noble [63]. "These interactions occur every time a food is consumed", says Marcus Stieger (Wageningen UR, TIFN). "Aroma and taste are perceived simultaneously. The other sensory dimensions, such as mouthfeel, sound and vision, are also involved ."

Cross-modal interactions are based on a learned association mechanism. Research [64] shows that expert panellists are able to distinguish between different tastes and aromas, whereas untrained panellists apparently lack this ability.

Congruent aromas

Taste-aroma interactions only work with so-called congruent aromas. If consumers associate particular aromas (bouillon, for example) with salty products, then the principle may apply. By using the right aromas, Unilever has shown that salt can be reduced by around 20% in bouillons and soups while retaining the full flavour profile. Furthermore, it was possible to boost the reduction to over 30% when these aromas were combined with salt substitutes, according to Gerrit Smit.

Surprisingly little research has been done to date on salty taste-aroma interactions, especially when compared with interactions between sweet tastes. There are a few studies [65, 66, 67] that have demonstrated the effect in such food products as cheese and soy sauce.
Relatively little is known as yet about the reductions in NaCl that can be achieved with the aid of cross-modal interactions. Peter de Kok, principal scientist at NIZO, claims that this method may lead to NaCl reductions of up to 50% if it is combined with other tools (KCl, flavour enhancers, etc.).

Herbs and spices

The use of herbs and spices as salt substitutes is not mentioned in the scientific literature. They are used, however, even though the salt-replacing effect is minimal. Kees den Uijl (Euroma) argues that nutmeg, pepper and other spices can, to some extent, compensate for NaCl in certain meat products such as boterhamworst (Dutch sausage). On its website HAK advises consumers to use certain herbs or spices such as nutmeg with French beans and spinach, or rosemary with garden peas and broad beans. "Herbs and spices of this kind can also be used instead of salt to season vegetables", the company adds.

Vion's bacon

NIZO is currently researching the role of characteristic product aromas ("top notes") in salt perception in a collaborative project with Vion and FrieslandCampina [68]. The research is partly subsidised by Food Nutrition Delta.

Vion chose bacon as the model product in this study. With a NaCl content of 3.8%, bacon is one of the saltiest products in the Vion portfolio. NIZO has produced a "bacon bouillon" which is based on Vion's bacon. Due to the bacon aromas, this bouillon has been found to taste saltier than a standard solution to which the same amount of salt has been added.

Milner

Milner cheese is being put under the microscope in the research programme for FrieslandCampina. Researchers are exploring potential avenues for influencing enzyme activity.
Ripening enzymes precipitate the breakdown of proteins into peptides and amino acids. These are then further broken down into aldehydes, acids and sulfur components, which in turn determine the flavour of the cheese. Thus it is possible to influence enzyme activity – and consequently aroma and taste – by adjusting processing parameters. Further research should ultimately culminate in the identification of the key aroma compounds in Milner cheese.
The advantage of using aromas that are naturally inherent in a product is that manufacturers are not required to declare these separately on the label. A disadvantage is that it is time-consuming – and therefore costly – to identify characteristic product aromas that stimulate salt perception. There are, however, tools that allow for rapid screening. For example, NIZO has developed a system known as the MicroCheese model which can make and screen "mini-cheeses" [69].

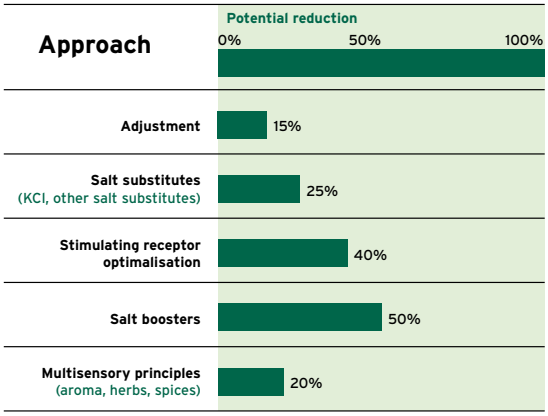
Proson Taste

Sonneveld's Proson Taste [70] "character influencer" is based on cross-modal interaction. "Proson contains natural bread aromas, aldehydes, which we have encapsulated in fat", explains I&D manager Peter Weegels. Due to the encapsulation process the aldehydes take longer to evaporate during the baking process and the subsequent storage period, according to Weegels.

Sonneveld claims that by adding 1% Proson Taste it is possible to reduce the amount of salt in a bread recipe by 50% without this reduction being detrimental to the flavour and texture of the bread. "Only trained panellists can taste the difference", according to Weegels. "The average consumer will not notice any difference."

