Company Name: Food and Drink Federation (FDF) and British Retail Consortium (BRC)

Project Name: Evaluation of Technological Approaches to Salt Reduction

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Executive Summary

The Food and Drink Federation (FDF) and British Retail Consortium (BRC) have identified eight product categories that present significant challenges in meeting 2012 Responsibility Deal salt targets. These are: meat and meat products; bread particularly specialty and morning goods; cheese particularly cheddar and soft cheeses; extruded and pelleted snacks; cakes, pastries and fruit pies; pesto and other thick sauces; all other puddings and canned fish.

The challenges in reducing salt are different in each product category and the multiple functions of salt in each application need to be considered when reducing salt, e.g. taste, technical function, extending shelf life (and therefore reducing food waste) as well as the role of salt in food safety.

This report has reviewed current options for salt reduction and identified new and emerging technologies and ingredients that may be utilised. It has reviewed each technology and ingredient and highlighted both beneficial attributes and limitations in use.

The current options have been provided as these may be useful to companies who are just starting their salt reduction work. The emerging technologies and ingredients may help companies who have exhausted the use of current options, but their effectiveness will need assessing on an individual product basis. The future research highlights how salt reduction work is still an active field, however these solutions may not be available for some time.

Ingredients identified in this review that may be used to help further reduce salt are based on mineral salts, flavour enhancers and/or combinations of these ingredients together. Any additional ingredients will need to be considered in the context of consumer acceptability and clean label policies, as well as the impact on shelf life/food safety.

Many of the potential ingredients solutions identified contain potassium salts. However, there is clear and consistent advice from the Food Standards Agency (FSA) and the Department of Health (DH) not to use potassium based salt replacement ingredients.
Potential technologies for salt reduction have been identified that are based on restructuring of salt crystals and/or repositioning of salt in food matrices. These technologies offer the advantage of reducing salt level with no impact on product labelling. In the future, this may include nano technologies, although these may be subject to specific authorisation procedures in common with other new technologies.

In some cases, ingredients and technologies are being used successfully in commercial products that meet the 2012 targets. However, this does not necessarily mean they are suitable for all products within that category. It cannot be assumed that technologies can simply be transferred between different products even when within the same food category. Each manufacturer will need to verify solutions for their product formulation and processing conditions and assess impact on flavour profile, product safety and shelf-life.

There is often a significant lead time to market in developing salt reduction solutions. Some of the solutions currently under development may not be commercially available for some time.

There appears to be a lack of clarity amongst ingredient manufacturers around the need to conduct shelf life and/or microbiological challenge trials to determine the safety and stability of a new product formulation containing new salt reduction ingredients. Often work will have to be undertaken collaboratively with a specific manufacturer, after initial work has been undertaken. Lack of industry-wide guidelines advising on the nature and level of food safety and shelf life work required is thought to be the main reason for such lack of clarity.
Recommendations

In order to facilitate further salt reduction the following recommendations have been reached based on an assessment of current difficulties in implementing identified solutions:

1. DH should review their advice against using potassium based solutions, and consider if there are specific applications, for example raising agents, or food categories for which the use of potassium may be appropriate.

2. Some new technologies identified might require EU approval, for example novel foods, nanotechnologies. Industry bodies should work with appropriate government departments to ensure there is widespread awareness and knowledge of the process an ingredient or technology would need to undergo.

3. It is recommended that industry bodies and the FSA work together to produce simple guidance on minimum food safety requirements that ingredient manufacturers should meet prior to marketing products.
Background

Since 2005, when the Food Standards Agency started developing a salt reduction strategy, manufacturers and retailers have been fully supportive of the drive to reduce salt consumption in the population. This support has been recently demonstrated by industry taking an active part in the Secretary of State’s Responsibility Deal on Public Health. Companies have made the following commitment:

"We commit to the salt targets for the end of 2012 agreed by the Responsibility Deal, which collectively will deliver a further 15% reduction on 2010 targets. For some products this will require acceptable technical solutions which we are working to achieve. These targets will give a total salt reduction of nearly 1g per person per day compared to 2007 levels in food. We recognise that achieving the public health goal of consuming no more than 6g of salt per person per day will necessitate action across the whole industry, Government, NGOs and individuals".

The wording of the pledge reflects the fact that after years of using different techniques to reduce the levels of salt in foods, in some food categories further reducing salt with the currently available approaches will lead to an adverse impact on flavour and adverse affects on food safety. For some products, lower salt levels mean a shorter shelf life which will lead to increased food waste. In other products salt performs an important technological function and to date appropriate alternatives have not been found.

The pledge acknowledges that new technological solutions are required in order to be able to meet some of the Responsibility Deal 2012 salt targets. To help find those new solutions retailers and manufacturers through BRC and FDF commissioned this report to investigate ways to reduce salt concentration in foods. This review aims to give a comprehensive list of emerging technological solutions and a critical evaluation of which products these may be useful for and identification of any knowledge gaps. In this report Leatherhead Food Research outlines potential technical solutions and assesses each for its impact on salt reduction and likely effects on other product attributes such as consumer acceptability, product shelf-life and functionality.

The key categories identified by the FDF and BRC as presenting a significant challenge in meeting the FSA 2012 targets are outlined below.
In the following section, particular emphasis is given to the technological functions of salt over and above its use as a flavouring in the given application. Articles on salt reduction sometimes refer to salt levels and sometimes refer to sodium levels. For consistency, the term “salt” is used in this report. Salt (NaCl) consists of 40% sodium and 60% chloride with 2.5g salt being equivalent to 1g sodium.

**Meat and meat products**

This product category is very diverse, containing bacon, ham and other cured meats, sausages, meat pies, cooked uncured meat, reformed whole muscle, comminuted or chopped reformed products, burger and grill steaks and frankfurters, hotdogs and burgers. In addition it contains some products that are PDOs which limits the potential to reformulate due to their protected status e.g. Prosciutto di Parma.

Salt plays a crucial role in the preservation and microbiological safety of meat products. As a preservative salt reduces the water activity and prevents the growth of food poisoning and spoilage organisms. A reduction in salt levels therefore may lead to a reduction in shelf-life and therefore a potential increase in food waste.

Pilot trials within food industry companies on various products within this category have shown that reducing salt results in the exponential growth of pathogens which could impact on food safety. Consequently there would be a requirement to reduce the shelf-life on these products, which could impact on food waste. Reducing salt can also lead to a greening effect which would not be acceptable to consumers (Grant et al, 1988). This
effect has been observed by a number of companies running trials on reduced salt cured meat products.

To ensure the quality and safety of reduced salt meat products it might be necessary to add other antimicrobial compounds. For example products such as potassium lactate and sodium diacetate have been shown to be effective in maintaining microbial shelf-life in products where salt has been reduced by up to 40% (Devlieghere et al, 2009). However this is not a practice which is currently widely used in the UK due to taste and consumer acceptability.

It should also be considered that the European Commission has already reduced the permitted levels of nitrite and nitrate in meat products and is currently looking at potentially reducing them further. Since a combination of salt and nitrites/nitrates is commonly used for preservation of meat products, any reduction in the quantity of nitrates in these products will result in a greater reliance on the preservative effect of salt.

Salt is important to both the taste and aroma of meat products for several reasons. Firstly the sodium in salt binds to protein receptors and imparts the salty taste that consumers are familiar with. Secondly sodium enhances some of the natural flavours present in meat such as savoury and meaty notes. Salt is also effective at releasing volatile aroma compounds from the food matrix, therefore improving the aroma of the product. Salt effectively changes the osmotic pressure in a given product and makes the volatile aroma compounds less soluble in the food matrix. Hence these volatile compounds are more easily released into the atmosphere as an aroma.

In terms of the flavour, it could be argued that the main challenge in reducing salt in meat products is not in fact the reduction in saltiness itself but the loss of impact on enhancing the meaty and savoury flavours in the product.

A further technical challenge is that salt also interacts with meat proteins, in particular the myofibrillar proteins which are then extracted and enabled to bind water which is retained within the meat product. Therefore reducing salt in meat products may lead to products that are different texturally as well as in terms of their flavour profile.
Bread and rolls with additions and morning goods

The main challenge in making low salt bread is that it becomes sticky and is less easy to process with lowering salt levels, meaning that there is a potential for the sticky dough to stop processing lines, leading to down time and wastage (Speirs et al, 2009).

The rheological properties of dough are dependent on the concentration of salt. A very low usage rate effectively weakens the gluten which makes the dough sticky.

The additional functions of salt in bread are stabilizing the yeast fermentation rate, and enhancing the flavour of the finished product. It also impacts on the finished product crust colour and has an impact of the product volume (Gelsinov, 2012).

In morning goods the sodium comes from salt, sodium bicarbonate and leavening acid. All these sources need to be taken into account when reducing overall sodium levels, although the major contributors to sodium content are the salt and the sodium bicarbonate. Therefore in considering salt reduction, there are two challenges, replacing both the sodium chloride and the sodium bicarbonate.

Cheese particularly soft cheeses and cheddar

The cheese category is very large and covers a diverse product range which includes some PDOs which limits the potential to reformulated e.g. Camembert de Normandie and Feta. In addition it should be considered that a number of products are imported from countries which may not be following the same salt reduction programme as the UK.

In addition to supplying flavour, salt performs many functions in cheese (Rowney et al, 2004). The concentration and distribution of salt in cheese has a major influence on various aspects of cheese quality (Fox et al 2000) including texture (Kaya, 2002), modifying the water–binding capacity of casein within the cheese matrix (Pastorino et al, 2003) and apparent viscosity (Floury et al, 2009). Salt also controls the growth of lactic acid bacteria as well as preventing undesirable microbial growth. Salt replacement affects the casein micelles and the sodium and phosphorus equilibrium.

The perception of saltiness may also be impacted by the fat level in the cheese. It has been demonstrated that reducing salt levels has an impact on aroma release particularly in low fat products. Therefore formulating cheese with both reduced salt and reduced fat presents an even larger challenge than reducing salt alone (Saint-Eve et al 2009).
**Extruded and pelleted snacks**

Salt in snacks is important in the overall flavour profile since it not only adds flavour in itself but also enhances many of the other flavourings used. It also acts a carrier for the uniform distribution of other ingredients such as flavours, colours and antioxidants on the surface of the snacks.

The main focus of salt reduction of snacks has been to reduce the surface salt, but the further reductions originally outlined by the FSA may require reduction of salts in the snack matrix itself where it can have important processing and textural benefits. In extruded snacks salt regulates the expansion and to this end it is included in the dough matrix before expansion. Lowering salt content in the base dough can result in poor expansion and unacceptable product texture although it has been reported that using starch with high amyllopectin content in the dough base, can aid adequate expansion when salt levels are reduced in the dough base (De Vries, 2008).

**Cakes, pastries and fruit pies**

In sweet baked goods the sodium comes from salt, sodium bicarbonate and leavening acid. All these sources of sodium need to be taken into account when reducing overall sodium levels with salt and sodium bicarbonate being the major contributors.

**Pesto and other thick sauces**

Pesto itself contains parmesan and / or other hard cheeses as a primary ingredient and this is a key source of salt. Parmesan is a PDO which limits the potential for these products to be reformulated.

In order to achieve the correct consistency thick sauces often contain additional thickeners. It has been reported that the suppression of flavour including saltiness by a wide range of thickeners is concentration dependent (Baines, 1987). For example it has been found that for Hydroxypropyl methyl cellulose (HPMC) thickened products a considerable decrease in perception is detected for both flavour and saltiness with increasing viscosity. Therefore higher levels of salt are required in high viscosity products to maximize taste compared to less viscous products.
All other puddings

This category includes processed and pre-prepared puddings that are not included in other specific categories. It includes products such as bread and butter pudding, brownie desserts, crumbles and trifles but excludes fruit pies and all other desserts made with shortcrust and choux pastry.

In these products salt is often found in the individual ingredients such as bread or biscuit bases. Any added salt has the main purpose of flavouring and enhancement of other flavours present in the product formulation.

Canned fish

Salt in canned fish occurs primarily in canned salmon and canned tuna in brine. Since most of the canned fish available in the UK is sourced from overseas canneries, it must be recognised that the salt levels within these products are largely within their control and any reduction depends largely on influencing these overseas canneries. In addition all canned tuna is frozen in brine before it is put in oil, water or more brine. This is a preservative practice which is quite unique to tuna and so in this instance salt is present as a preservative as well as for flavour.

Sodium chloride is commonly added to thermally processed fish products where it acts as a flavour enhancer. Salt addition also impacts on cook yield, texture and lipid oxidation (Baublits et al, 2006, Gallart et al, 2007, and Jittinandana et al, 2002). It has been demonstrated that 1.5% salt reduces cook loss of canned pink salmon by 15.4% and area shrinkage by 24.6%. Product with added salt is also more tender and a reduction in salt levels can be expected to result in a firmer product that may be noticeably different to the consumer (Kong et al, 2008).
### Approach

The project was completed by conducting both a literature review and an on-line industry survey. Both of these sources of information were used to identify current technologies for salt reduction. In addition a series of telephone interviews were carried out with companies and research organisations willing to provide information and this identified potentially new ingredients and technologies and ongoing research projects of interest that are discussed later in this report. This approach is summarized below.

![Diagram of Approach]

#### Literature Review

Leatherhead database (Foodline Web) of peer-reviewed literature, technical reports and patents was searched for information relevant to the report. The database includes 1000 international journals, 2000 book chapters per year as well as standards, government papers and technical reports, EP, British and PCT patent applications and US and Japanese granted patents. This database was searched for information pertinent to the project and full search strategy is outlined in Appendix 1a.
As a result some 740 papers, patents and news articles were reviewed. These served as a source of up to date information on current technologies for salt reduction as well as highlighting current research projects and potential technological solutions. Several companies and research organizations were then contacted for further discussions and all contributors are listed.

**Design of industry survey**

Leatherhead conducted an on-line survey of food and drink ingredients suppliers (i.e. suppliers of preservatives, flavours, flavour enhancers etc.) to identify new and emerging salt reduction solutions. The survey was sent to a total of 2,074 individual contacts (R&D, Marketing and NPD roles) from 297 global companies and was open for ten weeks from February to April 2012. A total of 119 responses were collected providing a response rate of 6%. Further details are below:

<table>
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<tr>
<th>Survey Title:</th>
<th>Technological approaches to salt reduction</th>
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<tr>
<td>Purpose:</td>
<td>To identify new and emerging salt reduction solutions.</td>
</tr>
<tr>
<td>Survey design:</td>
<td>Leatherhead designed the survey and approved by the FDF/BRC Steering Committee. A pilot survey was conducted March 2012.</td>
</tr>
<tr>
<td>Survey type:</td>
<td>Online. Respondents filled in themselves with no additional support. Answers are self-declared. Email sent to respondents with link to survey. Several reminder emails were sent whilst the survey was open.</td>
</tr>
<tr>
<td>Question types:</td>
<td>7 questions. Mix of open and closed questions.</td>
</tr>
<tr>
<td>Timing:</td>
<td>Should take respondents no more than 15 minutes to complete.</td>
</tr>
<tr>
<td>Population and response:</td>
<td>Total 2,074</td>
</tr>
<tr>
<td>Population description:</td>
<td>Contacts were primarily sourced from Leatherhead’s Goldmine database. Wider research was conducted to identify companies of relevance not currently in the database. <strong>Selection Criteria:</strong></td>
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<tr>
<td></td>
<td>• Food and drink ingredients suppliers*.</td>
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<tr>
<td></td>
<td>o Selected on the basis that the company’s product portfolio includes on (or more) of the following: preservatives, flavours, flavour enhancers.</td>
</tr>
<tr>
<td></td>
<td>• Job role.</td>
</tr>
<tr>
<td></td>
<td>o Contacts with a R&amp;D, NPD, and Marketing role were selected.</td>
</tr>
<tr>
<td></td>
<td>No discrimination was made as to company size and/or geographic location.</td>
</tr>
<tr>
<td>Confidentiality:</td>
<td>Respondents were assured that individual responses and comments would not be made publically available to encourage participation. Respondents were assured survey responses would be reported in summary format.</td>
</tr>
<tr>
<td>Contact Page:</td>
<td>Respondents were asked to volunteer contact details to enable Leatherhead to contact them upon completion of the survey to obtain further information about salt reduction solutions. 14 contacts provided their details and were subsequently contacted via telephone.</td>
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Full details of the survey can be found in appendix 1b.
Current Options for Salt Reduction

Summary

There are a number of approaches to salt reduction that are currently being used successfully including:

- Small step reduction
- Increased use of spices
- Use of mineral salts
- Use of phosphates
- Use of taste enhancers

Each of these solutions is outlined below.

Small step reduction

Preference for salt has a strong environmental component and does not appear to be hereditary, so will therefore be dictated by the salt concentration of the foods we consume (Wise et al 2007). Studies have shown that preference for salty foods is flexible with repeated exposure to lower salt foods shifting preference towards these foods (Girgis 2003). Evidence therefore suggests the slow and gradual reduction of salt from a formulation can go unnoticed by consumers as the palate adjusts to the revised sensory profile if changes are small enough and across foods within a product category, and possible more broadly across all foods.

This approach is sometimes referred to as small step reduction and when gradually continued over time, large reductions can be achieved. This approach has already been widely adopted by the food industry and significant reductions have been achieved in many cases in addition to modifying the taste expectations and perception of the population as a whole over time.

Current position

This approach has already been widely adopted by the food industry and a level will almost inevitably be reached below which loss in appealing flavour will be noticed by consumers. Therefore this approach on its own is unlikely to deliver the public health requirement. In addition, for companies who have not already embarked on this process
where there may still be significant reductions in salt content that can be achieved, by its
nature this process will not deliver results in a short timeframe.

**Increase spices**

By careful reformulation of products and use of highly flavoured spices, products can be
reformulated with lower salt levels. This is often a preferred approach over using mineral
salts as it results in a cleaner label product. A number of companies have adopted this
approach and it is particularly successful in products such as sauces.

**Current position**

This approach is only suited to products that lend themselves to flavouring with spices
such as soups, sauces and ready meals but is not suited to applications such as cheese
and bread.

**Use of mineral salts: - KCl**

Potassium chloride (KCl) is the most popular choice as a feasible salt replacer
(Murphy, 1981, Klaauw, 1995). It has been shown that potassium chloride has an
equivalent antimicrobial effect on typical pathogenic bacterial species (Bidlas, 2008). Its
acceptability is, however, limited due to its pronounced bitter, chemical, metallic taste
and aftertaste. Sodium reduction obtained by simply substituting a proportion of the
sodium chloride with potassium chloride is the easiest option for manufacturers.
However, masking the undesirable sensory attributes associated with potassium chloride
remains a problem. The taste profile for sodium chloride is shown in Figure 1. Potassium
chloride does not have the same flavour profile as salt, as shown in Figure 2.

![Figure 1: Taste Profile Sodium Chloride](image)
In recent years, work has been carried out to try and eliminate the undesirable bitter and metallic tastes associated with the introduction of other salts. Most commonly, potassium chloride is combined with monosodium glutamate (MSG), or yeast extracts or other flavourings.

There are currently a number of commercial salt replacers available, made up with various combinations of sodium chloride and potassium chloride.

In bakery products, it has been reported that additives such as potassium chloride have a similar effect on strengthening gluten to salt (Tournay, 2009), so using salt replacers based on potassium chloride or other ions may overcome this issue.

This has been demonstrated practically with a 32.3% reduced sodium brown bread being reported that was acceptable in terms of baking qualities, appearance and texture and taste. In this case the potassium, magnesium and calcium contents of the bread were increased by 55.2%, 69% and 34.8% respectively (Charlton et al, 2007).

Current position

Although the technological function of potassium salts has been demonstrated, manufacturers often do not use these salts on the basis of advice from the FSA and DH regarding their implications in renal health. In addition, in some instances the flavour profile limits use.
Use of other mineral salts

Ingredients that are naturally rich in mineral salts may be a viable option for salt reduction in some cases. For example, ingredients have also been developed that are based on a blend of minerals from the fractionation of milk and contain up to 5 times less sodium than salt. They are granulated so that the particles are equivalent in size to standard salt and can be labelled as “mineral concentrate (milk salt)”. However milk salt is also an allergen and this would also be required on product labels.

To date trials have been conducted with this milk fraction in bread, sausages and cooked ham and work is currently ongoing in cheese. Supplier information indicates that a cooked ham product with equivalent salt level of 1.3% can be achieved without significant impact on the product texture, cooking loss, pH or water activity (Lactosalt, 2011).

Another ingredient naturally rich in minerals is whey permeate. Whey permeate is a byproduct from whey protein concentrate, whey protein isolate, ultra-filtered milk, milk protein concentrate or milk protein isolate. The composition of spray-dried permeate varies but typically contains a minimum of 59% lactose, maximum of 10% protein and 27% ash. Researchers at the University of Wisconsin Centre of Dairy Research have assessed the salt-enhancement properties of whey permeate and concluded that the mineral salts in the ash – calcium, phosphate, magnesium and potassium are functioning as salt enhancers while the non protein nitrogen compounds found in the protein urea, creatine, creatinine, uric acid and ammonia may serve as flavour potentiators. Significant reductions in sodium have been achieved in cakes and muffins formulated with whey permeate (Minasian, 2011).

A further mineral salt that has attracted some attention is magnesium sulphate which provides both a bitter and a salty taste, depending on its concentration (Delwiche, 1995, Lawless, 2003). At low levels it is associated with a salty taste compared to at high levels, being bitter (Shallenberger, 1993). For this reason it may have the potential to be used as a salt replacer.

Magnesium sulphate has been reported in a number of different patents relating to salt replacement (Rood, 1984, Kurppa, 1988, Morrant and Kaszuba 2007, Ryberg 2006)
where it has been used in conjunction with other salts to reduce the level of sodium present.

Mineral salts form the basis for some of the new ingredients that have been identified.

*Current position*

There is some potential for further exploration of use of mineral salts, discussed later in the section on emerging technological and Ingredients solutions. However there are allergy concerns for some extracts which may limit usage.

**Phosphates**

Phosphates are commonly used in processed meat products to extract protein and help with water binding. Even though sodium phosphates contribute to the overall sodium content of the product, they can allow a reduction in the amount of sodium chloride needed for protein functionality and therefore reduce the overall sodium content in the product. In addition potassium phosphates can be used instead of sodium phosphates.

*Current position*

There are maximum legal usage limits for phosphates and these need to be adhered to. There are also some consumer acceptability issues.

**Taste enhancers**

Salt enhancers are substances that do not have a salty taste in themselves, but enhance a salty taste when used in combination with sodium chloride. A range of ingredients is reported to act as salt enhancers including products such as amino acids, monosodium glutamate, lactates, yeast products and other flavourings. Taste enhancers work by activating receptors in the mouth and throat, which helps compensate for the salt reduction and enhance flavour.