Flavour enhancers have greatest potential

Of all the currently available means of sodium reduction, flavour enhancers have the greatest potential (50% less NaCl), followed by salt substitutes, the stimulation of taste receptors and reduction without substitution.
Much is expected of salt boosters, which are specific components that influence salt perception. Research into these boosters is still in its infancy.



Source: Unilever

Marketing salt reduction

Marketing salt reduction is no easy matter. Whereas claims like "Less Fat" or "Less Sugar" still attract the attention of the consumer, "Less Salt" would appear at present to be a less commercial proposition. We can assume that most manufacturers reduce the salt content of their products "secretly". The 12% reduction that the FNLI has pledged to achieve in 2010 is, in the majority of cases, attainable simply by reducing the NaCl content.

Nutrition Enhancement Programme

Unilever, with its Nutrition Enhancement Programme [71], has in the past few years removed substantial amounts of salt – and fat (saturated) and sugar – from its product portfolio. The multinational does not explicitly mention this to the consumer, however, although it has invited the press to take a closer look at this initiative. In addition, it uses the 'Ik kies bewust' ("I am making an informed choice") logo to inform the consumer – more implicitly – about salt reduction.

As mentioned previously, HAK has created a website to inform consumers about the steps it has taken to reduce salt in canned vegetables. The manufacturer emphasises the flavour of its products ("Less salt, pure flavour").

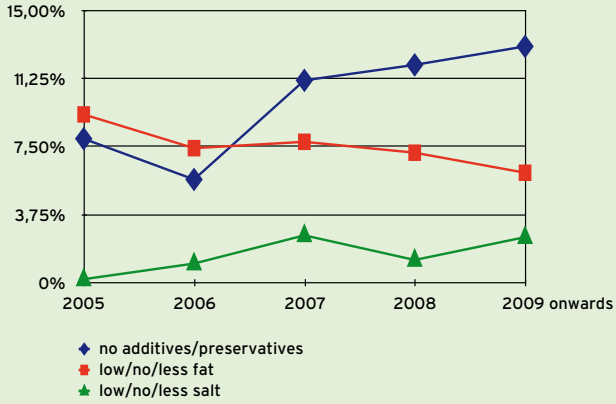
There are, however, manufacturers that explicitly state on the label that their product contains less salt. FrieslandCampina has even added this message to one of its brand names (see the next paragraph).

Milner Minder Zout

In 2007 FrieslandCampina launched a reduced-salt cheese, Milner Minder Zout [(Milner less salt), [72], on the market. This mild cheese contains 30% less salt and tastes "just as deliciously full-flavoured as normal Milner", according to the company.

But FrieslandCampina is in the minority. According to data published by Innova Market Insights for the period from 2007 to 2009, the number of product introductions in Europe with a low-salt claim fluctuated around 1.5%. This is a somewhat different to products that claim to contain "no additives/ preservatives", a category which experienced substantial growth over a five-year period. In the Netherlands the proportion of product introductions with a low-salt claim rose from 1.7% in 2007 to 3.0% in 2009.

Product introductions in the Netherlands: specific claims as a percentage of the total number of introductions



The number of salt claims fluctuates over time, with peaks of 3% in 2007 and 2009. The general trend is upwards.

Source: Innova Market Insights

In the Netherlands the picture with regard to products with less-salt claims is rather more favourable. Whereas in 2005 there was barely a single product on the market, by 2009 the proportion of such products had risen to just over 2%.

"Salt higher on the agenda"

"Despite the fact that it is still a controversial topic, salt reduction is a key objective of government policy – and industry is responding to this challenge", says analyst Lu Ann Williams of Innova Market Insights. "We can expect to see many innovative reduced-salt products in the coming months.'

Growth in the US

Whereas in Europe the growth in products with salt claims is still lagging behind products with other claims, this category is experiencing a boom in the United States [73]. A third of all products with a salt claim that were recorded by Innova Market Insights in 2009 had been launched on the American market. The company recorded 714 new products with a "low sodium claim" in the US in 2009 (compared with 603 products in 2008 and 364 in 2007). In Europe, 301 new less-salt products emerged in 2009 – a modest increase compared with the 291 new products that appeared in 2008. The biggest market categories for less-salt products were flavourings (65), breakfast cereals (63), soups (31) and breads (27).

"Reductions in product salt content happen far more often than the consumer might think", according to Williams. "Many consumers associate less salt with less taste. Some manufacturers (including Unilever) lower the salt content of their products gradually, without too much publicity. That way they limit the risk of customers switching to a rival brand."

Salt claims

Another, not insignificant, reason is that products with salt-reduction claims [74] must satisfy certain conditions.