Umami, best described as a pleasant savoury taste is featuring increasingly on menus around the world and has potential in salt reduction. Incorporating umami tastes in certain flavours is increasingly seen as a way to compensate for lower salt content in processed foods. Umami is imparted by the amino acid glutamate and a number of ribonucleotides including inosinate (Carter et al, 2011). MSG has long been the easy route to umami but this has negative consumer connotations and there are many alternative sources of natural umami taste including, tomatoes and onions. Research
shows that umami is triggered by glutamates, a high concentration of which is found in these vegetables in addition to many other plants such as green tea, seaweed and mushrooms. The umami taste is further stimulated when these ingredients are fermented, pickled, or roasted since these processes appear to boost the levels of key amino acids (Patton, 2010). A new mushroom extract ingredient for enhancing umami is available for reducing sodium levels in dairy based dressings and cheese sauces. It is made from champignon mushroom (Agaricus bisporus) extract which is mixed with palm oil and spray dried onto a maltodextrin carrier (Scelta Mushrooms).

Additionally it has been demonstrated that by using soy sauce, salt can be significantly reduced in salad dressing, soups and stir fried pork (Kremer et al, 2009). However it should be noted that in this study consumer acceptance was measured after only one exposure and the replacement of salt in foods with soy sauce may well lead to subtle differences in flavour profile that could become more apparent after repeated exposure and in turn might either decrease or increase product liking.

*Current position*
Salt enhancers still have potential, but may have consumer acceptability issues as they will need to be listed in the ingredients list, and clearly are most likely to work in savoury products where salt performs a flavour role.

In addition food producers should be advised to conduct repeated exposure tests to ensure long term acceptance of salt reduced foods using a umami alternative.
Results from Industry Survey

Summary

The survey results identified that there are a number of commercially available salt reduction solutions. These can be categorised as 1) Natural preservatives 2) Yeast extracts 3) Flavour and flavour perception 4) Alternative salts and 5) Other solutions. Moreover the solutions claim to provide one (or more) functions including sensory characteristics, consumer acceptance, safety and shelf-life and consumer acceptance that is applicable to one (or more) of the product category areas.

Results

Of the 119 responses, 105 provided an answer to question 1 “Does your company currently provide any salt reduction solutions? Of these 84.5% (88) claimed to provide a solution and 15.5% (17) stated they did not.

The respondents that stated they did not currently provide any solutions (i.e. 17) were subsequently asked whether (to the best of their knowledge) the company intends to develop salt reduction solutions. Just over a quarter stated their company did intend to develop a salt reduction solution, one fifth stated no – the company did not intend to develop a solution(s) - and just over half stated they did not know.

The 26.7% of respondents were asked to comment on the nature of the work they intend to undertake (i.e. what scientific studies they intended to do); however, no response was provided.

The companies that answered yes to Q1 (the company currently has a salt reduction solution) were subsequently asked to list all the products they have available. 44 respondents answered this question providing a basic description of the solution.

The range of solutions can be grouped into five categories as follows:

1. **Natural preservatives.** These were described as natural antimicrobials used to prevent the growth of microorganisms in cheese products and pesto and other thick sauces (e.g. ‘use of natural preservatives to prevent growth of microorganisms as a consequent [sic] of salt reduction’).
2. **Yeast extracts.** High nucleotide and deactivated yeast extracts were described as solutions that could be used to improve the sensory characteristics and consumer acceptance of a range of products and rheological improvement. These could be used in isolation or in conjunction with other salt replacement solutions (e.g. ‘potassium chloride or ammonium chloride).

3. **Alternative salts.** A number of solutions were identified as alternatives to sodium chloride such as:
   a. **Low sodium salt.** Several sodium chloride solutions were identified that claim to have reduced sodium levels that can impart the same flavour impact and function.
   b. **Potassium Chloride.** Identified as a direct alternative to sodium chloride or in conjunction with sodium chloride in varying ratios. Other potassium salts identified were tripotassium citrate, potassium gluconate and potassium lactate.
   c. **Magnesal salt.** This solution was identified as a cryo-crystallised salt based on magnesium chloride that can be used in conjunction with other solutions such as umami ingredients and flavours or as a 1:1 replacement. The solution claims to provide a range of functions including safety and shelf-life, physical stability, sensory characteristics and consumer acceptance.

4. **Flavour and flavour perception.** Several respondents put forward solutions that aim to maintain or improve the flavour of the product where salt has been reduced and/or to alter the way saltiness is perceived/experienced in the mouth. The solutions are summarised as follows:
   a. **Natural flavourings/alternative flavouring ingredients.** These include extracts from natural sources and blends of seasoning and spices that flavour the product with less need for salt to be added for consumer acceptance. The vast majority of these ingredients are claimed to provide a solution in maintaining the sensory characteristics of the product and/or consumer acceptance; however, some identified safety and shelf-life characteristics as well.
   b. **Umami ingredients.** Ingredients such as glutamate salts, nucleotides, hydrolysed vegetable protein (HVP), yeast extracts were identified as solutions helping to overcome the challenges of salt reduction on flavour.
   c. **Taste Receptor Behaviour.** Some solutions were identified that contain salt with varying particle sizes and densities that target the taste receptors
in the mouth to perceive a salty taste but with less sodium. For example salt crystals with a high surface area but low bulk density.

d. **Masking products.** Several solutions were identified that claim to mask the bitter aftertaste of potassium.

5. **Others solutions** including:

a. Glucono-delta lactate – identified as a sodium free chemical leavening agent.

b. Potassium bicarbonate – identified as a solution to Sodium Bicarbonate as a 1:1 replacement for use in chemically leavened goods.

c. Enzymes were proposed as a solution by one respondent as a means to address technological processing challenges in low sodium bakery and cereal products (no further details as to how this could be achieved were provided). Use of enzymes with a preservative function was also put forward by one respondent but no further details were provided.

It is not possible to categorise all of the solutions provided by the survey respondents. However, it is clear that the majority of solutions (19 in total) would be defined as a ‘Flavour and flavour perception’ solutions, followed by ‘Alternative salt’ solutions (11 in total). There were relatively fewer ‘Yeast extract’ (7), ‘Natural preservative’ (3) and ‘Other’ (3) solutions put forward. In many cases there was insufficient information provided to be able to categorise the solution.

Question three asked respondents to indicate which function(s) their solution provided (sensory characteristics, consumer acceptance, safety and shelf-life and physical stability) against a list of product category applications. Respondents were presented with a table and were able to select as many, or few, functions and applications they deemed appropriate.
Figure 3 shows that the respondents claim to provide more solutions designed to improve sensory characteristics and consumer acceptance than safety and shelf-life and physical stability. It also shows a clear orientation towards meat and meat products and bread and cereal product applications. By contrast there are relatively fewer solutions that claim to address safety and shelf life and physical stability functions and fewer solutions applicable to product categories such as ‘all other puddings’ and ‘canned fish’.

Respondents were asked to indicate whether scientific studies were conducted to validate the solutions they claim to provide. The majority (71.4%) stated they had conducted scientific studies to validate their solutions; however (28.6%) have not.

Of the respondents that claimed to have conducted scientific studies - they were further asked to state whether these studies had been done internally (i.e. by the company itself) or through an independent third party. The results clearly show that the majority (70%) of scientific studies have been conducted internally with 30% having been conducted by an external third party.
The survey results indicate that there are scientific studies to validate the efficacy of these solutions although it should be noted the majority of these have not been conducted by an independent third party. The limitations of this survey are:

1. The results are only representative of the companies surveyed.
2. It is not possible to evaluate the efficacy of the solutions put forward.
3. We are unable to determine when the solutions were developed and therefore cannot judge whether they represent ‘new’ or ‘existing’ solutions.

These limitations were addressed in a series of follow up telephone interviews with the survey respondents that indicated they were willing to share further information and in the wider research carried out by Leatherhead (e.g. the literature review).
Review of Emerging Technology and Ingredients Solutions Identified

This study has identified some potential technologies for salt reduction that have been demonstrated in scientific studies and may offer solutions to the food industry in the future. In addition ingredients solutions that have been developed or commercialised within the last 12-24 months have been identified as a result of the industry survey and literature review. Those companies who have provided further information on these technologies and ingredients solutions are listed in Appendix 8.
Inhomogeneous salt distribution

The use of inhomogeneous tastant distribution in both bread and cheese products has been described (Stieger et al 2009). In the case of bread products, the dough is divided into 2 parts and each part has different salt levels added – one high and one low to average out at a salt level of 1.5%.

![Bread showing layering of doughs with different salt contents](image)

*Picture 1: Bread showing layering of doughs with different salt contents*


The two doughs may then be combined by sheeting just prior to moulding. Breads with inhomogeneous salt distribution were perceived as saltier and several peaks of saltiness were perceived during chewing. This phenomenon was also observed after 24 hours storage and appeared to remain after five days frozen storage and four hours thawing indicating that the mobility of the salt is limited. However salt reduces yeast activity so therefore this technique requires the amount of yeast in each portion of dough to be adjusted to obtain a constant fermentation speed in each dough, independent of salt concentration. In addition it should be noted that whilst this technique may have the potential to get to a lower salt level, at the levels described in the study this is still 50% above the 2012 salt target.
More recently the same authors have demonstrated and reported that sensory contrast in bread induced by encapsulated salt can enhance saltiness and allows for a salt reduction of up to 50% whilst maintaining salt intensity (Martijn et al, 2012). In this study, consumer panels indicated that although saltiness perception was increased overall, this was not preferred by consumers. Nevertheless this is an approach that may be investigated further for its potential in salt reduction.

**Adjusted salt crystal size**

Once in solution, salt will behave in the same manner, irrespective of its pre-dissolution crystalline nature. However, in dusting applications where salt is added as a solid, it might be expected that the crystal characteristics of the salt could influence the perceived sensory saltiness. This is because in order to contribute to sensory saltiness, the salt must dissolve in the mouth. The rate of dissolution in the mouth must be related to the characteristics of the salt crystal, including crystal form (shape and density) and the crystal size (surface area, bulk density), and it would therefore be expected that such difference in crystal characteristics might be manifested in altered sensory perception of crystalline salt such as altered intensities and/or altered salt release rates.

Work conducted at Leatherhead Food Research has confirmed that saltiness perception is changed when the crystal size is altered. Figure 4 shows that using smaller particle size salt leads to a larger initial perception of saltiness. Shaped like tiny hollow pyramid shells, Alberger salt crystals have an irregular surface, which makes them cling to foods and any other spices more readily, yet dissolve faster in the mouth. For topical applications, such as crackers and other snack foods, that translates to a maximum flavour burst, with a minimum amount of salt.
Figure 4: Salt intensity vs. time for salt crystals of differing sizes

Source: Leatherhead Food Research 2007

In addition it is likely that having salt crystals of smaller particle sizes could help with more even dispersion thus requiring a lower overall salt level.

Adjusting crystal structure and size is the basis of new technologies such as Eminates Soda –Lo® product which is described later. It should be noted that none of the products currently available are based on nano particles, although this may offer solutions in the future subject to EU approval.

Salt associated aromas

Another possible approach to salt reduction could be odour–induced saltiness enhancement by a salty-congruent odour. Selected odours might be used to compensate for salt reduction.

A few scientific studies have been conducted looking at the effect of enhancement of saltiness by odours and such an effect could be of interest to product developers. The concept of odour induced taste enhancement has been shown previously for tastes such
as sweetness, bitterness and sourness but only a few have looked at saltiness. It has been suggested that saltiness could be enhanced by cheese odour (Pioneer, 2004). Soy sauce odour has also been demonstrated to enhance saltiness perception (Djordjevic, 2004).

A recent study looking at odour induced taste enhancement found that in some cases the ratings of saltiness of food products was also affected by the names of the food products, even prior to tasting. For example anchovy and bacon items were considered to be the most saltiness–associated food names. Intensity ratings were found to be subjective measures of our perception and expectations that are influenced by our knowledge and experience. In model systems some odours such as carrot and tomato were shown to have a low or even negative effect on salt perception and a positive effect on sweetness (Lawrence, 2009).
Review of Ingredient Solutions Identified

Technical criteria documents

Specific criteria documents were put together to cover aspects of the food safety/shelf life, sensory and consumer acceptance trials that companies may have previously carried out to assess the efficacy of their salt reduction additives and ingredients. Information gathered would then be used to assess the scope and scale of any work previously conducted and to help identify any technical gaps that would need to be highlighted and responded to.

Criteria documents focused on technological advances of the different additives and ingredients solutions in the last 12-18 months and covered general but also specific questions around experimental approaches and methodologies followed (see Appendix 2 and 3). Documents were forwarded to companies that had previously indicated their willingness to be contacted and provide further information. It should be noted that the information provided in this part of the report is based on the information provided by the participating companies and do not constitute Leatherhead’s opinions on the functionality and/or efficacy of individual ingredients and processes. A full set of responses received is also included in Appendices 5, 6 and 7.
Summary of ingredients solutions identified

Table 1 highlights the products identified as offering potential solutions for salt reduction. Each solution is then described in more detail, outlining potential applications, beneficial attributes and any barriers to use.
## Table 1: Potential Solutions for Salt Reduction

<table>
<thead>
<tr>
<th>Product</th>
<th>Company</th>
<th>Potential Applications *</th>
<th>Benefits</th>
<th>Shelf-Life**</th>
<th>Functionality</th>
<th>Consumer Acceptance ***</th>
<th>Clean Label</th>
<th>Other Barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smart Salt® patented technology with magnesal</td>
<td>SmartSalt</td>
<td>Meat and meat products, bakery and cereal products, cheese products, snacks, soups and ready to eat meals</td>
<td>Optimised blends to be used as 1:1 salt replacement for different products</td>
<td>Trials have been conducted and reports available</td>
<td>Assessed for effect on pH and a_w and for functionality in bread products</td>
<td>Evaluated extensively in commercial development facilities and manufacturing environments as well as food research establishments,</td>
<td>Labelling requirements vary depending on geographical and preferred blending option. Smart Salt® is able to provide advice on request</td>
<td>None Identified</td>
</tr>
<tr>
<td>Yeast extract enhancers and combinations</td>
<td>DSM</td>
<td>Soups, sauces, ready to eat meals, meat products, bakery and seasonings</td>
<td>Reduction in sodium levels and good flavour profile</td>
<td>No trials on shelf-life conducted</td>
<td>No effect on functionality other than replacing taste of salt</td>
<td>Sensory and consumer acceptability trials conducted</td>
<td>Yeast extract and/or natural flavouring would need to be declared in accordance with (EC) No 1334/2008</td>
<td>Powder properties of salt versus the yeast extract based ingredients may be different in handling, in factory.</td>
</tr>
<tr>
<td>PuraQ Arome NA4</td>
<td>Purac</td>
<td>Processed cooked meats both cured and uncured, bakery products, sauces, snacks and ready to eat meals.</td>
<td>Provides savoury taste, compensates for lack of flavour and contributing towards lowering the water activity of the food.</td>
<td>Shelf-life trials have been conducted</td>
<td>Effect on water activity has been evaluated</td>
<td>Sensory and consumer trials conducted</td>
<td>Natural flavouring would need to be declared in accordance with (EC) No 1334/2008.</td>
<td>None identified</td>
</tr>
<tr>
<td>Suprasel® Loso OneGrain™</td>
<td>Akzonobel</td>
<td>Bakery specifically bread and morning goods. Product for meat in development</td>
<td>Provides NaCl, KCl and yeast extract in one grain with a defined blend ratio</td>
<td>Trials in progress</td>
<td>Effect on bread dough functionality similar to salt</td>
<td>Consumer trials conducted in Dutch style bread</td>
<td>Contains NaCl, KCl and yeast extract</td>
<td>Contains KCl which is currently not advised for use by DH</td>
</tr>
<tr>
<td>Product</td>
<td>Company</td>
<td>Potential Applications *</td>
<td>Benefits</td>
<td>Shelf-Life**</td>
<td>Functionality</td>
<td>Consumer Acceptance ***</td>
<td>Clean Label</td>
<td>Other Barriers</td>
</tr>
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</tr>
<tr>
<td>Sub4salt®</td>
<td>Jungbunzlauer</td>
<td>Suitable for all applications</td>
<td>1:1 substitute with easy handling properties</td>
<td>Shelf-life trials conducted</td>
<td>Effect on water activity has been evaluated</td>
<td>Sensory and consumer acceptability trials have been conducted in a range of different products</td>
<td>Contains NaCl, KCl and sodium gluconate</td>
<td>Contains KCl which is currently not advised for use by DH</td>
</tr>
<tr>
<td>SaltPrint® 4D and 5D</td>
<td>Firmenich</td>
<td>Soups, sauces ready meals and potato crisps</td>
<td>Salt enhancers designed to allow reduction in salt level of up to 45%</td>
<td>None conducted to date</td>
<td>No data</td>
<td>Sensory and consumer acceptability trials have been carried out in a range of different products</td>
<td>Natural flavouring would need to be declared in accordance with (EC) No 1334/2008</td>
<td>SaltPrint 5d is designed to be used in conjunction with KCl which is currently not advised for use by DH</td>
</tr>
<tr>
<td>Salt Enhancer</td>
<td>Natural Taste Consulting</td>
<td>Demonstrated so far in meat, bakery, dairy and beverages but potential across food industry</td>
<td>Salt enhancer with the additional benefit of masking off notes associated with KCl</td>
<td>None conducted to date</td>
<td>No data</td>
<td>Tests have been conducted in soups and meat, bakery, cheese and isotonic beverages</td>
<td>Natural flavouring would need to be declared in accordance with (EC) No 1334/2008</td>
<td>None identified</td>
</tr>
<tr>
<td>Sante</td>
<td>Lycored</td>
<td>Meat and meat analogues, soups, seasonings, sauces and snacks.</td>
<td>Reduction of up to 30% in salt levels with no detrimental effects on taste</td>
<td>No data</td>
<td>No data</td>
<td>Sensory tests conducted on Sante itself but not in food products. Trials may have been conducted by end product manufacturers but results would be proprietary</td>
<td>Sante is a natural product, entirely originating from tomato</td>
<td>None Identified</td>
</tr>
<tr>
<td>Superbind™ HB-CT</td>
<td>Innophos</td>
<td>Comminate Meats</td>
<td>Effective protein extraction in meat with lower use level than salt</td>
<td>Some food safety work is in progress</td>
<td>Designed to reproduce the same binding functionality in meats as salt</td>
<td>Sensory and consumer acceptability trials carried out</td>
<td>Labelled as phosphates</td>
<td>Potential negative consumer perception</td>
</tr>
<tr>
<td>Product</td>
<td>Company</td>
<td>Potential Applications *</td>
<td>Benefits</td>
<td>Shelf-Life**</td>
<td>Functionality</td>
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</tr>
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</tr>
<tr>
<td>FlakeSelect™ &amp; SodiumSense™</td>
<td>Cargill</td>
<td>Meats (beef, pork, and poultry), dairy (e.g. natural cheese, cottage cheese), bakery (breads, tortillas), cereals, snacks &amp; seasonings, canned vegetables, beverages</td>
<td>Address the functional roles of salt in food applications, such as, taste (salty and flavour enhancement), texture, protein modification and microbial management,</td>
<td>Shelf life trials are in progress</td>
<td>No data</td>
<td>Some sensory and consumer trials conducted</td>
<td>FlakeSelect™ labelled as Potassium chloride or Salt and Potassium Chloride SodiumSense™ labelled as Potassium Chloride and Natural Flavouring</td>
<td>Contains KCl which is currently not advised for use by DH</td>
</tr>
<tr>
<td>KUDOS Potassium bicarbonate</td>
<td>Kudos Blends</td>
<td>Sweet baked goods including products such as fruit scones, crumpets, and muffins. Potassium bicarbonate designed to be used in place of sodium bicarbonate</td>
<td>The shelf life of the end product, i.e. the baked cake, is not affected or altered by using potassium bicarbonate in place of sodium bicarbonate.</td>
<td>Fine particle size ensures full dissolution in batter, delivering products with equivalent volume, texture and eating characteristics to those based on sodium bicarbonate.</td>
<td>A recognised bakery ingredient and is being used commercially in many products</td>
<td>Labelled as potassium bicarbonate</td>
<td>Contains potassium which is currently not advised for use by DH</td>
<td></td>
</tr>
<tr>
<td>Soda-Lo®</td>
<td>Eminate</td>
<td>Currently used in bread, pies, pastry and pizza bases. Potential use in cheese and meat products</td>
<td>Labelled as salt</td>
<td>Results in bread have demonstrated that bakers can also achieve significant increases in shelf-life, trials ongoing in cheese</td>
<td>Soda-Lo® is salt but has a smaller particle size, it enhances product functionality as demonstrated in bread where the salt crystals cross link gluten more effectively than standard salt</td>
<td>When used at the correct levels there is no impact on taste and this has been demonstrated in bread and cheese. It is being used commercially in bread, pies and pastry and pizza bases.</td>
<td>Labelled as salt</td>
<td>None identified</td>
</tr>
<tr>
<td>Product</td>
<td>Company</td>
<td>Potential Applications*</td>
<td>Benefits</td>
<td>Shelf-Life**</td>
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<tr>
<td>Seaweed</td>
<td>SeaGreens</td>
<td>Bread</td>
<td>Additional Satiety Effect</td>
<td>No data</td>
<td>No impact on bake quality of Bread</td>
<td>Trials in progress</td>
<td>Labelled a Seagreens (Ascophyllum nodosum), this is a clean label product that is also manufactured from a sustainable source.</td>
<td>Imparts a green coloration to products in which it is used.</td>
</tr>
<tr>
<td>Seaweed</td>
<td>Wild Flavours</td>
<td>Soups, sauces and salad dressings, Meats, Bread and baked goods, Salty snacks, Meal kits, Canned foods, Vegetable beverages and bouillons, cube and powders</td>
<td>1:1 replacement that imparts a umami taste</td>
<td>No data</td>
<td>No data</td>
<td>A consumer acceptability study has been conducted with potato chips using employees as test subjects. Samples were blind coded. No significant differences were identified between acceptability and perceived saltiness</td>
<td>Low sodium sea salt/ natural flavouring</td>
<td>None Identified</td>
</tr>
</tbody>
</table>

* Some product applications work has been conducted outside of the UK and therefore products may differ to those typical UK products **Full details of safety and shelf-life trials can be found in appendix 6. **Full details of sensory and consumer trials can be found in appendix 7.

Limited information was available on the cost of these solutions. Where data was available it indicated the cost would be more than using salt. However the extent of this varied for the same product dependent on its use.
Smart Salt® by SmartSalt

Description of the method/ingredient
Smart Salt® is the brand name given to a sodium reduction system which is based on a triple co-crystallised mineral salt, rich in magnesium. This offers a novel and patented taste enhancement technology. According to the information provided, magnesal, as either a triple or double co-crystallised mineral salt, acts as the foundation stone for building salt or sodium reduction opportunities in foods as shown in figure 5.

![Figure 5: Description of Smart Salt® Product Range](source)

Source: Smart Salt®

Potential applications
It was indicated that Smart Salt® has been evaluated in a very broad range of products since 2006, mainly in the USA. Evaluation has been conducted in the following product ranges; meat and meat products, bakery and cereal products, cheese products, snacks, soups and ready to eat meals. The product has been
introduced in the UK over the last 12-24 months and Leatherhead Food Research have carried out both sensory and safety trials with this product.

**Beneficial attributes**

It was indicated that Smart Salt® is commercially available as two formulation types; directly as magnesal and in optimized blends, the benefits of which are outlined in Figure 6.

![Figure 6: Benefits of Smart Salt Products](source: Smart Salt)
Effect on product shelf life and safety
It was indicated that both shelf life and challenge testing trials have been carried out. Challenge testing work was carried out in bread and meat against standard salt with very positive conclusions made. Reports and results can be available upon request.

Effect on product functionality
It was indicated that the processing characteristics of a 50% reduced salt white bread has been evaluated against regular salt. The Smart Salt® blend out-performed the regular reduced salt version in some important areas including: tolerance for dough rise, volume of final product, development time, breakdown time and dough weakening value.

In general terms Smart Salt® has been assessed for its impacts on water activity and pH compared to foods containing salt.

Effect on taste/consumer acceptability
It was indicated that Smart Salt® has been evaluated extensively in commercial development facilities and manufacturing environments as well as food research establishments, globally in most application categories. Most of Smart Salt® commercial development has been made under confidentiality agreements so specific information cannot be disclosed. However, in summary, extensive taste testing using techniques such as Quantitative Descriptive Analysis (QDA), Progressive Profiling (PP) and consumer acceptance studies have been carried out both in the US and in Europe at independent research establishments. Data have indicated that Smart Salt® products have a very high consumer acceptability compared to full salt products even at salt reduction levels of 40-50% with no significant difference in taste or preservation qualities of the final product.

Effect on retailers’ / manufacturers’ clean label policies
It was indicated that labelling requirements vary depending on geographical and preferred blending option. Smart Salt® is able to provide advice on request.

Cost implications
No cost implications have been raised.

Other barriers / risks
No barriers were highlighted in the information provided.
Yeast Extract-derived/ Natural Flavour products by DSM Food Specialties

Description of the method/ingredient
According to the information provided, DSM Food Specialties have developed a range of products in the last 12-18 months. All products are yeast extract based, or are based on natural flavouring. These “building block” ingredients provide a foodstuff with flavour, taste, the enhancement of taste, and also the mouth feel properties that salt would otherwise provide. The approach to achieve this was to combine salt taste donors, salt taste enhancers, bitterness maskers, specialised aroma donors as well as added components to contribute to the mouth feel of the food.

Potential applications / product scope
Potential applications that were identified by the company include the following:

- Soups, sauces, ready to eat meals.
- Meat products
- (Fine) bakery
- Seasonings

Beneficial attributes
Reduction in sodium levels and good taste are the beneficial attributes identified by the company.

Effect on product shelf life and safety
It was indicated that food safety/shelf life data on real food products containing the specific salt reduction technologies is not currently available. The company indicated that if any such work has been done this would have been carried out by the food manufacturers that have taken up the technology. Several examples of real food product that include DSM technology are on the market. The company further indicated that if there were any food safety / shelf life related issues, this would be coming from the reduction of salt level itself, rather than then the introduction of DSM technology.

Effect on product functionality
No effects on product functionality were discussed by DSM.
Effect on taste/consumer acceptability
Information on the sensory and consumer acceptability trials carried out is included in Appendix 7, as this was provided by the company.

Effect on retailers’ / manufacturers’ clean label policies
It was indicated that both the yeast extract and/or natural flavouring would need to be declared in accordance with (EC) No 1334/2008.

Cost implications
Indicative costs were provided as 0.01-0.05 EUR per serving. It was further advised that the final cost will be dependent upon serving size, the complexity of the food and also the percentage of sodium salt present and percentage reduction.

Other Barriers/ Risks
It was indicated that the powder properties of salt versus the yeast extract based ingredients might be different in handling, in factory.
PuraQ Arome NA4 by Purac

Description of the method/ingredient
PuraQ Arome NA4 is the brand name for a newly developed alternative flavour technology by Purac. The product is a result of a controlled fermentation of cane sugar, and therefore is claimed to be completely natural.

Potential applications / product scope
Purac have identified their target as savoury applications as the natural flavour has shown the most promising performances in this food area. The target products include processed cooked meats both cured and uncured, bakery products, sauces, snacks and ready to eat meals.

Beneficial attributes
It was indicated that PuraQ Arome NA4 is designed to compensate for the reduced level of salts in food; its functions include providing a savoury taste, compensating for a lack of flavour and also compensating for salt as a solute, i.e. it contributes towards lowering the water activity of the food.

Effect on product shelf life and safety
It was indicated that both shelf life and challenge testing trials have been carried out on real food products containing the particular ingredient and some experimental details have been provided (see Appendix 6). It was further advised that due to confidentiality issues, report availability would need to be further discussed.

Effect on product functionality
It was indicated that Purac have evaluated some of the functional aspects as well as taste aspects of introducing PuraQ Arome NA4 to foods. The technical effects studied include loss of texture and water activity of the foods.

Effect on taste/consumer acceptability
Sensory tests involved triangle tests, followed by testing at more extensive taste panels. Details on the methodology/approach followed are included as provided in Appendix 7.
Effect on retailers’ / manufacturers’ clean label policies

It was indicated that PuraQ Arome NA4 is a natural product and therefore its inclusion in the food does not require an additional E number to be added. The product is labelled as natural flavour by Purac.

Cost implications

Cost is described by Purac as minimal, especially in comparison to other flavour based salt reduction solutions.

Other Barriers/ Risks

No further barriers or risks were raised.
Suprasel® Loso OneGrain™ by AkzoNobel

Description of the method/ingredient
Manufactured by AkzoNobel this range of ingredients has been commercially available for the last 12 months. Based on proprietary technology, Suprasel® Loso OneGrain™ combines NaCl with KCl and flavour into one grain. The grains are the same size as salt grains but the ingredients within each grain are homogeneously distributed as shown in Figure 7. Products currently commercially available and used in the Netherlands include a 30% sodium reduction and a 50% reduction option. In addition, a product that contains iodine specifically designed for the bakery sector is available and a product for the meat sector, containing additional nitrite is currently in development.

![Figure 7: Traditional blending results in inhomogeneous distribution (Left) OneGrain technology produces an homogenous product composition (Right). Source: AkzoNobel](image)

Potential Applications
It was indicated that work to date has focussed on the bakery sector, primarily bread but also some morning goods including products like croissants. A product is in development for the meat sector but it will be up to 2 years before this is commercially available.

Beneficial attributes
The key advantages is the fact that it delivers the NaCl, KCl and yeast extract blend in a ratio and format that has been determined to offer the best solution for salt reduction in terms of taste. The key benefit of using Suprasel® Loso OneGrain™ versus a standard blend of mineral salts is that the product is homogeneous and there is minimal dusting.
Effect on product shelf life and safety

It was indicated that both shelf life and challenge testing trials of real food products containing the specific ingredient are currently in progress. It is estimated that results will be available by the end of 2012 and therefore, no specific information was provided other than that included in the relevant document (Appendix 6).

Effect on product functionality

It was advised that in Dutch Style white tin bread, dough properties have been assessed during and after kneading, during proving and moulding, at the end of the second proving, during baking and after cooling. No significant differences in dough behaviour, and processability compared to standard salt were observed. This has been successfully commercialised by several bakeries in the Netherlands with some product having as low as 0.5% salt.

Effect on taste/consumer acceptability

It was indicated that trials have been conducted in Dutch style breads which showed that products that are acceptable to consumers in terms of taste are feasible. This is further demonstrated by the fact that the product is being used commercially by a major supermarket chain in the Netherlands and a number of artisanal bakers. Full responses to the sensory and consumer acceptability criteria questions are included in Appendix 7.

Effect on retailers’/manufacturers’ clean label policies

It was indicated Suprasel® Loso OneGrain™ A30 and B50 contain NaCl, KCl and yeast extract. Suprasel® Loso OneGrain™ A50 also contains a flavour.

Cost implications

It was indicated that costs mainly depend on the application with some examples given below:

- in 100 gram bread ~€ 0,004
- in 100 gram of meat ~€ 0,005
- chicken soup: €0.003/serving
- crisps: €0.008/serving
Other Barriers/ Risks

No specific barriers were indicated other than that involving the negative perception around potassium chloride.
Sub4salt® by Jungbunzlauer

Description of the method/ingredient
Based on the information provided, sub4salt® is a salt replacement product that is able to replace the salt in foods without sacrificing taste. Sub4salt® is made up of sodium chloride, potassium chloride and sodium gluconate. It has the potential to reduce sodium levels in food by 50%.

It was indicated that developments in the last 12-18 months involve the following:
- Establishment of recipes with the patented sub4salt® specifically towards the American cuisine (e.g. French fries, tacos, burgers, and respective sauces) yielding 25-35% sodium reduction, and
- Development of new sub4salt® blends to address improved functionality and taste in certain processed food applications.

Potential applications / product scope
It was indicated that sub4salt® can be used to replace salt in all applications in which it is necessary to reduce salt.

Beneficial attributes
The company summarised the beneficial attributes of sub4salt® as follows:

- Similarity in taste with salt – Even though the sodium content of sub4salt® is much lower than in salt, it still tastes almost entirely like salt and thus imparts identical taste to the food item it is used in.
- Identical dosage level as salt – Being a 1:1 substitute, the dosage levels of sub4salt® are same as that of salt and hence it does not create any complexity in terms of change in recipe of the end-product to the end-users.
- Absence of common side-effects – End product using sub4salt® does not give rise to any side-effect such as bitter, metallic or broth-like taste that is sometimes associated with products containing MSG, yeast extracts or potassium chloride.
- Ease of handling – It can be easily handled by manufacturing personnel as it does not cause dust formation and it also does not have any complex mixing or calculation requirements.
Effect on product shelf life and safety
It was indicated that trials on microbial shelf life studies and comparison of a\textsubscript{w} value shows no significant differences between sub4salt\textsuperscript{®} and standard salt in water based solution. It was suggested that work has been done across all product categories, however results are not available for publication. It was not indicated that microbiological challenge trials on foods containing sub4salt\textsuperscript{®} have been carried out. Please refer to Appendix 6 for the full responses to the criteria document.

Effect on product functionality
Based on the information provided, sub4salt\textsuperscript{®} has approximately 40 % better water solubility compared to neat rock salt. Effects on water activity were also described with comparable results obtained between sub4salt\textsuperscript{®} and salt. Work on density and freezing point depression at different sub4salt\textsuperscript{®} and salt concentrations has also been carried out by the company and is available on request.

Effect on taste/consumer acceptability
The company indicated that both sensory and consumer acceptability trials have been carried out in a range of different products. Please refer to Appendix 7 for a full response to the Sensory and Consumer Acceptability criteria document. Part of the results obtained were provided in the form of separate recipe cards, however the company indicated that details on analysis and sensory panel tests cannot be provided due to a patent situation.

Effect on retailers’/manufacturers’ clean label policies
The product contains Sodium chloride, Potassium chloride and Sodium gluconate.

Cost implications
The company indicated that compared to normal salt, sub4salt\textsuperscript{®} is more expensive, however the company further indicates that the higher price can be justified taken into account all the added benefits from the use of the product.

Other Barriers/ Risks
No barriers/risks were identified.
SaltPrint® 4D and 5D by Firmenich

Description of the method/ingredient
Firmenich have developed two product lines in the last 12-18 months. The salt enhancer SaltPrint® 4D, is designed to be used in combination with salt and is able to reproduce perception of sensory attributes when salt levels are reduced by 25%. The other product SaltPrint® 5D is specifically designed to be used in conjunction with salt and potassium chloride as it is able to mask the bitter notes of potassium chloride that otherwise decrease consumer acceptability. It was advised that incorporation of SaltPrint® 5D in foods such as chicken broth enables the overall sodium levels to be reduced by up to 45%.

Potential applications / product scope
Firmenich has identified their primary product scope as soups, sauces and ready meals. Validation experiments for their salt reduction solutions were conducted in a chicken broth based system and also in potato crisps.

Beneficial attributes
It was indicated that the main attributes of the SaltPrint® salt enhancers is that they allow for the salt levels in food to be decreased when they are incorporated in food. For SaltPrint® 4D decrease of up to 30% has been shown, and for SaltPrint® 5D a decrease of 45% when potassium chloride is also included in the formulation of a chicken based broth. In potato crisps a salt reduction of 30% was achieved. A central benefit of SaltPrint® 5D is its ability to disguise the undesirable taste of potassium chloride. It was further advised that SaltPrint® products have additional benefits of being natural, certified for use in Kosher and Halal foods, suitable for vegetarians, free of major allergens and do not use genetically modified crops in the products.

Effect on product shelf life and safety
It was indicated that no safety or shelf life trials of real food products containing SaltPrint® 4D and 5D have been conducted as these are new products.
Effect on product functionality
No problems with product’s functionality have been highlighted in the material provided.

Effect on taste/consumer acceptability
It was indicated that the company tested the sensory efficiency of both SaltPrint® products in multiple applications and some promotional material indicating the overall approach and methodology employed has been provided as a supplementary material that can be available upon request. The company indicated that additional sensory work is being carried out in bakery and meat products.

Effect on retailers’ / manufacturers’ clean label policies
It was indicated that SaltPrint® 4D and 5D are not salt replacing strategies but salt enhancing, thus they would not need to be labelled as an additional E number. It is worth noting SaltPrint® 5D is designed to be used in conjunction with potassium chloride which does require an E number label.

Cost implications
Cost implications were not commented upon in the information provided.

Other Barriers/ Risks
No further product issues were raised.
Salt Enhancer by Natural Taste Consulting

Description of the method/ingredient
Salt enhancer is a salt enhancing product by Natural Taste Consulting. It is a white soluble hydroscopic powder designed to have a two year shelf life. The product has been specifically designed to enhance the saltiness of existing salts within the food. This enables the overall level of salt within the food to be decreased by up to 30%. Salt enhancer is derived from the bacterial fermentation of a specific plant protein and as such it was indicated that it will be labelled as natural flavour for the European and US markets.

Potential applications / product scope
It was indicated that Salt enhancer has scope for a wide application across the food industry and that it has been demonstrated to be effective in the areas of meat, bakery, dairy and beverages with applications in other food industries yet to be determined.

Beneficial attributes
Natural Taste Consulting describes salt reductions of up to 30% in foodstuffs using salt enhancer instead of salt. The product has the additional benefit of masking the off-notes of potassium chloride and therefore can be used in combination with this product as well. It was claimed that when potassium chloride is also added as an alternative to salt an overall reduction of 50% sodium can be achieved in the final food product.

Effect on product shelf life and safety
It was indicated that tests so far show that Salt Enhancer survives the most rigorous of food processing. No shelf life or challenge trials in real food products containing the ingredient have yet been carried out as this is a new product, however the company indicated that they would be happy to embark on such trials with industry, if required.

Effect on product functionality
No effects on product functionality were mentioned.
**Effect on taste/consumer acceptability**

Two consumer acceptability tests were performed; first low salt chicken soup +/- salt enhancer, then a very low salt chicken soup containing potassium chloride +/- salt enhancer. Sensory trials were conducted on 50 consumers by an independent, accredited laboratory. Tests have also been conducted with meat, bakery, cheese and isotonic beverages using an expert panel. No specific information was provided on the trials conducted other than that included in Appendix 7.

**Effect on retailers’ / manufacturers’ clean label policies**

It was indicated that there would be no addition of further E numbers to the manufacturers labels as the product would be labelled as natural flavour.

**Cost implications**

It was indicated that like all alternative products on the market, salt enhancer cannot compete with actual salt. However, Natural Taste Consulting have considered their product against other competitors and are confident it offers a competitive performance, and also value for money.

**Other Barriers/ Risks**

No further barriers were raised by Natural Taste Consulting.
SANTE by Lycored

Description of the method/ingredient
SANTE is the brand name for an alternative flavour technology developed by Lycored. SANTE is a natural extract from tomato that delivers umami taste, as well as mouth feel, in savoury food products.

Potential applications / product scope
It was indicated that this product applies only to savoury foods. The potential applications described by Lycored include: meat and meat analogues, soups, seasonings, sauces and snacks.

Beneficial attributes
It was advised that incorporation on Lycored’s SANTE into the products formulation allows for a reduction of up to 30% in salt levels with no detrimental effects on taste.

Effect on product shelf life and safety
It was indicated that the shelf life of SANTE as an individual ingredient has been established at different storage temperatures based on physical, chemical, organoleptic and microbiological testing.
According to the information provided, no shelf life or challenge trials on food products containing SANTE have been carried out by the company. This type of work may have been carried out by individual customers using the ingredient and if so, would be confidential.

Effect on product functionality
No effects on product functionality were noted.

Effect on taste/consumer acceptability
Each batch of product is assessed by a small internal panel for colour, umami and off-taste. Please refer to Appendix 7 for a full set of the relevant information.

Effect on retailers’ / manufacturers’ clean label policies
It was indicated that SANTE is a natural product, entirely originating from tomato. Therefore clean labels are possible on the end food product.
Cost implications
No comments on cost implications were made.

Other Barriers/ Risks
No further barriers were raised.
Superbind™ HB-CT (& others) by Innophos

Description of the method/ingredient

Innophos is a functional ingredient supplier which produces several non- or reduced sodium ingredients designed for use in a variety of food products. One of their salt reducing solutions is Superbind™ HB-CT, a product designed to replace the function of salt in comminute meats. Salt is used to bind meats as it aids the solubilisation of proteins. The manufacturer claims that with the incorporation of Superbind™ HB-CT, a much lower level of salt is needed to achieve the same effect.

According to the information provided, the latest developments (12-18 months) involved the following:

Meat: SuperBind™ HB-CT: Maximizing the protein extraction by optimizing the capability from phosphates and so lowering the usage of salt needed for protein solubilisation.

Dairy: Replace current sodium based emulsifying salts by low/reduced sodium emulsifying salts. Emulsifying salts contribute 44-48% of sodium in processed cheese.

Potential applications / product scope

Based on the information provided, Innophos products are food-area specific. Calcium based raising agents are being used in the place of sodium based raising agents in chemically raised bakery products. SuperBind™ HB-CT, a phosphate based product, replaces the protein binding function of salt in meat products as it more functional (requires 0.5%) in protein extraction than salt (requires 1.5-2.5%).

For the dairy industry Innophos developed a reduced sodium emulsifying salt. Currently emulsifying salts contribute 44-48% of sodium from processed cheese so reducing the sodium levels from these would be of benefit to the industry.

Beneficial attributes

It was indicated that the majority of products have been designed for direct substitution so they have the added benefit of ease of use.
**Effect on product shelf life and safety**

According to the manufacturer, where a simple salt ingredient substitution takes place safety and shelf life concerns are not anticipated as the ingredient substitution should not affect the water activity of the food product. For Superbind\textsuperscript{TM} HB-CT, food safety (by challenge studies) and shelf life studies are scheduled for meat product(s) under the storage conditions of vacuum packing and refrigeration temperatures. The manufacturer indicated that all food safety work is currently in progress and so full details of experimental approach could not be provided to include in this report. Please refer to Appendix 6 for a full account of the responses received from the manufacturer.

**Effect on product functionality**

It was indicated that Superbind\textsuperscript{TM} HB-CT is designed to reproduce the same binding functionality in meats as salt would.

**Effect on taste/consumer acceptability**

Information on the sensory and consumer acceptability trials carried out has been provided and included in Appendix 7. It was indicated that both sensory analysis and consumer acceptability tests are performed in house, primarily by hedonistic descriptive tests but also with some triangle tests.

**Effect on retailers’ / manufacturers’ clean label policies**

Not specified, however it was indicated that in most cases an E number is not added.

**Cost implications**

It was indicated that costs are highly dependent upon the specific technology being applied in each case and that the potassium analogues are more costly than the calcium and phosphate alternative technologies. The intended food group would also have cost implications; for example low sodium options for whole meat cuts would be different to those of comminute meats.

**Other Barriers/ Risks**

Cost was indicated to be a potential barrier as reduced salt solutions are more expensive than salt, although this is still product dependent.
FlakeSelect™ & SodiumSense™ by Cargill

Description of the method/ingredient
It was indicated that both products have been developed in the last 12-18 months:

- FlakeSelect™ – patent pending process that physically modifies single or multiple ingredients to add functionality
- SodiumSense™ – a cost effective sodium reduction product formulated to provide similar liking as full salted food products.

At the same time, the company indicated that research is currently on-going in order to understand the functional role of salt in various food applications and devise reduced sodium solutions and also to understand particle size and crystal morphology on salty taste perception in various food applications. Please refer to Appendix 5, 6 and 7 for a full set of responses from the company.

Potential applications / product scope
The company reported activity in the following food categories:
- meats (beef, pork, and poultry), dairy (e.g. natural cheese, cottage cheese), bakery (breads, tortillas), cereals, snacks & seasonings, canned vegetables, beverages (e.g. tomato juice)
- food processing and foodservice channels

Beneficial attributes
These solutions are designed to:

- address the functional roles of salt in food applications, such as, taste (salty and flavour enhancement), texture, protein modification and microbial management,
- help mitigate potential flavour changes and help build back the flavour enhancement properties of salt, natural flavours are added to some of the solutions.

Effect on product shelf life and safety
It was indicated that shelf life trials have only recently been carried out as this is an on-going research program. Some further information on the conditions of testing are included in Appendix 6.
**Effect on product functionality**

No effect particularly highlighted.

**Effect on taste/consumer acceptability**

The company provided details of the analysis carried out as follows:

- Difference Testing: triangle tests with employees (consumers)
- Acceptance (Liking/Preference) Test with employees
- Trained and QDA panels used for more specific analysis such as screening samples for the consumer panel and specific attribute testing, e.g. bitter tasting

Claims made based on available data involve the absence of any statistical difference between control and reduced sodium products (up to 50% sodium reduction) for liking (overall, flavour and aftertaste) and “just about right” (saltiness, flavour strength).

Please refer to Appendix 7 for a full details of the methodology/approach followed.

**Effect on retailers’ / manufacturers’ clean label policies**

The company identified that the ingredient label declaration can be geographically dependent as per the US example below for the different salt reduction technologies available by the company:

- **Alberger® – Salt**
- **FlakeSelect™ – “Potassium chloride” or “Salt and Potassium Chloride”**
- **Premier™ potassium chloride – Potassium Chloride**
- **SaltWise® – “Potassium Chloride and Natural Flavourings” or “Potassium Chloride, Autolyzed Yeast Extract and Natural Flavorings”**
- **SodiumSense™ – “Potassium Chloride and Natural Flavourings” or “Potassium Chloride, Autolyzed Yeast Extract and Natural Flavorings”**

The company also mentioned that in some situations, particle size and crystal morphology can be leveraged to help impart an intense salty impression by understanding the relationship between surface area and rates of dissolution. This benefit is most successful in topical or in systems where there is limited water availability. In this case, the label would read “salt”.

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Cost implications
The company indicated that for any solution, including just removing salt, the cost structure will most likely increase. Therefore it is best to evaluate the formulation as a whole to determine if there is other cost saving opportunities. Cost implications will range between 2.5 to 25 times the price of basic salt depending on the solution.

Other Barriers/ Risks
No other risk/barrier was identified. The company further indicated that product testing should always be re-evaluated with changes in formulation to ensure shelf life and food safety.
KUDOS™ Potassium Bicarbonate by Kudos Blends

Description of the method/ingredient
It was indicated that this new (developed in the last 12-18 months) patented grade of potassium bicarbonate makes up an essential part of low sodium baking powders. It is needed to react with the acids in order to liberate carbon dioxide to provide aeration in baked goods. 18 months work of R&D has gone into this product to make it hydrophobic. By nature, potassium bicarbonate is very reactive and is often associated as being unusable due to the fact it compacts into hard lumps / cakes; this unstable nature has often deterred bakers from its use.