The claim "low sodium/salt content" is only permitted if the product contains no more than 0.12 gram of sodium per 100 grams. Products with a "very low sodium/salt content" must not contain more than 0.04 gram of sodium per 100 grams.

For the record, a product may only bear a "sodium-free/no salt" label if it contains no more than 0.005 gram of sodium per 100 grams. Comparative claims, such as "lower than a comparable product", are possible, but the difference in salt content must then be at least 25%.

Health marking

Health marks – and in particular "Ik Kies Bewust" and Albert Heijn's "Gezonde Keuze Klavertje" – also include criteria with regard to sodium content [75, 76]. These criteria, expressed in milligrams per 100 grams or milligrams per kcal, vary from one product category to another. These variations relate to such aspects as functionality (bread) and shelf-life (meat products).

In 2007 the Stichting Ik Kies Bewust (Dutch Choices Foundation) had already set the "salt bar" higher [77] for certain product categories, such as soups. A further reduction is anticipated for other product categories such as main-course meals and bread.

Needless to say, more stringent sodium standards serve as an incentive for manufacturers of well-known brands and private label suppliers to reduce the sodium content of their products.

The management of salt reduction

The way in which salt reduction is handled is at least as important as the technology, if not more so. After all, you cannot solve a salt problem by leaving it entirely to the discretion of the private sector. "Companies will then be constrained by the fear that competitors may not reduce the sodium content of their products. Clearly, there can be no sound business case for investing in healthier products and then losing market share", points out Marianne Geleijnse (WUR).

Keeping everyone on board

It comes as no surprise that Geleijnse, who is also a member of WASH (World Action on Salt & Health), advocates an integrated approach that reduces the risk of some producers "jumping ship". "Salt reduction, or to be more precise a gradual reduction in salt whereby the NaCl content is slowly scaled back, is most effective if every manufacturer joins in. Salt is an acquired taste. In order to allow consumers to get used to a less salty taste, salt reduction must take place across the board."

No industry-wide agreement has been reached in the Netherlands , despite pressure from the Dutch Consumer Association. Dutch Minister of Health Ab Klink has stated that salt reduction must be regulated by the food industry [78].

FNLI action plan

This is precisely what is being done in the Netherlands. The Federation of the Dutch Food Industry (FNLI) unveiled an action plan in 2008 which set the goal of reducing salt by 12% in 2010 (compared with the situation portrayed in the Netherlands Nutrient Databank (NEVO) table for 2006) [79]. The FNLI's Christine Grit explains that interim monitoring, which will be conducted by the relevant industry organisations, has yet to take place. It is still too early to say what progress has been made. The results are expected to be unveiled in May-June.

Sector-by-sector approach

Various sectors have now launched "joined-up" initiatives aimed at reducing salt levels in food. For example, TNO (the Organisation for Applied Research), acting on behalf of the Product Board for Livestock and Meat (PVV), has investigated whether it is possible to reduce the salt content of bacon.

This year TNO has concluded an agreement with the VBZ (Dutch Biscuit, Chocolate and Confectionery Association) whereby the research organisation will over the next two years provide knowledge and solutions designed to reduce salt levels in this sector.

Within the Dutch Dairy Organisation (NZO) a working group is investigating salt reduction in semi-hard cheeses. This group includes representatives of the foremost cheese-makers in the Netherlands. Their goal is a 15% reduction in 2010. Then they will consider whether a further reduction, in terms of shelf-life, texture and taste, is achievable.

The Consumer Association, which had earlier declared itself in favour of such an agreement, published a study in 2009 showing that salt levels in food had, if anything, increased rather than decreased since a survey conducted in 2007 [80].
The above exercise should be viewed in light of the fact that the Consumer Association was, in 2007, measuring NaCl per 100 grams, whereas by 2009 measurements were being conducted on a per-portion basis. This makes a direct comparison exceedingly difficult, unless the portion size is defined in grams. According to the Consumer Association, the two surveys have, in fact, been harmonised and consequently the picture has not been distorted.
Ultimately, a repetition of both the RIVM survey and the FNLI monitoring programme will be required in order to provide a definitive answer. This will take place in 2010 in collaboration with the industry organisations.
Be that as it may, the Ministry of Health wants the food industry to resolve the problem itself. We shall discovered in the course of 2010 whether industry has, in fact, reduced the salt content of its food products by 12%. The FNLI, for its part, has already indicated that it will embark on phase two of its programme after 2010. It hopes that this will achieve an average reduction of 20 to 30%. The deadline for this second phase is not yet known. In actual fact, the stated target is somewhat conservative. Emmo Meijer, who chairs the Food Nutrition Delta steering committee, indicated in 2008 that 40% is not beyond the realms of possibility.