It was further indicated that this new patented grade of KUDOS potassium bicarbonate, specifically developed for the baking industry, has two key and critical characteristics a) it is of a particular fine particle size achieved through a totally unique milling process and b) has a hydrophobic component to it, which makes the fine powder water repellent. The water repellent property markedly improves the stability of the powder, thus making shipping, handling and storage very easy. It was further indicated that the technology behind this powder also lends itself to improving the shelf life of any blends of which the KUDOS potassium bicarbonate is incorporated into, such as baking powders, premixes and concentrates.

Potential applications / product scope
According to the manufacturer, this product is suitable for use in sweet baked goods including products such as fruit scones, crumpets, and muffins. By using it in place of standard baking powder, the salt content of baked products can be reduced by up to 50%.

Beneficial attributes
According to the manufacturer, this product has been specially formulated to match, and in some cases improve, the taste of products baked with potassium rather than sodium. Since bakers can replace the sodium bicarbonate with potassium bicarbonate, the sodium levels are significantly reduced, meaning they can still add salt for flavour and shelf-life while maintaining low sodium targets.
**Effect on product shelf life and safety**

Extensive shelf life trials have been carried out on baking powders containing KUDOS™ potassium bicarbonate. The water repellent technology of the specific potassium bicarbonate helps to improve the shelf life of low sodium baking powders. The shelf life of the end product, i.e. the baked cake, is not affected or altered by using potassium bicarbonate and should be no different to when any other ingredient is used. No reports or raw data have been provided as part of this report, however it was indicated that these could be available upon request.

According to the information provided, microbiological challenge trials have not been conducted. Please refer to Appendix 6 for the full responses to the food safety/shelf life criteria document.

**Effect on product functionality**

It was claimed that with a fine particle size ensuring full dissolution in the dough or batter, the leavening power is maximised delivering products with equivalent volume, texture and eating characteristics to those based on sodium bicarbonate.

**Effect on taste/consumer acceptability**

This is now a recognised bakery ingredient and is being used commercially in many products. Please refer to Appendix 7 for the full responses to the sensory/consumer acceptability trials conducted.

Taste tests were carried out by Leatherhead Food Research between pancakes and scones made with potassium bicarbonate and a control made with sodium bicarbonate. In all the tests, there was very little, if any difference noticed in the majority of modalities including overall liking at the 95% confidence level.

**Effect on retailers’ / manufacturers’ clean label policies**

It was indicated that there would be no effect on clean label solutions – simply swapping one E number for another E number.

**Cost implications**

According to the manufacturer, potassium bicarbonate is more expensive as it is a rarer mineral; however baking powders make up such a small amount of the recipe, that any cost increase is proportionately small. Cost is higher than sodium
bicarbonate but because the use levels are low, the added cost is proportionally small. For example in cakes an increased cost of £0.001/100g.

Other Barriers/Risks
According to the manufacturer, potassium based products are thought to affect people suffering with chronic renal failure as potassium could lead to toxicity due to kidney impairment, a condition that affects less than 1% of the population.
Soda-Lo® by Eminate

Description of the ingredient
According to the information provided, Eminate’s Soda-Lo® salt was engineered using technology that changes the structure of salt crystals to create free-flowing, microscopic hollow balls, with the consistency of talc and a shelf-life of 18 months. At 5–10 microns, the particles are a fraction of the size of standard salt (c.200–500 microns), and deliver an intense, salty hit on the taste buds. It has been commercially available for the last 12-18 months and a recent license agreement has been signed with Tate and Lyle for the worldwide rights to Soda-Lo®. Product is shown in Figure 8 below.

Figure 8: Electron Micrograph of Soda-Lo®
Source: Eminate Ltd

Potential Applications
Based on the information provided, the product is currently being commercially used in bread, pies, pastry and pizza bases in the UK. In bread, it can reduce salt levels by as much as 70% taking salt levels from 2% to as low as 0.6%. Work is currently ongoing in cheddar cheese where salt levels have so far been reduced to 1.2-1.4% with no adverse impact on micro stability of the cheese after 12 months and a comparable taste profile to control cheese with 2% salt. Cheese manufacturers have so far been limited in how far they can reduce the salt because the salt plays a key role in biochemical pathways during the production process. Since Soda-Lo® is salt, these pathways are not affected. Another of the key challenges in reducing salt in cheese has been the inefficient distribution of salt within the cheese matrix commonly seen particularly where hand salting is used by smaller manufacturers. As a result of its small particle size, Soda–Lo® disperses more evenly throughout the product matrix and this is claimed to be the reason for its successful application in bread and
cheese to date. It was also indicated that some trials have also been conducted in
cured meats but without success at this stage. However, there may be potential for
further work in this area.

**Beneficial attributes**

It was claimed that one of the key benefits of Soda-Lo® is that it is labelled simply as
salt and so it has no impact on labelling.

**Effect on product Shelf-life and Safety**

According to the company, results in bread have demonstrated that bakers can also
achieve significant increases in shelf-life as the tiny salt crystals cross-link the gluten
in dough more effectively than standard salt, helping to retain moisture. The end
product has also the same structure, texture, weight and volume as products based
on standard salt. Furthermore, the company has indicated that trials to-date in
cheddar cheese have shown that Soda-Lo® provides effective protection from
spoilage of yeasts and moulds after 6 months. No data on food safety/shelf life trials
carried out and/or currently in progress has been submitted by the company as part
of this report.

**Effect on Product Functionality**

According to the manufacturer, since Soda-Lo® is salt but has a smaller particle size,
it enhances product functionality as this has been demonstrated in bread where the
salt crystals cross link gluten more effectively than standard salt. Furthermore, in
cheese it has been demonstrated that the particles result in a more even distribution
of the salt.

**Effect on Taste/Consumer Acceptability**

Based on the information provided, due to the smaller particle size, the saltiness
perception is enhanced meaning that Soda-Lo® can be used at lower levels than
standard salt. When used at the correct levels there is no impact on taste and this
has been demonstrated in bread and cheese. It is being used commercially in bread,
pies and pastry and pizza bases.

**Effect on retailers’/manufacturers’ clean label policies**

Soda-Lo® is labelled simply as salt so there is no impact on labelling or clean label
policy.
Cost Implications
It was indicated that Soda-Lo® is more expensive than standard salt but it is used at lower levels. However, in-use cost is still likely to be higher than using standard salt.

Other Barriers/ Risks
Further work is required using Soda-Lo® in product applications such as bacon and cured meats. However, in the applications where research has been carried out good success has been achieved as demonstrated by the commercial use of the product by several manufacturers.
**SeaGreens®**

*Description of the method/ingredient*
Seagreens is a wrack seaweed product (Ascophyllum nodosum). It naturally contains salt but typically at levels as low as 0.09g salt /g. In addition it contains a naturally high mineral content e.g. 1.5% calcium and 1.75% potassium.

*Potential applications / product scope*
Research conducted at Sheffield Hallam University and Teeside University has demonstrated taste and textural acceptability in breads. In particular breads with additions for example sundried tomato and basil bread, it was shown using sensory panels that product manufactured with 100% coarse wrack (0.3gsalt/100g bread)was preferred to a control with 1.3gsalt/100g loaf. There was no negative effect on bake and sensory quality but effect on shelf-life was not considered.

*Beneficial attributes*
Initial research has also shown that seaweed enriched bread may impact on satiety as well as reducing sodium levels (Hall et al, 2012)

*Effect on product shelf life and safety*
Awaiting feedback from Sheffield Hallam University.

*Effect on product functionality*
Results in bread indicated that there was no impact on bake quality in bread.

*Effect on taste/consumer acceptability*
Sensory evaluations have been conducted, and are currently on-going, information is not available as publication in peer-reviewed journals is planned.

*Effect on retailers’/ manufacturers’ clean label policies*
Labelled as Seagreens (Ascophyllum nodosum), this is a clean label product that is also manufactured from a sustainable source.

*Cost implications*
More expensive in use cost than salt.

*Other Barriers/ Risks*
The green colour effect it imparts into foodstuffs is an important consideration to make.
Sea SaltTrim™ by Wild Flavor

Description of the method/ingredient
The company indicated that Sea SaltTrim™ is comprised of low sodium sea salt, naturally rich in potassium chloride and other minerals, combined with a WILD natural flavouring that overcomes the bitter metallic notes of the potassium.

Potential applications / product scope
The company indicated that Sea SaltTrim™ is suitable to replace common salt in the following applications:
- Soups, sauces and salad dressings
- Meats
- Bread and baked goods
- Salty snacks
- Meal kits, side dishes and frozen entrees
- Canned foods
- Vegetable beverages and bouillons, cube and powders

Beneficial attributes
It was indicated that Sea SaltTrim™ is a 1:1 replacement system for salt in foods. Incorporation of Sea SaltTrim™ instead of salt imparts a salty/umami taste without the high sodium levels as it contains 45% less sodium than salt. Sea SaltTrim™ is also kosher, non-GMO, vegetarian and non-allergenic.

Effect on product shelf life and safety
The company indicated that considerable work has been carried out with Sea SaltTrim™ in various applications, however all foods tested also contained chemical preservatives and it wasn't the aim of the work to determine microbiological stability in these systems utilizing Sea SaltTrim™. The company further indicated that although Sea SaltTrim™ will suppress water activity in a similar way to sodium chloride, it cannot be claimed that adequate work has been carried out to-date to determine the safety of products containing Sea SaltTrim™. Furthermore, independent trials may have been carried out by food manufacturers using Sea SaltTrim™ and data will therefore be confidential.
**Effect on product functionality**
No particular effect was indicated.

**Effect on taste/consumer acceptability**
A consumer acceptability study has been conducted with potato chips using employees as test subjects. Samples were blind coded. No significant differences were identified between acceptability and perceived saltiness by Wild flavour. Please refer to Appendix 7 for a full set of response to the Sensory and Consumer Acceptability Criteria document.

**Effect on retailers’ / manufacturers’ clean label policies**
It was indicated that labelling would involve: low sodium sea salt/ natural flavouring.

**Cost implications**
It was indicated that Sea SaltTrim® as in the case of other salt replacement technologies, is more costly than common salt, however cost implications depend upon the final use rate of Sea SaltTrim® in the finished product.

**Other Barriers/ Risks**
No known barriers or risks associated with Sea SaltTrim® were identified.
Summary of Food Safety and Shelf-Life Responses

Table 2 below summarises the shelf-life trials and challenge testing that has been conducted on each of the potential solutions identified.
Table 2: Summary of Food safety and Shelf life information

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<thead>
<tr>
<th>Company</th>
<th>Product</th>
<th>Shelf life trials</th>
<th>Challenge trials</th>
<th>Comments</th>
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<td>Work done to standards; reports can be available</td>
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<td>DSM</td>
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<td>SaltPrint® 4D and 5D</td>
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<td>Work carried out by customers so results and experimental details not</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>available</td>
</tr>
<tr>
<td>Innophos</td>
<td>Superbind™ HB-CT</td>
<td>Yes</td>
<td>No</td>
<td>Products are new and so all food safety work is in progress at the</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>moment. Challenge tests scheduled later on for sausages</td>
</tr>
<tr>
<td>Cargill</td>
<td>FlakeSelect™ &amp; SodiumSense™</td>
<td>Yes</td>
<td>No</td>
<td>To-date shelf life analysis done only; this is an on-going research</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>program</td>
</tr>
<tr>
<td>Kudos Blends</td>
<td>KUDOS™ potassium bicarbonate</td>
<td>No</td>
<td>No</td>
<td>Indicated that shelf life trials of baking powders containing the ingredient have been carried out. Reports can be available, upon request</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------------</td>
<td>----</td>
<td>----</td>
<td>---------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Eminate</td>
<td>Soda-Lo®</td>
<td>Yes</td>
<td>No</td>
<td>Work in progress so data cannot be available</td>
</tr>
<tr>
<td>SeaGreens</td>
<td>Seaweed</td>
<td>No</td>
<td>No</td>
<td>Shelf life work is on-going and commercially sensitive. Some of the work may be published in peer review journals so cannot yet become available</td>
</tr>
<tr>
<td>Wild Flavours</td>
<td>Sea SaltTrim™</td>
<td>No</td>
<td>No</td>
<td>Although extensive work has been done, food safety and shelf life trials have not been looked due to the presence of chemical preservatives in products. Any work done by food manufacturers is not accessible.</td>
</tr>
</tbody>
</table>

The data gathering exercise indicated that:

For the purpose of this report, accessible data on the effects of salt reduction technologies, developed in the last 12-18 months, on the shelf life and safety of real food products is very limited. Following the responses received as part of this project, and other discussions with relevant parties, some of the main reasons for the lack of such information are summarized below:

- Technologies included in this report have only been developed in the last 12-18 months and so such trials are currently in progress or have not yet started.
- Manufacturers of salt reduction technologies do not necessarily have access to such information. It is generally expected that food product manufacturers interested in talking up the different solutions would be responsible to carry out the necessary trials as relevant to their own food products.
- License agreements, patents, or other publications covering the technological details or efficacy of individual technologies are in progress making access to the results limited or confidential to specific parties.
- Some salt reduction technology manufacturers believe that as long as it is shown that their individual salt reduction technology does not affect the water
activity of the food products, food safety and/or shelf life trials may not be necessary.

- The shelf life analysis of salt reduction ingredients in isolation has been considered sufficient.
- High costs involved in carrying out food safety and shelf life trials put off companies developing salt reduction technologies especially when access to food manufacturing facilities is also required in the manufacturing of products containing the new salt reduction technologies.

Furthermore, it was made clear that there is an overall confusion around the need to conduct shelf life and/or microbiological challenge trials to determine the safety and stability of a new product formulation (containing new salt reduction ingredients in this case). Lack of industry-wide guidelines advising on the nature and level of food safety and shelf life work required is thought to be the main reason for such confusion.
Research Projects

As part of this review, several research organisations were contacted and provided information on current and ongoing research in the area of salt reduction technologies. Leatherhead Food Research would like to acknowledge Campden BRI, TNO and Nottingham University for their contribution of research reports.

Campden BRI (UK)

A comprehensive review was conducted to outline the current state of knowledge of the effect of salt on dough and bread quality, their underlying causes and potential solutions (Gates et al, 2011). Much of the literature indicates that a key reason for the reduced quality of low salt bread is the reduction in mixing stability. Reducing mixing energy and using flour with higher mixing stability are potential solutions to this problem. This review concludes that replacement of sodium chloride with potassium chloride on an equimolar basis appears to result in bread with similar technological properties, but that total replacement of sodium chloride with potassium chloride is not possible for both safety and organoleptic reasons.

In response to the fact that large scale plant bakers experience difficulties in reducing the salt content of premium bread due to changes in the handling properties of dough at reduced salt contents, the FSA funded a project to understanding the influence of physical and chemical properties on stickiness, collapse and open texture in bread (Spiers et al, 2009). This project essentially focused on how the level of salt addition affected the dynamics of water and salt distribution in the mixed dough. Carried out by Campden BRI in collaboration with Nottingham University and Food Processing Faraday, the findings of this research do not give rise to a limited set of well-defined actions for bakers to undertake to facilitate the processing of dough with reduced salt content. There are however positive indications of approaches which could be helpful. These include use of methods to increase the elasticity of the dough which may help overcome the reduction in elasticity as salt content is lowered; the use of different qualities of raw materials or mixing regimes optimised for reduced salt and use of ingredients to remove naturally present materials which interfere with gluten development. What is clear is that the effects of salt on dough handling are most probably mediated through different mechanisms from the effects on loaf volume and that therefore different strategies will be required to address each consequence. Any
loss of loaf volume experienced as salt content is reduced might be compensated for by the use of raw materials or ingredients which delay the onset of starch gelatinisation. In addition, ingredients which maintain a gas-tight dough to higher temperature could have a role to play. There is potential for further work to be conducted in this area to further understand the effects of salt on dough handling.

TNO: - Reduction of Sodium in Meat Products (Netherlands)

The role of sodium in meat products is dependent on the type of meat product concerned. In some cases such as sausages and cooked ham it is the effect of sodium chloride on the myofibrillar proteins that is of key importance, whereas in dried fermented products like salamis the effect of shelf-life is more important. One of the key replacers for sodium chloride in meat products is potassium chloride and despite negative connotations with its taste, some companies have successfully launched products containing potassium salts and reduced sodium. Work published by TNO highlights that when exchanging cations in meat products, this should be based on the ion content as opposed to the gram level to achieve comparable results in terms of texture and shelflife. Bearing this in mind, replacing sodium chloride with potassium chloride would result in more KCl g/g having to be added to achieve the same level of ions. This therefore increases the risk of off taste (Verkleij, Goldbohm and de Jong, 2011).

In products where water and or fat binding is essential such as sausages or cooked ham, the major role of salt is the solubilisation of the myofibrillar proteins. A certain amount of myofibrillar protein is necessary to obtain and retain good structure after heating. Simply reducing the salt levels lowers the protein solubility and results in reduced water holding capacity. Recent work at TNO, has demonstrated that in fact chloride is far more important than sodium with respect to the solubilisation of the myofibrillar proteins and water binding and that some other anions, iodides in particular perform even better than chloride. However this work addressed only this function of salt and did not address consequence on product taste or shelf-life (Verkleij and de Jong, 2010).

In dry fermented meat products such as salami the role of salt is not related to the solubilisation of the protein but to the minimisation of free water and prevention of microbial growth.
TNO have also carried out a project in bacon looking at the effect of different brine compositions on structure and yield. These compositions based on combinations of potassium chloride and potassium lactate were tested on a small industrial scale by multi needle injection and tumbling. The sensory properties of the bacon slices were assessed by trained sensory panels with respect to colour, external appearance, consistency, taste and smell. On the basis of this research some companies in the Netherlands successfully launched bacon with up to 40% lower sodium content, without adversely affecting taste, yield, structure and shelf-life of the bacon (Verkleij, 2009). The resultant products contained approx 3g/100g salt which is slightly above the current 2012 target. It should also be noted that bacon in the Netherlands is different to bacon produced in the UK.

**Technology Strategy Board (UK)**

A TSB consortium project was carried out between 2007 and 2010 to develop and demonstrate advanced process technologies and product microstructures that could allow up to 80% salt reduction in processed foods without adversely affecting flavour. Conducted by partners Unilever, Ansys, University of Nottingham and the University of Birmingham, novel tools and methods were used firstly to establish the ‘design rules’ for saltiness perception, secondly to engineer and model complex product microstructures, and thirdly to measure and control salt release from food materials. Design and processing of double emulsions, shown in schematic form below in Figure 9, were at the core of the research as this microstructure offers the possibility of ‘partitioning’ salt to enhance perception in liquid and semi-liquid food products.

![Figure 9: Schematic Diagram of W/O/W Emulsion](source: Leatherhead Food Research)
Using double emulsions (w/o/w), the sodium can be concentrated in the external aqueous phase while the internal aqueous phase does not contain sodium, which results in an overall reduction of the sodium content. W/O/W or water in oil in water emulsions were used to validate the hypothesis that increasing salt concentration in the external product phase of an aqueous based semi-liquid food enhances salt perception by comparing saltiness perception from these emulsions to saltiness perception from single emulsions of the same oil content and comparable droplet size distribution. Applying the same levels of oil and salt as in model emulsions a statistically significant number of trained sensory panellists found a double emulsion based liquid food product saltier than a single emulsion based product. To further extend this finding, a single emulsion was created and compared to a double emulsion containing 10% less salt than the single emulsion. Sensory evaluation of the samples indicated no significant difference in saltiness was perceived between the samples suggesting that double emulsions offer an advantage when employed in ‘real food’ systems, enabling a reduction in salt to be achieved but resulting in no significant difference in the consumer’s perception of salt. This technique is only of interest in liquid food products based on emulsions such as sauces.

**Nottingham University (UK)**

Nottingham University are currently actively researching how salt crystals could be developed to get across the saliva barrier faster. This research which will be carried out over the next four years could potentially enable less salt to be used in food products, but with the same salt perception by the consumer.

**Danish Meat Research Institute (DMRI) (Denmark)**

In a slaughterhouse many co-products such as trimmed meat, mechanical deboned meat and bone cake are available. These raw materials from beef, pork and poultry can be used to produce meat protein extract or MPE via an enzymatic process. An investigation was carried out on the effect of MPE as a meat ingredient replacer in sodium reduced ham. DMRI performed several pilot plant studies to assess the benefits of MPE in processed meat. When used in production of cooked cured ham, the trials demonstrated that it is possible to reduce salt content up to 36% without affecting the taste, flavor, colour and texture of the cooked cured ham. They were able to produce a ham product with only 1.6% salt which was acceptable from a
sensory point of view but the impact on safety was not assessed (Mehrtens Rothe, 2011).

**Leatherhead Food Research (UK)**

Following on from work on salt or different particle sizes, Leatherhead is currently conducting a study to evaluate emerging micro- and nano-technologies for enhanced ingredient functionality. This project will investigate ways to alter the size of ingredients and assess how this influences behaviour in food products. This is a member funded project due for completion by 2013.
Conclusions

The FDF and BRC have identified eight product categories in which meeting the 2012 FSA targets has presented a challenge. In this review Leatherhead Food Research have highlighted the key issues with replacing or reducing salt in these product categories.

Companies that have so far made good progress in salt reduction using small step reductions may now need to consider use of new ingredients or technologies to achieve further reductions.

New and emerging ingredients, technologies and ongoing research on salt reduction have been reviewed. It is fair to say that there is no simple solution for each of the food categories concerned but solutions that offer potential in part have been highlighted.

The challenges in reducing salt are different in different product categories and the multiple functions of salt in each application need to be considered when reducing salt. When making reductions, all sources of sodium in a given application need to be taken into account. For example much of the sodium in bakery products comes from the baking powder.

Ingredients that may be used to help further reduce salt are based on mineral salts, flavour enhancers, products that enhance umami or combinations of these ingredients together.

One key trend with consumers over the last few years has been clean label and “natural”. This means that many of the potential solutions for salt reduction whilst offering a technological solution may not be acceptable to the consumer.

In addition there is reluctance towards using ingredients solutions based on potassium salts on the basis of clear and consistent advice from the FSA and DH not to use potassium based salt replacement ingredients.
Other technologies are based on adjusted salt crystal size or structure and these technologies are more aligned with consumer demand for clean label policies as in some cases often they require labelling simply as “salt”.

The solutions or technologies identified are likely to cost more than salt but it is unlikely this price premium could be passed on to the consumer in the finished product. Given the current economic climate, it is likely this may represent a key barrier to further investigation of the technological solutions identified at this time.

With regards to information on food safety, access to information on the effects of the different technologies on the safety and shelf life of real food products has been limited. Such information is either confidential to specific manufacturers, and therefore open access is restricted, or work is currently in progress.

Leatherhead’s research has further highlighted the fact that there is a lack of clarity around the need to conduct shelf life and/or microbiological challenge trials to determine the safety and stability of a new product formulation (containing new salt reduction ingredients in this case). Cases of shelf life trials of the individual ingredients, rather than of food products containing them, have sometimes been reported. However ingredient manufacturers tend to assume the responsibility for producing this data rests with the food manufacturers. In reality, often work will have to be undertaken collaboratively. Lack of industry-wide guidelines detailing the food safety and shelf life work required is thought to be the main reason for such lack of clarity.

In all food categories identified it is possible to find products on the market that are in compliance with the FSA 2012 targets. However, it would be simplistic to assume that this means all products within that category can utilise the same formulation or technology. Each manufacturer would need to carry out trials to assess a solution for their own formulation and processing conditions, and then verify the finished products from a sensory, safety, labelling and cost perspective.
In order to facilitate further salt reduction the following recommendations have been reached based on an assessment of current difficulties in implementing identified solutions:

1. DH should review their advice against using potassium based solutions, and consider if there are specific applications, for example raising agents, or food categories for which the use of potassium may be appropriate.

2. Some new technologies identified might require EU approval, for example novel foods, nanotechnologies. Industry bodies should work with appropriate government departments to ensure there is widespread awareness and knowledge of the process an ingredient or technology would need to undergo.

3. It is recommended that industry bodies and the FSA work together to produce simple guidance on minimum food safety requirements that ingredient manufacturers should meet prior to marketing products.
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Verkleij T J, Stekelenburg F K. Sodium reduction in bacon, how industry meets research. TNO Quality of Life, Internal Document

Verkleij T J, de Jong G A H. Reducing the sodium level of meat products shouldn’t be difficult. TNO Quality of Life, Internal Document


### Appendix 1a: Literature Review Design

Searches were conducted on Leatherhead Food Research's Foodline web database in order to identify papers of relevance to the key categories of food products concerned with the project. The full search strategy is outlined below. In total 740 papers and patents were identified as being of relevance to the project.

<table>
<thead>
<tr>
<th>Search ID</th>
<th>Search Term</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1112</td>
<td>Salt OR Sodium chloride OR sodium OR NaCl</td>
<td>39436</td>
</tr>
<tr>
<td>S1094</td>
<td>replace* or enhance* or reduc* or reform*</td>
<td>138789</td>
</tr>
<tr>
<td>S1109</td>
<td>canned and (fish or tuna or salmon or sardine* or mackerel or pilchard* or shellfish or prawn* or crab or mussel*)</td>
<td>1697</td>
</tr>
<tr>
<td>S1108</td>
<td>pudding* or dessert* or crumble* or trifle*</td>
<td>7636</td>
</tr>
<tr>
<td>S1107</td>
<td>pesto or (sauce and (stir fry or thick or thai or curry or pasta)) or paste*</td>
<td>18086</td>
</tr>
<tr>
<td>S1106</td>
<td>cake* or sponge or malt loaf or muffin or doughnut or donut or flapjack or brownie or iced finger* or pastry or pastries or danish or fruit pie or dessert* or apple pie* or tarte au citron or tarte au chocolat or treacle tart or lemon meringue or custard tart or banoffee pie or eclair or profiterole* or choux bun*</td>
<td>19219</td>
</tr>
<tr>
<td>S1105</td>
<td>extruded snack* or corn puff or potato hoop or savoury snack* or pellet*</td>
<td>2730</td>
</tr>
<tr>
<td>S1103</td>
<td>(cheese* and (hard or cheddar or cheshire or lancashire or wensleydale or caerphilly or double gloucester or leicester or derby)) or fresh cheese or soft cheese or reduced fat cheese</td>
<td>6860</td>
</tr>
<tr>
<td>S1102</td>
<td>(bread and (roll* or speciality or specialty or cheese or olive* or sundried tomato)) or morning goods or scone* or crumpet* or pikelet* or muffin* or pancake* or bagel* or croissant* or brioch or soda farl or waffle* or hot cross bun or teacake</td>
<td>4954</td>
</tr>
<tr>
<td>ID</td>
<td>Description</td>
<td>Score</td>
</tr>
<tr>
<td>------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>S1101 J/B/P/I</td>
<td>(bacon and (sliced or streaky or smoked or unsmoked or joint)) or ham or cured meat or sausage* or sausage meat or meat stuffing or meat pie or pork pie* or sausage roll* or game pie* or cornish pasty or meat pasty or meat-based pastry or beef or lamb or chicken or turkey or pork or comminute or chopped or reform* or burger* or grillssteak or hamburger or kebab* or frankfurter* or hotdog*</td>
<td>82189</td>
</tr>
<tr>
<td>S1098 J/B/P/I</td>
<td>shelf-life or safe* or preserv* or micro* or water activity or acidity or pH</td>
<td>231468</td>
</tr>
<tr>
<td>S1095 J/B/P/I</td>
<td>function* or flavour or flavor or texture or perception or colour or color or viscosity or thick* or mouthfeel or physical characteristic* or taste or stability or sensory or aroma or smell or odour or odor or bitter or umami or metallic or astringen* or kokumi or appearance or ferment* or enzyme or quality</td>
<td>360803</td>
</tr>
<tr>
<td>S1113 J/B/P/I</td>
<td>(S1112 AND S1094 AND (S1095 OR S1098) AND (S1101 OR S1103 OR S1105 OR S1106 OR S1107 OR S1108 OR S1109)) After 01/01/2005</td>
<td>741</td>
</tr>
</tbody>
</table>
Appendix 1b: Industry Survey Questions

Industry Survey Questions

Front Page: About the Survey
Leatherhead Food Research has been appointed by the Food and Drink Federation (FDF) and the British Retail Consortium (BRC) to provide a review of the full range of technological solutions available for salt reduction in food.

We aim to provide:

- A comprehensive list of known technological solutions
- A guide as to which applications these products may be useful for salt replacement or reduction
- An evaluation of scientific studies backing up potential solutions in order to identify any knowledge gaps

This is part of the FDF and BRC commitment to the Secretary of State’s Responsibility Deal whereby they undertook to commit to the 2012 targets for NaCl levels in food providing that workable technical solutions could be found.

As part of this project, Leatherhead is conducting a survey which we would welcome your input to.

Section 1: Your Details
Name:
Company:
Job Title:
Phone:
Email:

Section 2: Survey

1. Does your company currently provide any salt reduction solutions?

[Response type: Yes/No answer]
If yes go to Q2. If no go to Q1a.

1a. Does your company intend to develop any salt reduction solutions?

[Response type: yes, no, unaware]
If yes go to Q1b. If no/unaware go to end page.
1b. If appropriate please outline what scientific studies you intend to undertake.
[Response type: comment box]
Route all to Q6

2. Please list all the products you have available.
[Response type: comment box]

3. Please mark on the table below which product categories each solution is suitable for and which function or functions of salt it has been demonstrated to offer.

<table>
<thead>
<tr>
<th></th>
<th>Safety and shelf-life</th>
<th>Physical Stability</th>
<th>Sensory characteristics</th>
<th>Consumer Acceptance</th>
<th>Other (please specify below)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat and meat products</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bread and cereal products</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cheese products</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extruded and pelleted snacks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cakes, pastries, fruit pies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Pesto and other thick sauces</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All other puddings</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Canned fish</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

4. Have you conducted scientific studies to validate your salt reduction solutions?
   [Response type: Yes/No answer AND comment box]

5. Were these studies conducted internally or did you use an independent third party?
   [Response type: comment box]

6. Would you be happy to provide a full and formal copy of the report produced in each case?
   [Response type: yes/no answer]

7. Are you happy for us to contact you and discuss the work conducted in more detail? If Yes, please provide us with the details of the most appropriate contact in the comment box below.
End page:
Thank you for taking the time to complete this survey, your contribution is greatly appreciated.

Appendix 2: Safety Criteria Evaluation

1. Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.

2. Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technology.

3. Shelf life Vs Challenge test trials. Please indicate the type of analysis you have conducted in food safety trials that you have conducted.

4. Types of products per sector tested

<table>
<thead>
<tr>
<th>Meat and meat products</th>
<th>Please add specific products e.g. hams, sausages, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bread and cereal products</td>
<td></td>
</tr>
<tr>
<td>Cheese products</td>
<td></td>
</tr>
<tr>
<td>Extruded &amp; pelleted snacks</td>
<td></td>
</tr>
<tr>
<td>Cakes, pastries, fruit pies</td>
<td></td>
</tr>
<tr>
<td>Pesto &amp; thick sauces</td>
<td></td>
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<tr>
<td>Puddings</td>
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<tr>
<td>Canned fish</td>
<td></td>
</tr>
</tbody>
</table>
5. Please provide an indication of the level of interest your solution(s) have received from industry so far.


7. Accreditation status of labs doing the work. Please state.

8. Can reports/results be available if requested? Please indicate.

9. Some information on experimental details covering the following aspects is required. Please indicate the:
   - Number and type of microorganisms used in challenge testing (if appropriate)
   - Inoculation approach and strain pre-adaptation conditions
   - Number of replicates set up (no of batches tested for shelf life and/or challenge testing trials conducted)
   - Packaging, atmosphere and storage conditions
   - Duration of trials
   - Recovery methods used and overall sampling plan
   - Controls (negative and positive) set-up
   - Results: calculations and interpretation Vs claim verification. Please indicate the approach followed.

10. Please confirm that you are happy for us to include the above information within our final report.
Appendix 3: Sensory Criteria Evaluation

1. Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.

2. Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technologies.

3. Sensory analysis Vs Consumer acceptability trials. Please indicate the type of analysis you have conducted.

4. Types of products per sector tested in each type of trials

<table>
<thead>
<tr>
<th>Meat and meat products</th>
<th>Please add specific products e.g. hams, sausages, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bread and cereal products</td>
<td></td>
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<tr>
<td>Cheese products</td>
<td></td>
</tr>
<tr>
<td>Extruded &amp; pelleted snacks</td>
<td></td>
</tr>
<tr>
<td>Cakes, pastries, fruit pies</td>
<td></td>
</tr>
<tr>
<td>Pesto &amp; thick sauces</td>
<td></td>
</tr>
<tr>
<td>Puddings</td>
<td></td>
</tr>
<tr>
<td>Canned fish</td>
<td></td>
</tr>
</tbody>
</table>
5. Please provide an indication of the level of interest your solution(s) have received from industry so far.

6. Work done in-house/externally. Please indicate

7. Accreditation status of labs doing the work. Please state

8. Can reports/results be available, if requested? Please indicate

9. Some information on experimental details covering the following aspects are required:
   - Please provide an overview of the methodology used in each type of trials (Sensory & Consumer)
   - Please indicate the types of control trials conducted in each case
   - Please indicate the number of participants (trained panel & consumers) involved in each case
   - Please indicate the number of replicates set up in each case
   - Please indicate the use of any palate cleansers during the trials
   - Please confirm the statistical package/process used in the analysis of the data obtained
   - Please confirm the relevant claims that you are making for your solutions
## Appendix 4: List of Companies Sent Industry Questionnaire

**List of businesses surveyed***

<table>
<thead>
<tr>
<th>ABF Ingredients</th>
<th>Kerrygold Company Ltd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ajinomoto</td>
<td>Klinge Foods Ltd</td>
</tr>
<tr>
<td>BASF plc</td>
<td>Kyowa Hakko Europe</td>
</tr>
<tr>
<td>Biocatalysts Ltd</td>
<td>Leiber GmbH</td>
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<td>Biorigin</td>
<td>Lesaffre International</td>
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<td>Bioriginal Europe/Asia</td>
<td>LycoRed Ltd</td>
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<td>Carbery Food Ingredients Ltd</td>
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<td>Carbery Milk Products Ltd</td>
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<td>Cargill</td>
<td>Nutrinova GmbH</td>
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<td>Ogawa &amp; Co Ltd</td>
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<td>Kemira Oyj</td>
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<td>Kerry Foods</td>
<td>Wild Flavors Inc</td>
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*Please note that this list does not include all subsidiaries and divisions included in the survey distribution.*
Appendix 5: Responses to General Information Evaluation

Company: Smart Salt
Product: Smart Salt®

1. Please provide us with a brief description of your salt reduction solution(s)

Smart Salt® is the name given to a sodium reduction system which is based on a novel, unique and patented taste enhancement technology. The salt reduction system is based on magnesal, as either a triple or double co-crystallised mineral salt that is rich in magnesium. The Smart Salt® sodium/salt reduction system is a mineral salt solution.

2. Please provide us with an overview of the potential applications/product scope

Production blends of Smart Salt® have been optimised to use as 1:1 replacements for salt in most food applications, including table top products, based on stability and taste quality. However it is possible to blend magnesal with regular salt (sodium chloride), potassium chloride, sea salt and flavours to optimise formulations. It has been shown that using magnesal/sodium chloride blends, with no added potassium chloride, have been successful in some applications.

Using Smart Salt® technology allows 40 -50% sodium reduction in a broad range of food products which means that national sodium targets can be reached.

All Smart Salt® products are available as low- potassium or potassium-free and with the possibility of “natural” labelling in some markets.

Formulating options include the following:

Formulating with Option 1

Optimised blends of mineral salts are available based on magnesal. Taste characteristics have been optimised for a 1:1 replacement for salt. This allows easy handling for rapid formulation evaluation and development. The optimised blends are available with 20 – 60% sodium reduction levels.

Formulating with Option 2

Magnesal can be used to make in-house blends with other salts such as sodium chloride, sea salt and other ingredients such as umami-based flavours. Magnesal
has taste enhancement qualities which allows perfect optimisation of taste and sodium reduction levels with an improved and economic cost in use.

3. Please highlight any potential beneficial attributes of your salt reduction solutions

Smart Salt® has the following potential beneficial attributes:

- Reduces blood pressure - clinical evidence of efficacy
  An 8 week intervention study has indicated that Smart Salt® when used as a sodium chloride substitute in a broad range of industrially produced food products (salami, frankfurters, bread, soup, meatballs, RTE – meals based on pasta and minced meat, pizzas, casseroles, cheese and table salt) can significantly decrease systolic blood pressure compared to regular salt and also reduce daily sodium consumption by 3.3g to 5.75g/day.

Sarkkinen ES, Kastarinen MJ, Niskanen TH, Karjalainen, PH, Venäläinen TM, Udani, JK and Niskanen LK Feasibility and antihypertensive effect of...
replacing regular salt with mineral salt-rich in magnesium and potassium – in subjects with mildly elevated blood pressure. Results presented at The World Hypertensive Congress 2009, Beijing, China. Published by Nutrition Journal 2011, 10:88 and available at http://www.nutritionj.com/content/10/1/88

- Provides a salty taste with no bitter or metallic aftertastes - with up to 60% less sodium
- Provides a broad range of application opportunities due to its proven taste, preservation and technological functionality
- Reduces the use of other costly seasonings
- Reduces or eliminates the use of monosodium glutamate or yeast extracts
- Flexibility with its compositional components to correspond with your reformulating needs
- Perfect taste optimisation of formulations due to low levels of potassium – allowing controlled cost in use
- Delivers the additional health benefits of magnesium
- Offers sodium or salt reduction claim opportunities
- Easy handling because of its 1:1 replacement for salt and non-hygroscopic nature

Extensive taste testing using techniques such as Quantitative Descriptive Analysis (QDA), Progressive Profiling (PP) and Consumer Acceptance Trials (CAT) have been carried out both in the US and in Europe at independent research establishments.
In addition to basic shelf-life testing, two major microbiological challenge tests for the pathogenic species *Listeria monocytogenes* and *Bacillus cereus* were conducted in meat and bread products respectively with very positive outcomes.
Data have indicated that Smart Salt® products have a very high consumer acceptability compared to full salt products even at salt reduction levels of 40-50% with no significant difference in taste or preservation qualities of the final product.
Proof of concept: Smart Salt® has been evaluated in a very broad range of food products since 2006 - mainly in the USA. Its success can be attributed to its technological functionality, including a taste and preservation quality, that often mirrors regular salt. Preservation and technological functionality is not always achievable with sodium reducing products based on flavours.
All mineral salts used in Smart Salt® are approved for food use. Smart Salt® is food grade and suitable for food products in accordance with FCC, FAO/WHO and EC rules and regulations. It is GRAS (Generally Recognised as Safe) by US Food and Drugs Administration.

4. Please advice on the effect of your solution(s) on retailers and food manufacturers’ clean label policies

In the EU and UK magnesal labelling will be a combination of the following components depending on the final choice of reduction system:

- magnesium chloride, potassium chloride and flavouring
- magnesium chloride and potassium chloride
- magnesium chloride and flavouring

5. Please indicate any cost implications in the use of your solutions

Smart Salt® products are priced similarly to other low sodium mineral salts in the market because of the higher cost for magnesium chloride and potassium chloride. However, due to the low usage level of salt in the food products (typically 0.5 - 2% w/w), the cost increase is very marginal. At an usage level of 1%w/w, the additional production cost for a food product is about 0.02 EUR/kg food.

6. Please highlight any potential barriers or risks associated with the use of your solutions that we may need to be aware of.

No potential barriers or risks are anticipated to be associated with the use of Smart Salt®.

Magnesal and associated blends are potential taste enhancers. The following observations have been made through product development and formal taste trials:

- Smart Salt blends, SMS50 and SMS40 intensify: black pepper, green pepper, all spice, dried garlic, cinnamon, bay leaf, horseradish, rosemary, thyme and sage without extraneous flavours. Regular salt did not intensify these flavours at equivalent w/w addition.
- Spices unaffected by SMS50 and SMS40: parsley, coriander, dill, thyme and basil, dried onion and chilli powder.
- Magnesal, SMS40 and SMS45LA intensifies umami flavours
The following practical advice is given when considering reformulation with magnesal or Smart Salt ® blends vis a vis – flavour. This allows potential formulation cost savings of other ingredients.

- Reduce initial monosodium glutamate, yeast extract and spice seasoning by 50% and add back to formulations as required.
- Bitter spices such as turmeric, curcumin and nutmeg should be added to taste.
- Magnesal has taste synergy with other mineral salts and flavour modulators/enhancers – allowing the optimum level of sodium reduction with a balanced flavour profile.

7. Please confirm that you are happy for us to include the above information in our final report

It is confirmed that you can use the above information in your final report
Company: AkzoNobel
Product: Loso OneGrain™

1. Please provide us with a brief description of your salt reduction solution(s).

Loso OneGrain™
It's in the name. OneGrain technology turns salt into a free-flowing, easy-to-handle carrier of flavours, nutrients – whatever is required. It stores like salt, it behaves like salt, it can be used exactly like salt. In fact, OneGrain is a genuine like-for-like replacement for salt – in function and taste. In our current commercial products sodium chloride, potassium chloride and a flavour (yeast extract) are combined in one salt grain.

2. Please provide us with an overview of the potential applications/product scope.

In fact all food products. Examples: bakery, meat, diary, snacks, soups & sauces.

3. Please highlight any potential beneficial attributes of your salt reduction solutions.

Easy and effective 1 to 1 salt replacement, achieving up to 50% sodium reduction while keeping great taste and functionalities of salt.

4. Please advise on the effect of your solution(s) on retailers and food manufacturers’ clean label policies.

Loso OneGrain A30 and B50 are fully natural products. Loso OneGrain A50 contains a nature identical flavour.

5. Please indicate any cost implications in the use of your solutions.
Cost is use is dependent on the application, e.g.:
- in 100 gram bread ~€ 0,004
- in 100 gram of meat ~€ 0,005
- chicken soup: rm cost +18% = €0.003/serving
- crisps: rm cost +8% = €0.008/serving

6. Please highlight any potential barriers or risks associated with the use of your solutions that we may need to be aware of.

No barriers other than opinion that potassium chloride has negative perception, which is a shame since potassium chloride has even positive health benefits

7. Please confirm that you are happy for us to include the above information in our final report.

Approved
Company: Cargill
Product: SodiumSense™ and FlakeSelect™

1. Please provide us with a brief description of your salt reduction solution(s).
   a. Alberger® salts – unique crystal morphology that allows maximum flavour burst and salt intensity for topical applications.
   b. FlakeSelect™ – patent pending process that physically modifies single or multiple ingredients to add functionality.
   c. Premier™ potassium chloride – developed to meet the needs of food manufacturers for replacement of sodium chloride or potassium replacement.
   d. SaltWise® reduced sodium system – sodium reduction product formulated to provide similar liking as full salted food products.
   e. SodiumSense™ – a cost effective sodium reduction product formulated to provide similar liking as full salted food products.

2. Please provide us with an overview of the potential applications/product scope.
   a. Cargill reduced sodium product portfolio was developed to satisfy the needs of a broad range of applications including, meats (e.g. beef, pork and poultry), cheese (natural), sauces (e.g. tomato and cream based), soups (e.g. tomato, broth) dressings (e.g. tomato and cream based), bakery products (e.g. yeast and chemical leavened), cereal, chips (e.g. potato, tortilla).

3. Please highlight any potential beneficial attributes of your salt reduction solutions.
   a. Cargill’s reduced sodium solutions are designed to address the functional roles of salt in food applications, such as, taste (salty and flavour enhancement), texture, protein modification and microbial management.
b. Considering the Cargill solutions listed above, potassium chloride is a major component and will provide similar functionalities as salt.

c. To help mitigate potential flavour changes and help build back the flavour enhancement properties of salt, natural flavours are added to some of the solutions.

4. Please advise on the effect of your solution(s) on retailers and food manufacturers’ clean label policies.

a. In some applications, particle size and crystal morphology can be leveraged to help impart an intense salty impression by understanding the relationship between surface area and rates of dissolution. This benefit is most successful in topical or in systems where there is limited water availability. In this case, the label would read “salt”.

b. For our other solutions, the ingredient label declaration is geographically dependent.

i. US

1. Alberger® – Salt
2. FlakeSelect™ – “Potassium chloride” or “Salt and Potassium Chloride”
3. Premier™ potassium chloride – Potassium Chloride
4. SaltWise® – “Potassium Chloride and Natural Flavourings” or “Potassium Chloride, Autolyzed Yeast Extract and Natural Flavorings”
5. SodiumSense™ – “Potassium Chloride and Natural Flavourings” or “Potassium Chloride, Autolyzed Yeast Extract and Natural Flavorings”

5. Please indicate any cost implications in the use of your solutions.

a. For any solution, including just removing salt, the cost structure will most likely increase. Therefore it is best to evaluate the formulation as a whole to determine if there is other cost saving opportunities.

b. Cost implications will range between 2.5 to 25 times the price of basic salt depending on the solution
6. Please highlight any potential barriers or risks associated with the use of your solutions that we may need to be aware of.

   a. Cost was discussed above
   b. Clean label
   c. Product testing should always be re-evaluated with changes in formulation to ensure shelf-life and food safety

7. Please confirm that you are happy for us to include the above information in our final report.

   Confirmed
Company: DSM Food Specialties
Product: Yeast Extract-derived/ Natural Flavour products

1. Please provide us with a brief description of your salt reduction solution(s).

Building block ingredients providing flavour, taste, taste enhancement and mouth feel properties similar to that of sodium salt. All yeast extract based and/or from natural flavour.

2. Please provide us with an overview of the potential applications/product scope.

In general the culinary food; Soups, sauces, ready to eat meals.
Meat products
(Fine) bakery
Seasonings

3. Please highlight any potential beneficial attributes of your salt reduction solutions.

Low sodium good taste.

4. Please advise on the effect of your solution(s) on retailers and food manufacturers’ clean label policies.

Declaration yeast extract and/or Natural flavour according (EC) No 1334/2008.