Finland leads the way

A review of the situation abroad reveals that other countries have made more progress in this area. Finland has been engaged in efforts to curb sodium consumption ever since the 1970s [81]. The government opted for an integrated approach, which has seen government, industry and the medical profession working together on this problem.
Salt labelling has been compulsory in Finland since the 1980s. If a product contains more sodium than the prescribed limit then a warning must be placed on the label. If the product contains less salt than the limit, it can bear a "low-salt" label. Research [82] shows that salt intake in Finland has been cut by a third in the past 30 years. Partly as a result of this, the mortality rate from cardiovascular disease has fallen by 75-80%.
The WASH website provides an international overview of action plans that are in place in different countries. This underlines the wide range of approaches that are being adopted.
Given the globalisation of the food industry, a pan-European – or even global – approach would appear to be advisable.

Conclusion

The trend towards less salt (especially the sodium component) in processed food will continue unabated. The Netherlands has opted for a moderate approach whereby the food industry must itself tackle the problem. Ultimately, the food industry will have to cut the salt that is added to its food products by at least a third. It is not yet clear by when this will need to happen.

Companies whose business is predominantly export-based will have to keep a close eye on developments in key export markets. Salt is particularly high on the social agenda in the United Kingdom.

Patience

Fortunately there are various strategies that manufacturers can adopt in order to lower salt content. The simplest is to gradually reduce NaCl levels. The disadvantage of this approach lies in the fact that it is time-consuming. Moreover, it is questionable whether consumer organisations and politicians can show the necessary patience. Other salt blends may be effective, but they frequently give rise to taste anomalies. However, it may be possible to offset these (at least in part) by adding other components.

Flavour enhancers also have salt-reducing potential. Although taste anomalies are less common in this group, these products do have certain disadvantages, such as a somewhat compromised reputation (even though this is not necessarily warranted).

Physical stimulation and a multisensory approach are interesting options, largely because they are based on generally valid principles. Moreover, these options do not make use of all kinds of substitutes that are associated with extra costs or "side effects".

Marketing difficult

The task of marketing salt reduction is still fraught with difficulties, particularly when compared with other propositions. Salt is not currently high on the consumer agenda. Furthermore, there is a chance that consumers may associate less-salt claims with a reduced, bland flavour. In addition, salt reduction is a more costly option. Salt is so cheap that any alternative, except for simply using less salt, is more expensive.

Health marks, such as "Ik Kies Bewust" and Albert Heijn's "Gezonde Keuze Klavertje", undoubtedly impose certain requirements as regards NaCl content. It is anticipated that these standards will be made more rigorous in due course.

Corporate social responsibility is another factor to be considered. This applies particularly in the case of large companies, which are usually the first to come under the scrutiny of NGOs. Companies will need to ask themselves how they can lower salt content so that their products promote public health.

Finland

When all is said and done, the way in which salt reduction is managed is a critical success factor in the battle against salt. Each country is making its own choices in this regard. Finland is the country that has gathered the most experience when it comes to lowering salt intake. The Finns have demonstrated that an integrated approach, whereby government, industry, the healthcare sector and NGOs join forces, pays dividends.

That does not mean, however, that other approaches are necessarily less effective. Whereas the "bad" news is that salt reduction is a "long-haul" problem, the good news is that salt is an acquired taste, i.e. it is also a habit that can be kicked.

Appendix I

A visit to the supermarket

A sample survey conducted at a supermarket (in this case a Plus store in Wageningen) reveals that salt is a topic about which very little is said by the companies. But this does not mean that there is no lowering of salt levels within product ranges. As was indicated earlier in this report, the food industry is not allowed to say anything about these initiatives unless a substantial reduction has been achieved.

There is not a single meat product for which efforts to reduce salt have been publicised. Such phrases as "without artificial aroma and flavourings" and "without added sugars" have, however, been bandied about.

As far as cheese products are concerned, there is one well-known brand (Milner) with a lower-salt variant. This product is copied by the private labels.

One area in which attention is being focused on low-salt products, however, is health food. The products involved include Dutch ginger cake, treacle waffles and other cakes, vegetable bouillon and herbal salt.

Appendix II

Comparison of the nutritive value of standard products with lower-salt products. A direct comparison of such products with their less salty counterparts reveals that the latter contain more calories. An exception is the Milner cheese, which contains both less salt and less fat than a Gouda 48+ cheese.