5. Please indicate any cost implications in the use of your solutions.

Pending complexity of food.
Serving size.
Pending % of Sodium salt present and % of reduction.
0.01- 0.05 EUR/serving.
6. Please highlight any potential barriers or risks associated with the use of your solutions that we may need to be aware of.

Powder properties of salt versus yeast extract based ingredients might be different in handling in factory.
None, known till this date.

7. Please confirm that you are happy for us to include the above information in our final report.

Confirmed this info can be included.
Company: Innophos
Product: SuperBindTM HB-Ct (& others)

1. **Please provide us with a brief description of your salt reduction solution(s).**

Innophos is a functional ingredient supplier. As sodium in foods is contributed from different ingredient sources, we can provide alternative ingredients (non- or reduced-sodium ingredients) to deliver the same/similar functionality as sodium counterpart.

2. **Please provide us with an overview of the potential applications/product scope.**

Reduce sodium in pastries, cakes etc (chemically raised bakery products), calcium based raising agent to replace sodium based leavening acids.
Reduce sodium in valued added meat products (red and white meat), use of phosphate to lower the usage of salt since phosphates are more functional (usage: 0.5%) in protein extraction than salt (usage: 1.5.-2.5%); replace sodium based phosphates with reduced sodium phosphates.
Reduce sodium in dairy product (e.g. Process cheese): replace sodium based emulsifying salts with reduced sodium emulsifying salts.

3. **Please highlight any potential beneficial attributes of your salt reduction solutions.**

Most of the time, one to one replacement of current sodium based ingredient. Minimal impact on sensory, process-ability and shelf life.

4. **Please advise on the effect of your solution(s) on retailers and food manufacturers” clean label policies.**

In most cases, not adding E number.

5. **Please indicate any cost implications in the use of your solutions.**
Cost effects differ based on the applicable technology. In general, potassium analogs are likely to be more costly, while calcium or other phosphates would have only a small cost effect.

6. Please highlight any potential barriers or risks associated with the use of your solutions that we may need to be aware of.

Ingredient cost and functionality will be highly dependent on the food product selected. For example, low-sodium options for intact meats will be different than those for comminuted meats.

7. Please confirm that you are happy for us to include the above information in our final report.

Yes
Company: Jungbunzlauer
Product: sub4salt®

1. Please provide us with a brief description of your salt reduction solution(s).

Jungbunzlauer’s sub4salt® is much ahead of competition with its ability to replace salt completely without having to sacrifice on taste owing to the competitive advantages of the product outlined briefly below:

- Similarity in taste with salt – Though the sodium content of sub4salt® is much lower than in salt, still it tastes almost entirely like salt and thus imparts identical taste to the food item it is used in. None of the competing products of other manufacturers are able to replace salt in the 1:1 ratio.
- Absence of common side-effects – End product using sub4salt® does not give rise to any side-effect such as bitter, metallic or broth-like taste that is commonplace in products using MSG, yeast extracts or potassium chloride.
- Ease of handling – It can be easily handled by manufacturing personnel as it does not cause dust formation and it also does not have any complex mixing or calculation requirements.
- Jungbunzlauer provides its customers with a 3 years shelf life guarantee from the date of manufacturing for sub4salt®.
- Identical dosage level as salt – Being a 1:1 substitute, the dosage levels of sub4salt® are same as that of salt and hence does not create any complexity in terms of change in recipe of the end-product to the end-users.

2. Please provide us with an overview of the potential applications/product scope.

sub4salt® can be used to replace salt in all application in which it is necessary to reduce salt.

3. Please highlight any potential beneficial attributes of your salt reduction solutions.

- Suitable for all food categories which needs salt reduction
- Similar taste to standard salt
- No common side effects
- Easy to handle
- Identical dosage level as salt

4. Please advise on the effect of your solution(s) on retailers and food manufacturers’ clean label policies.

Based on the production process and as well as on the type of raw material used, it is our opinion that sub4salt® can be declared as “natural” material. But we are aware of the fact that every company has to define its own meaning of “natural”.

5. Please indicate any cost implications in the use of your solutions.

Compared to normal salt our sub4salt® is obviously more expensive. Thinking about all benefits which are provided by our product, the higher price can be legitimated.

6. Please highlight any potential barriers or risks associated with the use of your solutions that we may need to be aware of.

None – In 2008 the Frost & Sullivan Award for “Ingredient of the Year” was presented to Jungbunzlauer for its successful introduction of the highly beneficial food additive sub4salt® in the European food additives market. It’s use as a substitute for salt and it’s capability of reducing sodium content in processed foods by up to 50 %, was considered extremely significant in the market.

7. Please confirm that you are happy for us to include the above information in our final report.

We confirm that the above mentioned information can be used by Leatherhead for the report purpose.
Company: Kudos Blends
Product: KUDOS™ Potassium Bicarbonate

1. Please provide us with a brief description of your salt reduction solution(s).

It is not widely known that a large proportion of the sodium content in baked goods comes from the raising agent (baking powder) component in the form of sodium bicarbonate and sodium acid pyrophosphate. Sodium Acid Pyrophosphate is critical in controlling the reaction rates of baking powders, which allows for bakers to “fine tune” their products to achieve a wide variety of consumer friendly cakes, therefore it is difficult to replace this component with a sodium free alternative. The sodium bicarbonate can be replaced offering a 50% reduction in sodium levels! This can be done through the use of potassium bicarbonate as a replacement for sodium bicarbonate. Using KUDOS™ potassium bicarbonate, bakers can achieve up to 50% sodium reduction without compromising end product quality.

2. Please provide us with an overview of the potential applications/product scope.

It is possible for all major manufacturers of baked foods worldwide to use this unique, patented ingredient, that only Kudos can manufacture for sodium reduction. We already supply to some of the largest bakeries in the UK and worldwide, which include many house hold brand names! Kudos has distributors in Australia, Canada, New Zealand, USA and Ireland specifically appointed to promoting and selling our potassium bicarbonate worldwide!

3. Please highlight any potential beneficial attributes of your sodium reduction solutions.

   a. Lowers sodium
   b. Reduces high blood pressure
   c. Makes products appealing to health conscious consumers
   d. Extends shelf life due to patented “hydrophobic” technology of baking powders and bakery pre-mixes
e. Increases potassium level in diet

i. Vital mineral

ii. Essential for health

iii. Helps proactively lower blood pressure

iv. Essential for nervous function

v. Soothes stress and anxiety

vi. Modern day diets are low in potassium – negative health connotations – we need to increase our consumption according to medical professionals

4. Please advise on the effect of your solution(s) on retailers and food manufacturers’ clean label policies.

No effect on clean label solutions – simply swapping 1 E number for another E number.

5. Please indicate any cost implications in the use of your solutions.

Potassium bicarbonate is more expensive as it is a rarer mineral, however baking powders make up such a small amount of the recipe, that any cost increase is proportionately small. EG- in a cake, switching from potassium bicarbonate to sodium bicarbonate would have a cost increase of approx. £0.0001 per 100g!

6. Please highlight any potential barriers or risks associated with the use of your solutions that we may need to be aware of.

Retailers are not confident to endorse potassium based products due to the potential issue with those people suffering with chronic renal failure. Potassium could lead to toxicity in these people due to kidney impairment. However, this condition effects less than 1% of the population so we should consider better labelling, so renal failure sufferers can choose to avoid foods particularly high in potassium. Using potassium
bicarbonate to make a cake has the same potassium level as one third of a banana – yet it is not advised we avoid eating bananas.

7. **Please confirm that you are happy for us to include the above information in our final report.**

Yes – happy to include information
Company: Lycored  
Product: SANTE

1. Please provide us with a brief description of your salt reduction solution(s).

SANTE is a natural extract from tomato, it delivers Umami and kokumi taste and mouth feel in savoury food product. By enhancing the taste profile, certain amount of salt can be removed.

2. Please provide us with an overview of the potential applications/product scope.

Meat and Meat Analogues  
Soups  
Seasonings and sauces  
Snacks

3. Please highlight any potential beneficial attributes of your salt reduction solutions.

Using LycoRed SANTE MS you can reduce the salt levels at up to 30%  
SANTE is 100% from Tomato.

4. Please advise on the effect of your solution(s) on retailers and food manufacturers’ clean label policies.

Our product is 100% from tomato therefore can help to clean the labels of our customers’ food products.

5. Please indicate any cost implications in the use of your solutions.

6. Please highlight any potential barriers or risks associated with the use of your solutions that we may need to be aware of.

N/A
7. Please confirm that you are happy for us to include the above information in our final report.

yes
Company: Natural Taste Consulting
Product: Salt Enhancer

1. Please provide us with a brief description of your salt reduction solution(s).

The product is a white powder, has a neutral aroma, is instantly water soluble, is non-hygroscopic, is natural, kosher and has a two year shelf life. It acts as an enhancer of salt and reduces significantly the off notes of KCl.

2. Please provide us with an overview of the potential applications/product scope.

See earlier. A wide range of application have been evaluated by an expert panel and 1 sensory trial on French consumers carried out by and external source

3. Please highlight any potential beneficial attributes of your sugar reduction solutions.

We don’t work on sugar. Our product allows for up to a 30% reduction in salt by enhancing the saltiness of the final product. Furthermore, we have successfully achieved a 50% salt reduction through combination with KCl.

4. Please advise on the effect of your solution(s) on retailers and food manufacturers’ clean label policies.

Our product is labelled as “natural flavour”. Given than some retailers wish to avoid flavour on their label, and our product is derived from a natural fermentation of an edible protein source, we are working with Leatherhead to determine whether another label fitting the industry needs can be applied.

5. Please indicate any cost implications in the use of your solutions.

No product today can compete with the cost of salt. That said, we have tested our product against all competitive offerings and are confident that our product offers a better value/ performance.
6. Please highlight any potential barriers or risks associated with the use of your solutions that we may need to be aware of.

7. Please confirm that you are happy for us to include the above information in our final report.

Yes
Company: Purac
Product: PuraQ Arome NA4

1. Please provide us with a brief description of your salt reduction solution(s).

Solution is based on controlled fermentation of cane sugar, to be labelled as natural flavor.

2. Please provide us with an overview of the potential applications/product scope.

Particularly in savory applications the product is performing well. E.g. processed (cooked) meat cured/uncured, bakery, sauces, ready to eat meals

3. Please highlight any potential beneficial attributes of your salt reduction solutions.

When reducing salt compensates loss in water activity, provides savoury taste and compensates loss of flavour.

4. Please advise on the effect of your solution(s) on retailers and food manufacturers’ clean label policies.

Can be labelled as natural flavour; this is however not always the preference by retailer or manufacturer, especially when they do not have flavour on their labelling

5. Please indicate any cost implications in the use of your solutions.

Minimal cost effect in terms of cost in use, compared to other solutions which tend to be costly (specifically flavour based)

6. Please highlight any potential barriers or risks associated with the use of your solutions that we may need to be aware of.
NA

7. Please confirm that you are happy for us to include the above information in our final report.

No objection(s)
Company: Seaweed
Product: Seagreens®

1. Please provide us with a brief description of your salt reduction solution(s).

Seagreens® human food quality seaweed provides multiple attributes for health and nutrition. Seagreens’ name covers several particularly nutritious brown wrack seaweeds from sustainable wild harvesting where proprietary methods ensure international compliance for food and nutraceutical ingredients.

Seagreens have been working with Sheffield Hallam University for 4 years. During this time work has been undertaken to develop prototype products containing Seagreens human food quality wrack seaweed (*Ascophyllum nodosum*). This wild harvested seaweed has been incorporated into bakery products, processed meats and dairy foods. Sensory testing of some of these products has shown them to be acceptable to consumers. In addition, the Seagreens has been shown to have shelf-life extending properties and satiety enhancing potential when incorporated into food products.

2. Please provide us with an overview of the potential applications/product scope.

Seagreens® can be used in a wide variety of products, including:

- Breads, cereals and baked goods
- Processed meat products
- Soups, sauces and condiments
- Ready meals
- Special diet foods and dietetics
- Sports and snack foods
- Teas and beverages
- Nutritional supplements and therapeutics

3. Please highlight any potential beneficial attributes of your salt reduction solutions.
Seagreens has multiple technical and brand related attributes that are summarised below:

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<th>Seagreens’ Brand Attributes</th>
<th>Seagreens’ Product Attributes</th>
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<td>Wide and balanced nutritional profile</td>
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<td>Time and reputation in market</td>
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<td>Award winning</td>
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<td>International brand, global distribution</td>
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<td>Member of Seaweed Health Foundation</td>
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<td>Natural</td>
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<td>Sustainable</td>
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<td>Scalability and consistency</td>
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4. Please advise on the effect of your solution(s) on retailers and food manufacturers’ clean label policies.

Seagreens is a recognised brand that can be used on labels stating the brand name and species name if required.

5. Please indicate any cost implications in the use of your solutions.

Costs are dependent on volume

6. Please highlight any potential barriers or risks associated with the use of your solutions that we may need to be aware of.

7. Please confirm that you are happy for us to include the above information in our final report.

Yes – this is all in the public domain. Nutritional data is available on request.
Company: Wild flavors
Product: Sea Salt Trim®

1. Please provide us with a brief description of your salt reduction solution(s).

Sea SaltTrim™ uses low sodium sea salt, naturally rich in potassium chloride and other minerals, combined with a WILD natural flavouring which overcomes the bitter metallic notes of the potassium.

2. Please provide us with an overview of the potential applications/product scope.

Sea SaltTrim™ is suitable to replace common salt in the following applications
- Soups
- Sauces
- Meats
- Frozen Entrees
- Side Dishes
- Salad Dressing
- Canned Foods
- Salty Snacks
- Meal Kits
- Breads and Baked goods
- Vegetable Beverages
- Bouillons - cubes, powders

3. Please highlight any potential beneficial attributes of your salt reduction solutions.

- up to 45% less sodium than common salt
- Imparts salty/Umami taste without high sodium levels
- Natural label declaration – Low sodium sea salt / Natural Flavouring
- Kosher, non GMO, vegetarian and non allergen
– Sea SaltTrim™ is a 1:1 replacement system for common salt

4. Please advise on the effect of your solution(s) on retailers and food manufacturers’ clean label policies.

Natural label declaration – Low sodium sea salt / Natural Flavouring

5. Please indicate any cost implications in the use of your solutions

Sea SaltTrim® as with other salt replacement technologies we are familiar with is more costly than common salt. Cost implications depend upon the final use rate of Sea SaltTrim® in finished product.

6. Please highlight any potential barriers or risks associated with the use of your solutions that we may need to be aware of.

No known barriers or risks associated with Sea SaltTrim®

7. Please confirm that you are happy for us to include the above information in our final report.

Yes
Appendix 6: Responses to Safety Criteria Evaluation

Company: Smart Salt
Product: Smart Salt®

1. Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.

Smart Salt® is the brand name given to a sodium reduction system which is based on a novel, unique and patented taste enhancement technology. The salt reduction system is based on magnesal, as either a triple or double co-crystallised mineral salt that is rich in magnesium. The Smart Salt® sodium/salt reduction system is a mineral salt solution.

**Shelf life trials** have indicated that when using Smart Salt® to replace NaCl at 40-50% sodium/salt reduction levels the microbiological integrity and safety of food products can be maintained. In no-added preservative bread, Smart Salt® has been shown to increase processing lethality of pathogenic *B. cereus* and improve microbial shelf –life compared to a full salt control.

**Microbiological challenge tests** with pathogenic *L. monocytogenes* and *B. cereus* have indicated that Smart Salt® is as effective as a full sodium product in controlling the growth of these organisms in meat and bread respectively. Smart Salt® was shown to delay the initial growth of *L. monocytogenes* in no-added nitrate frankfurters compared to a full salt control at storage temperatures of 5°C.

Brines made with 4,6 and 8 % w/w Smart Salt® have shown that they do not support the growth of the halotolerant *S. aureus* and *M. luteus*. Infact there was a very significant reduction in bacterial numbers over the 24 hour incubation. Regular salt and other salt substitutes did not show this dramatic lethality.

Salt reduction systems based on flavours alone do not have such potential for microbiological control.

2. Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technology

Production blends of Smart Salt® have been optimised to use as 1:1 replacements for salt in most food applications, including table top products, based on stability and taste quality. However it is possible to blend magnesal with regular salt (sodium chloride), potassium chloride, sea salt and flavours to optimise formulations. It has been shown that using magnesal/sodium chloride blends, with no added potassium...
chloride, have been successful in some applications. Although based on mineral salts Smart Salt® does have taste enhancement qualities. All Smart Salt® products are available as low-potassium or potassium-free and with the possibility of “natural” labelling in some markets.

3. **Shelf life Vs Challenge test trials. Please indicate the type of analysis you have conducted in food safety trials that you have conducted.**

**Shelf-life** - aerobic and anaerobic TVC, yeast and moulds, Enterobacteriaceae, *Brochothrix thermosphacta*, lactic acid bacteria,

**Challenge tests** *B. subtilis* and *B. cereus*, *L. monocytogenes*, *S. aureus*, *M. luteus*

4. **Types of products per sector tested**

| Meat and meat products | Fresh beefburgers - shelf life including Enterobacteriaceae, *Brochothrix thermosphacta* and lactic acid bacteria
Cooked sliced ham – shelf life and lactic acid bacteria
RTE products including meat – casseroles, soups and risotto – shelf life
Frankfurters with and without preservative shelf life and pathogenic challenge test *L. monocytogenes*
Brine solutions 4, 6 and 8% w/w solutions – halotolerant challenge tests *S. aureus* and *M. luteus*
 |
| Bread and cereal products | White bread – without preservative – shelf-life and pathogenic challenge test *B. subtilis* and *B. cereus*
 |
| Cheese products | Edam cheese – shelf life including *E. coli*
 |
| Extruded & pelleted snacks | 
 |
| Cakes, pastries, fruit pies | 
 |
| Pesto & thick sauces | 
 |
puddings

Canned fish (Brine solutions 4, 6 and 8% w/v solutions – halotolerant challenge tests S. aureus and M. luteus)

5. Please provide an indication of the level of interest your solution(s) have received from industry so far.

There is a very high level of interest as data have indicated that Smart Salt® products have a very high consumer acceptability compared to full salt products even at salt reduction levels of 40-50% with no significant difference in taste or preservation qualities of the final product. National sodium targets can be met using Smart Salt® technology.

Smart Salt® has been evaluated extensively in commercial development facilities and manufacturing environments as well as food research establishments, in most application categories – some companies are close to launch. Most commercial development has been made under confidentiality agreements so we are not in a position to disclose the work done.


The most significant preservation trial data that can be shared includes:

**Shelf –life** - Work carried out at Foodwest Inc, University of Seinäjoki, Finland
- Dry Sausage : Production and preservation trial
- Shelf –life trial for cooked sliced ham
- Manufacturing (RTE) convenience foods for a clinical study I and II
- Frankfurter Survey part I and II
- Edam Cheese

**Shelf-life and Microbiological Challenge** - Work carried out at Leatherhead Food Research, UK

- Smart Salt evaluation of preservative properties in frankfurters (without added preservative) – pathogenic challenge *L. monocytogenes*
• Smart Salt evaluation of preservative properties in bread (without added preservative) – pathogenic challenge *B.subtilis* and *B.cereus*

**Microbiological Challenge** - Work carried out at National Food Laboratories Inc, USA

• 24 hour microbial incubation in 4, 6, 8% w/w brines vs regular salt and high potassium containing salts – halotolerant challenge *S.aureus* and *M.luteus*

**Shelf – life** - Work carried out at University of Bristol, School of Veterinary Sciences, UK

• Sodium replacement using Smart Salt in modified-atmosphere-packed, sulphite–free burgers: effects on spoilage flora – MSc Meat Science and Technology dissertation in the Faculty of Medical and Veterinary Sciences

7. **Accreditation status of labs doing the work. Please state**

Foodwest Ltd, established in 1995 is a consulting organisation that investigates the market on a broad scale and provides customers with the information and technology for the whole development process. [http://www.foodwest.fi/en/index.html](http://www.foodwest.fi/en/index.html)

Founded in 1919, Leatherhead Food Research has been a trusted partner to the food industry for nearly a century, offering an unparalleled breadth and depth of experience to help the food industry innovate and evolve. [http://www.leatherheadfood.com](http://www.leatherheadfood.com)

The National Food Lab, The NFL, is a consulting organization specializing in transforming inspiration and experience into innovative food and beverage development. They started in 1976 in Berkeley, California as the Technical Service Corporation (Tech S). In 1985 we were renamed The National Food Laboratory, Inc. and relocated to Dublin, CA. [http://www.thenfl.com](http://www.thenfl.com)

University of Bristol –The MSc in Meat Science and Technology is a well-established course which is unique in the UK, highly regarded by the meat
industry and attracts students from around the world.

http://www.bristol.ac.uk/vetscience/postgraduate/msc/

8. Can reports/results be available if requested? Please indicate

Reports or summaries of reports can be made available if requested

9. Some information on experimental details covering the following aspects is required. Please indicate the:

- Number and type of microorganisms used in challenge testing (if appropriate)

Challenge tests only:

**FRANKFURTERS**
The experimental approach and design of the *L. monocytogenes* challenge tests were based on the guidelines specified within the EU Technical Guidance Document on Shelf-life studies for *Listeria monocytogenes* in ready-to-eat products (November 2008).

**Strains used in the study:**
- *L. monocytogenes* NCTC 5348 (REF : L215)
- *L. monocytogenes* 5401/95 (REF : 214) ; isolated from a ham product
- *L. monocytogenes* NCTC 5214 (L207)

**Initial counts** 10³ - 10⁴ cfu/g

**BREAD**

**Strains used in the study:**
- *Bacillus cereus* NCTC 11145 (REF : B505)
- *Bacillus cereus* F2105 (REF :B525) ; bakery isolate
- *Bacillus cereus* NCTC 2599 (REF :B503)
- *Bacillus subtilis* NCTC 6276 (REF :B556 ; ropey bread isolate)
- *Bacillus subtilis var globigi* NCTC 10073 (REF :B522)
- *Bacillus subtilis* Bc3 – natural isolate ; bread (REF :B529)
- *Bacillus subtilis* 122757–A (REF :B520) ; natural isolate

**Initial counts:** A cocktail of *B. cereus and B. subtilis* at 10⁷-10⁸ spores/g of final product

**BRINES**

**Strains used in the study:**
- *S. aureus and M.luteus*

**Initial counts:** 10⁵ - 10⁷ cfu/ml

- Inoculation approach and strain pre-adaptation conditions
Challenge tests only:

**FRANKFURTERS**
Microbial culture preparation was carried out under optimum growth conditions for the organism (growth media and temperature). Cultures were centrifuged, washed, re-suspended in a saline solution to avoid altering the water activity of the products and combined in a cocktail. Enumeration of the resulting cocktail culture was carried out prior to inoculation to ensure that the protocols used delivered starting levels of ca. $10^3 - 10^4$ cfu/g.

**BREAD**
Lawns of *Bacillus* species were produced individually on nutrient agar (NA, Oxoid) incubated aerobically at 37°C for 5-7 days and monitored for spore formation by phase-contrast microscopy. For all strains used in this study cultures reached >95% spore content as determined by microscopic observation.

The sporulated bacterial plates were flooded and gently agitated with 10ml of sterile distilled water (SDW). The spore lawns were suspended in the SDW using a sterile swab and the cultures were then carefully transferred to sterile centrifuge glass vials. The re-suspended cultures were then subjected to heat treatment for approximately 10 min at 80°C in order to kill off any remaining vegetative cells.

Spore preparations were washed three times in sterile distilled water by centrifugation and re-suspension and examined by phase-contrast microscopy to determine the extent of sporulation.

**BRINES**
*S.aureus* and *M.luteus* were grown in Tryptic soy Broth and incubated at 35°C for 18 hours. The 18 hour cultures were centrifuged, washed and used for inoculation.

- Number of replicates set up (no of batches tested for shelf life and/or challenge testing trials conducted)

  Shelf life - triplicate

Challenge tests

**FRANKFURTERS**
3 replicates from 3 different commercial batches for each treatment

**BREAD**
3 replicates per treatment

**BRINE**
3 replicates per treatment

- Packaging, atmosphere and storage conditions

**FRANKFURTERS**
Vacuum-packed, 28 days at either 5 or 8°C

**BREAD**
No packaging, 6 days at 21 and 25°C

- Duration of trials

For shelf-life and challenge tests – normal shelf-life was used as a guide for sampling and duration of trials

- Recovery methods used and overall sampling plan

**FRANKFURTERS**

Three production batches of frankfurters containing the two salt types were tested regularly during storage and at $t = 0$ (immediately after inoculation), 5, 8, 14, 19, 23, and Day 28, & $t = 0$, 5, 8, 13, 16, 20 and Day 26 triplicate samples per product/batch stored at 5°C and 8°C, respectively were sampled. *Listeria* enumeration was carried out following Leatherhead’s UKAS-accredited methodology for enumeration of *L. monocytogenes* (Method Ref: UA19). Un-inoculated controls were processed in the same way as spiked samples.

**BREAD**

At each time point per storage temperature, for inoculated and for un-inoculated samples, the 3 loaves of bread were aseptically sliced (10 g portions). The samples were taken from the central portions of the slices without crust.

In order to facilitate microbial recovery, bread slices were suspended in maximum recovery diluent (MRD) to form a 1/10 dilution and
stomached for 30 seconds using a Colworth stomacher. From this suspension, a series of decimal dilutions were carried out and 0.1ml and 0.5ml spread plates were prepared using Polymyxin pyruvate egg yolk mannitol bromothymol blue agar (PEMBA; Oxoid Ltd.). Plates were incubated aerobically for 48 hours at 30°C before colonies were counted. Spiked samples were also analysed for total aerobic and anaerobic viable counts. Analysis was carried out using 1ml pour plates on Plate Count Agar (PCA, Oxoid Ltd.) incubated aerobically and anaerobically, respectively at 30°C for 48 hours prior to counting. Un-inoculated bread samples were analysed for total aerobic and anaerobic viable counts, as described above, and total yeast and mould counts to get an idea of the levels of background flora present in the different bread samples during storage. For Yeast and Mould enumeration, decimal dilutions were carried out and spread plates were prepared on Dichloran Rose Bengal Chloramphenicol Agar (DRBCA; Oxoid). Plates were incubated aerobically for 5 days at 25°C.

**BRINES**

Samples plated right after inoculation and placed in a 25°C incubator. After 24 hours the samples were plated again. All plates were poured with Plate Count Agar and incubated at 35°C for 48 hours, after which time they were counted and recorded.

- Controls (negative and positive) set-up

In all cases controls included at least one regular salt control and/or reduced regular salt control and a negative control i.e. no salt sample

- Results: calculations and interpretation Vs claim verification. Please indicate the approach followed.

- **FRANKFURTERS**

The results from the growth/survival of *L. monocytogenes* in the frankfurter samples (no nitrate added) containing NaCl or SMS40 (40% reduced salt) indicated that although both salt types were able to support the growth of *L. monocytogenes*, **SMS40 was able to delay**
the growth of the organism during storage mainly at 5°C. As expected, variation in *Listeria* counts over time amongst the different production batches of frankfurters containing the two types of salt were observed, justifying the EU requirements for the analysis of three product batches. The results from the control, un-inoculated samples indicated that both salt types were able to support the growth of the background flora in the samples to high levels during storage at both temperature conditions.

**BREAD**

The results have highlighted two main differences between NaCl and SMS40. Immediately post baking (and after cooling) of the SMS40 containing bread loaves there was a significant log drop, of up to 4.7-Logs, in *Bacillus* spp. counts compared with a drop of up to 3.4-Log in the table salt containing breads. Although in breads containing both salt types, *Bacillus* spp. counts later picked up to very high levels during storage this initial difference in lethality would indicate that SMS40 in combination with the heat applied during baking could contribute to an increased process lethality compared to table salt. Additionally, the results from the control, un-inoculated bread samples indicated that even though there was no difference in the yeast and mould counts over time, total aerobic viable counts in the table salt-containing bread samples significantly increased to ca.10⁴-10⁵ cfu/g at the end of the storage period (Day 6) under both storage temperatures. **Counts below the limit of detection were obtained throughout storage of the SMS40-containing control bread samples at 21°C, while small recovery (ca. 10-10² cfu/g) was observed in the samples stored at 25°C. These results could be considered as a preliminary indication of the ability of SMS40 to extend the shelf life of bread.** The bread samples did not contain commercial preservatives.

**BRINES**

Smart Salt SMS50 was the only mineral salt product to show a significant reduction in growth over a 24 hour incubation period
for both *S.aureus* (*ca.* $10^3$ cfu/ml) and *M.luteus* (*ca.* $10^2$ cfu/ml) at all brine concentrations.

10. Please confirm that you are happy for us to include the above information within our final report.

    We are happy for you to include the above information within your final report.
Company: AkzoNobel
Product: Loso OneGrain™

1. Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.

Suprasel® Loso OneGrain™

2. Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technology.

It's a combination of 1:1 replacement and salt enhancing additives

3. Shelf life Vs Challenge test trials. Please indicate the type of analysis you have conducted in food safety trials that you have conducted.

Both, sensory analysis by expert panels and in some cases consumer panels.

4. Types of products per sector tested:

<table>
<thead>
<tr>
<th>Meat and meat products</th>
<th>Hams, sausages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bread and cereal products</td>
<td>Sandwich bread (loaf), baguette, biscuits</td>
</tr>
<tr>
<td>Cheese products</td>
<td>Cheddar, feta (ongoing), esrom (ongoing)</td>
</tr>
<tr>
<td>Extruded &amp; pelleted snacks</td>
<td>Potato crisps</td>
</tr>
<tr>
<td>Cakes, pastries, fruit pies</td>
<td>Puff pastry</td>
</tr>
<tr>
<td>Pesto &amp; thick sauces</td>
<td>Instant soups</td>
</tr>
<tr>
<td>Puddings</td>
<td>n.a.</td>
</tr>
</tbody>
</table>
5. Please provide an indication of the level of interest your solution(s) have received from industry so far.

Many positive feedbacks worldwide


Both, professional application tests externally

7. Accreditation status of labs doing the work. Please state.

Silleker and Eurofin ISO/IEC 17025:2005

8. Can reports/results be available, if requested? Please indicate.

Yes, for bread, cheese and meat in general, more specific reports will be available by the end of this year.

9. Some information on experimental details covering the following aspects is required. Please indicate the:

   - Number and type of microorganisms used in challenge testing (if appropriate)

     Total plate count, staphylococcus aureus, enterobacteriaceae, listeria monocytogenes,

   - Inoculation approach and strain pre-adaptation conditions

     n.a.
- *Number of replicates set up (no of batches tested for shelf life and/or challenge testing trials conducted)*

  Always mono and duplo tests

- *Packaging, atmosphere and storage conditions*

  Depents what is required, for example, fresh cheese needs cold storage, fermented sausages only a closed packaging and storage at room temperature.

- *Duration of trials*

  The total trail can take a few months time by repeating it several times to finetune the results. Micro test takes only 2-3 weeks.

- *Recovery methods used and overall sampling plan*

  Different per application, we ask the laboratory always for their opinion everytime.

- *Controls (negative and positive) set-up*

  We always have a control product. That means a real market product.

- *Results: calculations and interpretation Vs claim verification. Please indicate the approach followed.*

  First, to find out what the limits per bacteria are per application. Than discuss with the laboratory what kind of test we will take.

10. *Please confirm that you are happy for us to include the above information within our final report.*

   Yes
1. Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.

- FlakeSelect™ – patent pending process that physically modifies single or multiple ingredients to add functionality
- SodiumSense™ – a cost effective sodium reduction product formulated to provide similar liking as full salted food products
- Ongoing research to understand the implications of replacing sodium chloride with potassium chloride in terms of microbial shelf-life and challenge tests for various food applications, such as, meats and dairy (e.g. cheese)

2. Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technology.

- Salt replacement, physically modified, modified, alternative flavour technology or combination of the three.

3. Shelf life Vs Challenge test trials. Please indicate the type of analysis you have conducted in food safety trials that you have conducted.

- Shelf life and challenge test trials

4. Types of products per sector tested:

<table>
<thead>
<tr>
<th>Meat and meat products</th>
<th>Ham</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bread and cereal products</td>
<td></td>
</tr>
<tr>
<td>Cheese products</td>
<td></td>
</tr>
</tbody>
</table>
Extruded & pelleted snacks

Cakes, pastries, fruit pies

Pesto & thick sauces

Puddings

Canned fish

5. Please provide an indication of the level of interest your solution(s) have received from industry so far.

- We are active in this area (through sales, research products or industry sodium sub-committees) in the following food categories: meats and dairy (e.g. natural cheese, cottage cheese),


- Internal: meat, bakery, snacks&cereal and dairy application labs
- External – Research facilities

7. Accreditation status of labs doing the work. Please state.

- Implementing good laboratory practices (GLP)
- Microbiology: “American Proficiency Institute” (API) non-pathogenic certification
- Chemistry (if applicable to project in question): USDA accreditation

8. Can reports/results be available if requested? Please indicate.

- Suitable reports may be generated for Leatherheads needs
9. Some information on experimental details covering the following aspects is required. Please indicate the:

- **Number and type of microorganisms used in challenge testing (if appropriate)**

  1. Aerobic and Anaerobic Plate Count, Enterobacteriaceae (3M Petrifilm)

- **Inoculation approach and strain pre-adaptation conditions**

  1. Products were not inoculated. Products were tested for organisms already presumptively present.

- **Number of replicates set up (no of batches tested for shelf life and/or challenge testing trials conducted)**

  1. Project expectations and objectives did not require replicates/additional repetitions to be conducted. Shelf-life testing was one-time trial.
  2. Additional research in progress

- **Packaging, atmosphere and storage conditions**

  1. Vacuum-Packaging

- **Duration of trials**

  1. Target shelf-life of 90+ days

- **Recovery methods used and overall sampling plan**

  1. Aerobic and Anaerobic Plate Count (3M APC Petrifilm)
     - AOAC Method# 990.12 (modified for incubation at 24C for 72 hours, +/- 2 hours)
  2. Enterobacteriaceae Plate Count (3M Enterobacteriaceae Petrifilm)
Compendium of Methods for the Microbiological Examination of Foods (incubate at 35°C for 24 hours +/- 2 hours)

- Controls (negative and positive) set-up

1. Control products represented the current formulation; test products included the reformulation.

- Results: calculations and interpretation Vs claim verification. Please indicate the approach followed.

1. Calculations and interpretation

10. Please confirm that you are happy for us to include the above information within our final report.

Confirmed.
Company: Innophos  
Product: SuperBindTM HB-CT (& others)

1. **Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.**

   Meat: SuperBind™ HB-CT: Maximizing the protein extraction by optimizing the capability from phosphates, we are able to lower the usage of NaCl needed for protein solubilisation.

   Dairy: Replace current sodium based emulsifying salts by low/reduced sodium emulsifying salts. Emulsifying salts contribute 44-48% of sodium in processed cheese.

2. **Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technology.**

   In general, our technology is sodium ingredient replacement, except SuperBind™ HB-CT replaces the physical functionality of salt.

3. **Shelf life Vs Challenge test trials. Please indicate the type of analysis you have conducted in food safety trials that you have conducted.**

   Since in most cases, we are not altering the level of salt and are not expecting shelf life (microbiological) concerns. However, on SuperBind™ HB-CT, shelf life and microbial challenge study is scheduled. No change in water activity is expected.
4. Types of products per sector tested:

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat and meat products</td>
<td>In schedule for sausage</td>
</tr>
<tr>
<td>Bread and cereal products</td>
<td>N/A</td>
</tr>
<tr>
<td>Cheese products</td>
<td>Process cheese – American and European formulations</td>
</tr>
<tr>
<td>Extruded &amp; pelleted snacks</td>
<td>N/A</td>
</tr>
<tr>
<td>Cakes, pastries, fruit pies</td>
<td>N/A</td>
</tr>
<tr>
<td>Pesto &amp; thick sauces</td>
<td>N/A</td>
</tr>
<tr>
<td>puddings</td>
<td>N/A</td>
</tr>
<tr>
<td>Canned fish</td>
<td>N/A</td>
</tr>
</tbody>
</table>

5. Please provide an indication of the level of interest your solution(s) have received from industry so far.

Although these ingredients have been launched only recently, significant Innophos and customer formulation work has occurred.


For shelf life tests, samples made in house; testing will be done externally

7. Accreditation status of labs doing the work. Please state.

Eurofins, leading food test lab in US
8. Can reports/results be available if requested? Please indicate.

Yes

9. Some information on experimental details covering the following aspects is required. Please indicate the:

- **Number and type of microorganisms used in challenge testing (if appropriate)**
  
  Total plate count; coliform; *listeria monocytogenes*; *Clostridium botulinum*

- **Inoculation approach and strain pre-adaptation conditions**
  
  Outside lab will decide from their expertise knowledge.

- **Number of replicates set up (no of batches tested for shelf life and/or challenge testing trials conducted)**
  
  1 batch, 2 replicates for each test

- **Packaging, atmosphere and storage conditions**
  
  Vacuum package; refrigerator storage;

- **Duration of trials**
  
  30 days

- **Recovery methods used and overall sampling plan**

- **Controls (negative and positive) set-up**
  
  Outside lab will decide from their expertise knowledge.
Results: calculations and interpretation Vs claim verification. Please indicate the approach followed.

10. Please confirm that you are happy for us to include the above information within our final report.

Yes
Company: Jungbunzlauer
Product: sub4salt®

1. Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.

- Establishment of recipes with our patented sub4salt® specifically towards the American cuisine (e.g. French fries, tacos, burgers and respective sauces), yielding 25-35% sodium reduction
- Development of new sub4salt® blends to address improved functionality and taste in certain processed food applications.

2. Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technology.

sub4salt® and new salt reduction blends are indicated to reduce (replace) sodium.

3. Shelf life Vs Challenge test trials. Please indicate the type of analysis you have conducted in food safety trials that you have conducted.

Trials on microbial shelf life studies and comparison of aw value shows no significant differences between sub4salt and standard salt in water based solution.

4. Types of products per sector tested:

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat and meat products</td>
<td>Done (results not available for publication)</td>
</tr>
<tr>
<td>Bread and cereal products</td>
<td>Done (results not available for publication)</td>
</tr>
<tr>
<td>Cheese products</td>
<td>Done (results not available for publication)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td>------------------------------------------------------</td>
</tr>
<tr>
<td>Extruded &amp; pelleted snacks</td>
<td>Done (results not available for publication)</td>
</tr>
<tr>
<td>Cakes, pastries, fruit pies</td>
<td>Done (results not available for publication)</td>
</tr>
<tr>
<td>Pesto &amp; thick sauces</td>
<td>Done (results not available for publication)</td>
</tr>
<tr>
<td>puddings</td>
<td>Done (results not available for publication)</td>
</tr>
<tr>
<td>Canned fish</td>
<td>Done (results not available for publication)</td>
</tr>
</tbody>
</table>

5. Please provide an indication of the level of interest your solution(s) have received from industry so far.

From producers of meat, bread and cheese products there is a high level of interest because the most of salt is used in these applications.


Trials for meat products and cakes were made externally, all others were handled in-house.

7. Accreditation status of labs doing the work. Please state.

Process evaluations and sensorical test panels are done with accredited institutes. Also any microbial and chemical analysis are mainly done with accredited labs.
8. Can reports/results be available if requested? Please indicate.

Results are available in form of recipe formula cards. It is not possible to give details on analysis or sensorical panel tests to the report due to patent situation.

9. Some information on experimental details covering the following aspects is required. Please indicate the:

No further details can be provided on the stability test of food trials. Enclosed please find the microbial test results on sub4salt®

- Number and type of microorganisms used in challenge testing (if appropriate)

- Inoculation approach and strain pre-adaptation conditions

- Number of replicates set up (no of batches tested for shelf life and/or challenge testing trials conducted

- Packaging, atmosphere and storage conditions

- Duration of trials

- Recovery methods used and overall sampling plan

- Controls (negative and positive) set-up

- Results: calculations and interpretation Vs claim verification. Please indicate the approach followed.
10. Please confirm that you are happy for us to include the above information within our final report.

We confirm that the above mentioned information can be used by Leatherhead for the report purpose.
Company: Kudos Blends
Product: KUDOS™ Potassium Bicarbonate

1. Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.

Kudos Blends offers sodium reduction solutions for all varieties of low sodium and sodium free baking powders. This NEW, unique, patented grade of potassium bicarbonate makes up an essential part of low sodium baking powders. It is needed to react with the acids in order to liberate carbon dioxide to provide aeration in baked goods.

2. Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technology.

KUDOS™ Potassium Bicarbonate is a replacement for sodium bicarbonate to help bakers achieve 50% reduction.

3. Shelf life Vs Challenge test trials. Please indicate the type of analysis you have conducted in food safety trials that you have conducted.

Extensive shelf life trials have been carried out on baking powders containing KUDOS™ Potassium Bicarbonate. The water repellent technology of the specific potassium bicarbonate unique to Kudos, helps to improve the shelf life of low sodium baking powders. The shelf life of the end product, i.e. the baked cake, is not affected or altered by using potassium bicarbonate and should be no different to when any other ingredient is used.

4. Types of products per sector tested:

<table>
<thead>
<tr>
<th>Meat and meat products</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bread and cereal products</td>
<td></td>
</tr>
<tr>
<td>----------------------------</td>
<td>---</td>
</tr>
<tr>
<td>Cheese products</td>
<td></td>
</tr>
<tr>
<td>Extruded &amp; pelleted snacks</td>
<td></td>
</tr>
<tr>
<td>Cakes, pastries, fruit pies</td>
<td>Baking Powders</td>
</tr>
<tr>
<td>Pesto &amp; thick sauces</td>
<td></td>
</tr>
<tr>
<td>puddings</td>
<td></td>
</tr>
<tr>
<td>Canned fish</td>
<td></td>
</tr>
</tbody>
</table>

5. Please provide an indication of the level of interest your solution(s) have received from industry so far.

We have received a large amount of interest in this product – we already supply some of the largest food producers in the UK and the rest of the world with this product to help them meet their 2012 salt guidelines. Kudos Blends is considered a thought leader in this subject area and due to our knowledge and experience have been asked to lecture at many national conferences. Kudos Blends was invited to the House of Commons to attend a parliamentary reception to recognise the work we have contributed towards to the sodium reduction industry.


18 months work of R&D has gone into this product to make it hydrophobic. By nature, potassium bicarbonate is very reactive and is often associated as being unusable due to the fact it compacts into hard lumps / cakes; this unstable nature has often deterred bakers from its use.
The unique patented grade of KUDOS potassium bicarbonate, specifically developed for the baking industry, has two key and critical characteristics: a) it is of a particular fine particle size achieved through a totally unique milling process and b) has a hydrophobic component to it, which makes the fine powder water repellent. The water repellent property markedly improves the stability of the powder, thus making shipping, handling and storage very easy. Further, and perhaps of more significance is that the unique technology behind this powder also lends itself to improving the shelf life of any blends of which the KUDOS potassium bicarbonate is incorporated into, such as baking powders, premixes and concentrates. Kudos can now sell potassium bicarbonate as a direct replacement for sodium bicarbonate, with all the functional properties, markedly improved stability and, in turn, a better shelf life whilst delivering a zero sodium option for bakers. This has resulted in Kudos obtaining a worldwide patent on this product for its manufacture and usage in low sodium leavening agents.

7. Accreditation status of labs doing the work. Please state.

Work carried out in Kudos Blends own lab by a team of PHD chemists.

8. Can reports/results be available if requested? Please indicate.

Yes – shelf life reports and brochure literature available upon request.

9. Some information on experimental details covering the following aspects is required. Please indicate the:

- Number and type of microorganisms used in challenge testing (if appropriate)

- Inoculation approach and strain pre-adaptation conditions

- Number of replicates set up (no of batches tested for shelf life and/or challenge testing trials conducted)
- Packaging, atmosphere and storage conditions

- Duration of trials

- Recovery methods used and overall sampling plan

- Controls (negative and positive) set-up

- Results: calculations and interpretation Vs claim verification. Please indicate the approach followed.

10. Please confirm that you are happy for us to include the above information within our final report.

Yes – happy to include details.
Company: Lycored
Product: SANTE

1. Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.

SANTE is a natural extract from tomato, it delivers Umami and kokumi taste and mouth feel in savoury food product. By enhancing the taste profile, certain amount of salt can be removed.

2. Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technology.

SANTE is NOT a salt replacer. SANTE enhances flavors and salty taste due to it characteristic.

3. Shelf life Vs Challenge test trials. Please indicate the type of analysis you have conducted in food safety trials that you have conducted.

SANTE produced under HACCP procedures. It is a natural tomato extract, therefore it is recognize as safe.

Each batch of SANTE is analysed for physical, chemical, organoleptic and microbiological tests.

The liquid form of SANTE is either aseptisized or kept frozen with very low micro count. Its shelf life is: 1 year for less than 20c storage, 2 years for 4c storage and 4 years for frozen. The reason for this terms is not for safety reason but for functionality reason. Since SANTE contains monosaccharides and free amino acids there is a risk of Millard reaction which can lead to browning, hence influence SANTE characteristics.

The powder form is a low water activity product and its shelf life is 2 year below 60% RH.
4. Types of products per sector tested:

<table>
<thead>
<tr>
<th>Product Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat and meat products</td>
<td>Sausages, meat loaf, hamburgers, patties</td>
</tr>
<tr>
<td>Bread and cereal products</td>
<td>Bread, crackers, snacks, pizza.</td>
</tr>
<tr>
<td>Cheese products</td>
<td>Commercial cheese – not traditional cheese.</td>
</tr>
<tr>
<td>Extruded &amp; pelleted snacks</td>
<td>Extruded (puffed) cereal snacks.</td>
</tr>
<tr>
<td>Cakes, pastries, fruit pies</td>
<td>Pizza. Not intended for sweet products</td>
</tr>
<tr>
<td>Pesto &amp; thick sauces</td>
<td>Tomato based sauces, white sauces such as ranch and French, thousand islands etc. Culinary product as well such as instant soups and canned soups</td>
</tr>
<tr>
<td>Puddings</td>
<td>No</td>
</tr>
<tr>
<td>Canned fish</td>
<td>No experience so far.</td>
</tr>
</tbody>
</table>

5. Please provide an indication of the level of interest your solution(s) have received from industry so far.

Level 0.2-1% in finished product

Not applicable – the customers do not share that with us. Nevertheless most of the application for the liquid form are pasteurized.