Example 1: Aromat flavour enhancer

Nutritive value per 100 g product	**Standard product:**	**Lower-salt product:**	**Difference:**
	Aromat flavour enhancer	**Aromat lower-salt flavour enhancer**	
Kcal	170	310	140
Protein (g)	9,9	20	10,1
Carbohydrates (g)	25	45	20
Sugars (g)	15	34	19
Fat (g)	3,9	4,2	0,3
Saturated fat (g)	1,3	1,3	0
Unsaturated fat (g)	2,6	2,5	-0,1
Sodium (g)	23,6	0,06	-23,54
Potassium (g)	0	11	11

Ingredients:

Aromat flavour enhancer:
Ingredients: Salt, flavour enhancers (E621, E627, E631), lactose, starch, hardened vegetable fat, onion, spices, aroma (with celery), garlic, maltodextrin, onion extract, mushroom extract.

Aromat lower-salt flavour enhancer:
Ingredients: lactose, flavour enhancer (E623, E622), potassium chloride, yeast, onion, citric acid (E336, E330, E334), hardened vegetable fat, garlic, spices, herbs, onion extract, mushroom extract, aromas (with celery).

Example 2: Opkikker groentefit versus Cup-a-Soup

Nutritive value per 100 ml	Standard product:	Lower-salt product:	Difference:
	Mushroom Cup-a-Soup (per 100ml)	Knorr groentefit forest mushrooms (per 100ml)	
Kcal	40	27	13
Protein (g)	0,8	0,7	-0,1
Carbohydrates (g)	4,5	5,1	0,6
Sugars (g)	0,7	0,9	0,2
Fat (g)	2	0,4	-1,6
Saturated fat (g)	0,9	0,2	0,7
Dietary fibre (g)	0,1	0,4	0,3
Sodium (g)	0,32	0,27	-0,05

Ingredients:

Mushroom Cup-a-Soup:
Ingredients: potato starch, vegetable fat, malto-dextrin, 13% croutons (wheat flour, vegetable fat, vegetable oil, yeast, salt, herb extract), salt, lactose, 5% mushroom extract, aroma (contains soy), yeast extract, glucose syrup, cream, whey proteins, milk proteins, wheat flour, skimmed milk, mushroom 0.5%, celery.

Knorr groentefit forest mushrooms:
Potato starch, dried onions, boletus mushrooms (3.7%), mushrooms (2%), mushroom extract, skimmed milk powder, salt, cream powder, yeast extract, vegetable oil, garlic, inulin, parsley, acerola berry extract aromas, chives, turmeric, pepper and thyme extract.

Example 3: Wholemeal bread versus low-sodium bread

Nutritive value per 100 g product	Standard product:	Lower-salt product:	Difference:
	Wholemeal bread	Becel low-sodium bread (wholemeal)	
Kcal	233	240	7
Protein (g)	8,4		
Carbohydrates (g)	43,5	37	-6,5
Sugars (g)	1,5		
Fat (g)	2,6	5,3	2,7
Saturated fat (g)	0,5	0,8	0,3
Unsaturated fat (g)	1,7	4,5	
Dietary fibre (g)	6,9	8	1,1
Sodium (g)	0,38	0,29	0,09
Potassium	270		

Ingredients:

Low-salt bread:
Wholemeal flour, water, linseed, wheat gluten, sunflower seeds, yeast, oat flakes, rice grits, malted barley flour, iodised salt, wheat middlings, potassium chloride, vegetable oil, malted barley extract, lupin flour, caramelised sugar, poppy seed, sourdough powder, emulsifiers E482 and E472e, sugar.

Wholemeal bread:
Wholemeal wheat flour, water, wheat gluten, baking yeast, sourdough (water, wheat flour, sourdough culture), baking salt, vegetable oil (palm, turnip), barley, malt extract, dextrose, emulsifiers E471, E472e, enzymes (wheat), malted wheat flour, malted wheat meal, turmeric extract

Example 4: Gouda 48+ cheese versus Milner less salt

Nutritive value per 100 g product	Standard product:	Lower-salt product:	Difference:
	Gouda cheese 48+	Milner less salt	
Kcal	390	283	-107
Protein (g)	25,5	29,6	4,1
Carbohydrates (g)	0	0	0
Sugars (g)	0	0	0
Fat (g)	32,5	18,3	-14,2
Saturated fat (g)	20	12,1	-7,9
Unsaturated fat (g)	11,5	6,2	-5,3
Dietary fibre (g)	0	0	0
Sodium (g)	0,87	0,51	-0,36
Potassium	80		

Ingredients:

Milner 30+ less salt:
Pasteurised half-fat milk, salt, rennet, preservative E251, colour E160 b.

Gouda 48+:
Milk, salt, rennet, colour: annatto.

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