7. Accreditation status of labs doing the work. Please state.

Internal and external labs according to Israeli standard.

8. Can reports/results be available if requested? Please indicate.

Under confidentially agreement

9. Some information on experimental details covering the following aspects is required. Please indicate the:

   - Number and type of microorganisms used in challenge testing (if appropriate)

      Total plate count, yeast and mold, coliforms, E coli, Salmonella

   - Inoculation approach and strain pre-adaptation conditions

      We are performing enrichment inoculation for each of the pathogen above

   - Number of replicates set up (no of batches tested for shelf life and/or challenge testing trials conducted)

      Between 2-4 replicates per batch

   - Packaging, atmosphere and storage conditions

      See paragraph 3

   - Duration of trials

      Not applicable
- **Recovery methods used and overall sampling plan**
  
  Not applicable

- **Controls (negative and positive) set-up**

  Not applicable regarding Micro tests.

- **Results: calculations and interpretation Vs claim verification. Please indicate the approach followed.**

  Pass or No Pass visibility and flavour taste- documented

10. Please confirm that you are happy for us to include the above information within our final report.

Yes
Company: Natural Taste Consulting
Product: Salt Enhancer

1. Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.

We have developed a powder product that acts specifically as a salt enhancer and masker of KCl off notes. The product is not a salt replacer but enhances the saltiness of existing salt products. The product can either be used to reduce salt by around 30% or used in combination with KCl to either enhance saltiness or reduce the off notes of KCl.

2. Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technology.

The product is derived from the bacterial fermentation of a specific plant protein and will be labelled as natural flavour in both Europe and the US. As mentioned above, the product is an enhancer of salt.

3. Shelf life Vs Challenge test trials. Please indicate the type of analysis you have conducted in food safety trials that you have conducted.

The product has undergone accelerated shelf life testing for a period of 9 months at 40°C in dry conditions with no detriment to the taste, colour, solubility or chemical profile (as determined by taste trials, solubility vs a control and HPLC).

4. Types of products per sector tested:

<p>| Meat and meat products | Sausages, Formed chicken nuggets and beef patties |</p>
<table>
<thead>
<tr>
<th>Bread and cereal products</th>
<th>Pizza dough</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheese products</td>
<td>Processed cheese</td>
</tr>
<tr>
<td>Extruded &amp; pelleted snacks</td>
<td>To be determined</td>
</tr>
<tr>
<td>Cakes, pastries, fruit pies</td>
<td>To be determined</td>
</tr>
<tr>
<td>Pesto &amp; thick sauces</td>
<td>Soups and sauces of varying consistency</td>
</tr>
<tr>
<td>Puddings</td>
<td>To be determined</td>
</tr>
<tr>
<td>Canned fish</td>
<td>To be determined</td>
</tr>
<tr>
<td>Other</td>
<td>Isotonic beverages</td>
</tr>
</tbody>
</table>

5. **Please provide an indication of the level of interest your solution(s) have received from industry so far.**

Knowing the industry exceptionally well and the competitive offerings, our product is second to none in terms of cost/ benefit. We have tested with several of the major players in the industry with excellent feedback.

6. **Work done in-house/externally. Please indicate.**

Internal: Development of the product including sourcing of a suitable protein source, bacterial strain, fermentation condition, drying shelf life testing and some sensory work

External: consumer tests on > 50 panelists
7. Accreditation status of labs doing the work. Please state.

The work was carried out by Natural Advantage, our development partner based in the US.

8. Can reports/results be available if requested? Please indicate.

There is no such report. Each test was carried out individually and the results reported to us verbally.

9. Some information on experimental details covering the following aspects is required. Please indicate the:

- Number and type of microorganisms used in challenge testing (if appropriate)

  Not appropriate. Our product is a powder and as such, does not support bacterial and fungal growth. Our product has been tested for microbial contamination and was negative for all pathogenic bacteria.

- Inoculation approach and strain pre-adaptation conditions

- Number of replicates set up (no of batches tested for shelf life and/or challenge testing trials conducted)

- Packaging, atmosphere and storage conditions

- Duration of trials

- Recovery methods used and overall sampling plan

- Controls (negative and positive) set-up
- Results: calculations and interpretation Vs claim verification. Please indicate the approach followed.

10. Please confirm that you are happy for us to include the above information within our final report.

Yes
Company: Purac  
Product: PuraQ Arome NA4  

1. Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.

Salt reduction solution based on fermentation: PuraQ Arome NA4  
Same as but most likely blend with vinegar to provide shelf life in addition

2. Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technology.

We might consider this solution as an alternative flavour technology. Our solutions are not necessarily replacement and definitely not salt enhancing additive or modified NaCL

3. Shelf life Vs Challenge test trials. Please indicate the type of analysis you have conducted in food safety trials that you have conducted.

First priority was to verify our product(s) are non toxic hence safe to eat; additional test were performed by 3rd party for preference testing and verify potential. Finally the shelf life and other technical effects have been evaluated (e.g. loss of texture, water activity)
4. **Types of products per sector tested:**

| Meat and meat products | Cured cooked sausage  
|                         | Uncured cooked sausage  
|                         | Cooked ham  
|                         | Fresh meat, e.g hamburger  
| Bread and cereal products | White bread  
|                         | Crusty bread, rolls  
|                         | Brown bread  
| Cheese products | None, although trials were conducted in cheese sauce  
| Extruded & pelleted snacks | Some test were done at customer producing extruded snacks as salt alternative  
| Cakes, pastries, fruit pies |  
| Pesto & thick sauces | Mayonnaise, brown sauces, BBQ sauce, Teriyaki/oriental sauce, pasta sauce  
| puddings |  
| Canned fish |  

5. **Please provide an indication of the level of interest your solution(s) have received from industry so far.**

We have received tremendous interest from the industry especially when we showcased at FIE and received the Food Excellence award for our solution PuraQ Arome NA4

Both in house and externally

7. Accreditation status of labs doing the work. Please state.

Essensor (The Netherlands), TNO

8. Can reports/results be available if requested? Please indicate.

To be discussed

9. Some information on experimental details covering the following aspects is required. Please indicate the:

   - **Number and type of microorganisms used in challenge testing (if appropriate)**
     
     Lactic acid bacteria, Leuconostoc

   - **Inoculation approach and strain pre-adaptation conditions**
     
     Yes, log 3, and strains are adapted to conditions

   - **Number of replicates set up (no of batches tested for shelf life and/or challenge testing trials conducted)**
     
     3

   - **Packaging, atmosphere and storage conditions**
     Vacuum packed, tray MAP and showcase simulation

   - **Duration of trials**
     
     60 days

   - **Recovery methods used and overall sampling plan**
- Controls (negative and positive) set-up

- Results: calculations and interpretation Vs claim verification. Please indicate the approach followed.

10. Please confirm that you are happy for us to include the above information within our final report.

No objection
Company: Wild flavors  
Product: Sea Salt Trim®

1. Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.

Sea SaltTrim®

2. Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technology.

Sea SaltTrim® is a 1:1 replacement system for common salt. It is comprised of low sodium sea salt, naturally rich in potassium chloride and other minerals, combined with a WILD natural flavouring which overcomes the bitter metallic notes of the potassium.

3. Shelf life Vs Challenge test trials. Please indicate the type of analysis you have conducted in food safety trials that you have conducted.

4. Types of products per sector tested

| Meat and meat products | No formal stability studies have been conducted in regard to food safety as all the meat products such as hot dogs include sodium nitrite for preservative. The same holds true for fermented sausages such as pepperoni which relies on lactic acid product resulting in a lower pH for is preservation method. Other experiences with sausage (breakfast-type) have been with frozen products were reduced salt is not a microbiological |
Bread and cereal products | No formal stability studies have been conducted in regard to food safety as all the bread products we have worked with have included acceptable chemical preservatives.

Cheese products | Sea SaltTrim® has been used in reduced sodium mozzarella cheese, but all stability studies have been conducted by the customer. WILD has not seen this data.

Extruded & pelleted snacks | No experience in this area

Cakes, pastries, fruit pies | Same as bread products

Pesto & thick sauces | Ranch Salad Dressing and Barbecue Sauce – formal six month stability run on reduced sodium vs. control for yeast and mold (non-inoculation). There was no difference noticed between the control and reduced sodium versions.

puddings | No experience in this area

Canned fish | No experience in this area

5. Please provide an indication of the level of interest your solution(s) have received from industry so far.
Considerable interest in our Sea SaltTrim® from the following industry segments: sauces, salad dressing, canned meat, canned entrée, frozen entrée, canned soup, luncheon meats, bread (white and whole wheat)


Microbiological study for the ranch dressing and barbecue sauce was run internally for a national association based in the U.S.

7. Accreditation status of labs doing the work. Please state.

8. Can reports/results be available if requested? Please indicate.

Reports would not be available as the work done does not belong to WILD Flavors.

9. Some information on experimental details covering the following aspects is required. Please indicate the:

- Number and type of microorganisms used in challenge testing (if appropriate)

- Inoculation approach and strain pre-adaptation conditions

- Number of replicates set up (no of batches tested for shelf life and/or challenge testing trials conducted

- Packaging, atmosphere and storage conditions

- Duration of trials

- Recovery methods used and overall sampling plan
- Controls (negative and positive) set-up

- Results: calculations and interpretation Vs claim verification. Please indicate the approach followed.

10. Please confirm that you are happy for us to include the above information within our final report.

Yes
Appendix 7: Responses to Sensory Criteria Evaluation

Company: Smart Salt
Product Smart Salt®

11. Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.

Smart Salt® is the name given to a sodium reduction system which is based on a novel, unique and patented taste enhancement technology. The salt reduction system is based on magnesal, as either a triple or double co-crystallised mineral salt that is rich in magnesium. The Smart Salt® sodium/salt reduction system is a mineral salt solution.

Quantitative Descriptive Analysis: Salt replacers based on potassium chloride alone or magnesium sulphate, can taste bitter or metallic in high concentrations limiting their use as salt substitutes in foods. Smart Salt® blends have been shown to offer the following advantages:
- Comparable salty taste characteristics to regular salt
- Improved taste profile compared to other sodium replacement systems
- No additional bitter or metallic off-notes at the same use levels as regular salt

Progressive Profiling: No significant differences at three mastication points (initial bite, mid-mouth, after-taste) for commercial quality, no-added nitrate/nitrite, regular salt and Smart Salt® SMS 40 (40% reduced salt) frankfurters. ~2%w/w addition level.

Consumer Acceptance Trials: The same frankfurters were subjected to a consumer acceptability evaluation where 52 shoppers (cross section of age and gender) were asked to score the products for overall liking, appearance, aroma, flavour and texture. At both 40% and 45% salt reduction levels there were no significant differences between these samples and the regular salt samples for all attributes at the 90% confidence levels.
Progressive Profiling: It has been shown by expert taste panel that there were no significant differences at initial bite, mid-mouth or aftertaste for flavour intensity, sour, yeasty, sweet or bitter attributes in bread using the Smart Salt® blend SMS 40 compared to regular salt. Salt intensity was slightly lower than regular salt at initial bite and mid-mouth but there were no significant differences in salt flavour at aftertaste ~ 1.2% w/w addition level.

Consumer Acceptance: The same bread samples were subjected to a consumer acceptability evaluation where 52 shoppers (cross section of age and gender) were asked to score the products for overall liking, appearance, aroma, flavour and texture. At both 40% and 45% salt reduction levels there were no significant differences between the samples for all attributes at the 90% confidence levels.

Quantitative Descriptive Analysis – Taste Enhancement: Magnesal and associated blends have been shown to be potential taste enhancers. The following observations have been made through product development and formal taste trials:

- Smart Salt blends, SMS50 and SMS40 intensify: black pepper, green pepper, all spice, dried garlic, cinnamon, bay leaf, horseradish, rosemary, thyme and sage without extraneous flavours. Regular salt did not intensify these flavours at equivalent w/w addition.
- Spices unaffected by SMS50 and SMS40: parsley, coriander, dill, thyme and basil, dried onion and chilli powder.
- Magnesal, SMS40 and SMS45LA intensify some umami flavours
- Magnesal intensifies menthol flavour with some bitterness

The following practical advice is given when considering reformulation with magnesal or Smart Salt® blends vis a vis flavour allowing potential formulation cost savings for other ingredients.

- Reduce initial monosodium glutamate, yeast extract and spice seasoning by 50% and add back to formulations as required.
- Bitter spices such as turmeric, curcumin and nutmeg should be added to taste.
Magnesal has taste synergy with other mineral salts and flavour modulators/enhancers – allowing the optimum level of sodium reduction with a balanced flavour profile.

12. Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technologies.

Production blends of Smart Salt® have been optimised to use as 1:1 replacements for salt in most food applications, including table top products, based on stability and taste quality. However it is possible to blend magnesal with regular salt (sodium chloride), potassium chloride, sea salt and flavours to optimise formulations. It has been shown that using magnesal/sodium chloride blends, with no added potassium chloride, have been successful in some applications. Although based on mineral salts Smart Salt® does have taste enhancement qualities.

All Smart Salt® products are available as low-potassium or potassium-free options and with the possibility of “natural” labelling in some markets.

13. Sensory analysis Vs Consumer acceptability trials. Please indicate the type of analysis you have conducted

Quantitative Descriptive Analysis (QDA) vs regular salt and reduced regular salt

Progressive Profiling (PP) vs regular salt

Consumer Acceptability Trials (CAT) vs regular salt

14. Types of products per sector tested in each type of trials

| Meat and meat products | Frankfurters (QDA, PP and CAT), Chilled beefburgers (QDA), Cooked ham (QDA), Chicken patties (QDA, CAT), Chicken luncheon meat (QDA, CAT), Salami (QDA), Ham casserole (QDA), Minced meat casserole (QDA), Chicken risotto (QDA), Chicken pasta (QDA), Chicken soup (QDA), Meatballs (QDA), |
## 5. Please provide an indication of the level of interest your solution(s) have received from industry so far.

There is a very high level of interest as data have indicated that Smart Salt® products have a very high consumer acceptability compared to full salt products even at salt reduction levels of 40-50% with no significant difference in taste or preservation qualities of the final product. This means that it is possible in many applications to reach national sodium reduction targets.

Smart Salt® has been evaluated extensively in commercial development facilities and manufacturing environments as well as food research establishments, in most application categories – some companies are close to launch. Most commercial development has been made under confidentiality agreements so we are not in a position to disclose the work done however we do know that it is possible to match existing regular salt flavour profiles using Smart Salt® - evidenced by in-house QDA or consumer panel.

## 6. Work done in-house/externally. Please indicate

The most significant sensory and consumer trial data that can be shared includes:

<table>
<thead>
<tr>
<th>QDA - Work carried out at Foodwest Inc, Seinäjoki, Finland</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Dry Sausage : Production and preservation trial</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bread and cereal products</th>
<th>White bread (QDA, PP and CAT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pizza dough (QDA)</td>
<td></td>
</tr>
<tr>
<td>Rye bread (QDA)</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Cheese products</th>
<th>Edam cheese (QDA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cottage cheese (QDA)</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Extruded &amp; pelleted snacks</th>
<th>Potato Chips (CAT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spice blends for snacks (QDA)</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Cakes, pastries, fruit pies</th>
<th>Crackers (QDA)</th>
</tr>
</thead>
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<table>
<thead>
<tr>
<th>Pesto &amp; thick sauces</th>
<th></th>
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<table>
<thead>
<tr>
<th>puddings</th>
<th></th>
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<tr>
<th>Canned fish</th>
<th></th>
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<table>
<thead>
<tr>
<th>Other</th>
<th>Soups (QDA), Vegetable Casserole (QDA), Salmon Chowder (QDA)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Table</strong></th>
<th><strong>Chicken broth (CAT)</strong></th>
<th><strong>Bread and cereal products</strong></th>
<th><strong>Cheese products</strong></th>
<th><strong>Extruded &amp; pelleted snacks</strong></th>
<th><strong>Cakes, pastries, fruit pies</strong></th>
<th><strong>Pesto &amp; thick sauces</strong></th>
<th><strong>puddings</strong></th>
<th><strong>Canned fish</strong></th>
<th><strong>Other</strong></th>
<th><strong>Soups (QDA), Vegetable Casserole (QDA), Salmon Chowder (QDA)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cat</strong></td>
<td>Chicken broth (CAT)</td>
<td>White bread (QDA, PP and CAT)</td>
<td>Edam cheese (QDA)</td>
<td>Potato Chips (CAT)</td>
<td>Crackers (QDA)</td>
<td></td>
<td></td>
<td></td>
<td>Soups (QDA)</td>
<td>Vegetable Casserole (QDA), Salmon Chowder (QDA)</td>
</tr>
</tbody>
</table>
- Shelf –life trial for cooked sliced ham
- Manufacturing (RTE) convenience foods for a clinical study I and II
- Baking with Smart Salt: Test I and II
- Smart Salt in Baking: bread rolls, rye bread and pizza doughs – recipes for Kuopio Clinical Trials
- Frankfurter Survey part I and II
- The Impact of Smart Salt blends on certain flavour enhancers and spice blends
- The Impact of Smart Salt on flavour intensity and aftertaste of common spices

QDA, PP and CAT - Work carried out at Leatherhead Food Research, UK

- Key sensory attributes of Smart Salt and other mineral salts (QDA)
- Key sensory attributes of Smart Salt products at 3 mastication points (PP) – bread and frankfurters
- Interaction of Smart Salt with basic tastes
- Interaction of Smart Salt with other umami tastes and taste combinations
- Consumer acceptability testing in bread and frankfurters (CAT)

CAT - Work carried out at National Food Laboratories Inc, USA

- Consumer acceptance testing of hot dogs, potato chips, green beans and chicken broth containing a salt substitute

Dietary compliance data from 8 week intervention study – Oy Foodfiles Ltd, Kuopio, Finland


QDA - Work carried out at University of Bristol, School of Veterinary Sciences, UK
- Sodium replacement using Smart Salt in modified-atmosphere-packed, sulphite–free burgers: effects on eating quality and other attributes – MSc dissertation

7. Accreditation status of labs doing the work. Please state

Foodwest Ltd, established in 1995 is a consulting organisation that investigates the market on a broad scale and provides customers with the information and technology for the whole development process. [http://www.foodwest.fi/en/index.html](http://www.foodwest.fi/en/index.html)

Founded in 1919, Leatherhead Food Research has been a trusted partner to the food industry for nearly a century, offering an unparalleled breadth and depth of experience to help the food industry innovate and evolve. [http://www.leatherheadfood.com](http://www.leatherheadfood.com)

The National Food Lab, The NFL, is a consulting organization specializing in transforming inspiration and experience into innovative food and beverage development. They started in 1976 in Berkeley, California as the Technical Service Corporation (Tech S). In 1985 we were renamed The National Food Laboratory, Inc. and relocated to Dublin, CA. [http://www.thenfl.com](http://www.thenfl.com)

Foodfiles is an independent contract research organisation (CRO) in the field of nutrition. Foodfiles performs clinical studies, offers services concerning regulatory affairs and consultation for the international food and pharmaceutical industry. Their core competence area is nutrition and health. [http://www.foodfiles.com/eng/?ID=1267](http://www.foodfiles.com/eng/?ID=1267)

University of Bristol – The MSc in Meat Science and Technology is a well-established course which is unique in the UK, highly regarded by the meat industry and attracts students from around the world. [http://www.bristol.ac.uk/vetscience/postgraduate/msc/](http://www.bristol.ac.uk/vetscience/postgraduate/msc/)

8. Can reports/results be available, if requested? Please indicate

Reports or summaries of reports can be made available if requested.

9. Some information on experimental details covering the following aspects are required:

- Please provide an overview of the methodology used in each type of trials (Sensory & Consumer)
Sensory Trials: QDA or PP assessors were drawn from trained sensory panels. All assessors were trained in the sensory evaluation of an extensive range of food and beverage products including salt/salty ingredients and were familiarised with the range of salts and flavours.

Product Profiling

A sensory profile was developed based on the principles of quantitative descriptive analysis (QDA).

Vocabulary generation and training

Assessors evaluated each of the samples independently and provided a detailed sensory description of the product. The panel then discussed their views and generated a consensus vocabulary, which consisted of specific attributes and definitions.

All salt samples were tested in triplicate. The samples were presented in a balanced presentation.

Assessment

- Each assessor carried out individual evaluations of samples, which were presented in a sequential monadic randomised fashion.

- All samples were presented blind to the assessors in 3 digit coded clear plastic pots.

- All assessments were carried out in separate booths.

  Assessors used line scales or hedonic scales to indicate intensity of attributes.

Consumer trials assessors were drawn from the general population with mixed gender and age groups. The respondents were asked to assess the products blind, in a randomised order to prevent bias from order effects. Respondents were asked to assess the products and score them on a hedonic scale for several key attributes, they were also asked to note down any particular likes or dislikes.

- Please indicate the types of control trials conducted in each case

  Controls included full regular salt and/or reduced regular salt controls.
- Please indicate the number of participants (trained panel & consumers) involved in each case

For QDA and PP trials - numbers of participants >10
Consumer panels – numbers of participants > 50

- Please indicate the number of replicates set up in each case

QDA and PP - Samples tasted in triplicate
Consumer panels - respondents were asked to assess the products blind, in a randomised order to prevent bias from order effects - they were also asked to note down any particular likes or dislikes

- Please indicate the use of any palate cleansers during the trials

Trained panel – water
Consumer panel – water

- Please confirm the statistical package/process used in the analysis of the data obtained

The multivariate analysis was carried out using ANOVA and Fisher’s LSD (Least Significant Difference) for multiple comparisons between samples

A significance level of 5% (95% confidence) was initially applied for measurement of statistical significant differences between samples. Data analysis was carried out using Senpaq v5.01. Principal Component Analysis (PCA) was also applied to some of the QDA data.

- Please confirm the relevant claims that you are making for your solutions
In summary, extensive taste testing using techniques such as Quantitative Descriptive Analysis (QDA), Progressive Profiling (PP) and Consumer Acceptance Trials (CAT) have been carried out both in the US and in Europe at independent research establishments and by major food manufacturers. Most often, it is possible to match flavour profiles and there are no significant differences in taste or acceptability between regular products and the reduced sodium/salt versions (40-50% reduction) made with Smart Salt® products. Taste synergies with umami flavours in particular and other flavouring ingredients can often lead to cost savings in formulations.

10. Please confirm that you are happy for us to include the above information within our final report.

We are happy for you to include the above information within the final report.
Company: AkzoNobel
Product: Loso OneGrain™

1. Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.

Suprasel® Loso OneGrain™

2. Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technologies.

It’s a combination of 1-1 replacement and salt enhancing additives

3. Sensory analysis Vs Consumer acceptability trials. Please indicate the type of analysis you have conducted.

Both, sensory analysis by expert panels and in some cases consumer panels.
4. Types of products per sector tested in each type of trials:

<table>
<thead>
<tr>
<th>Sector</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat and meat products</td>
<td>hams, sausages</td>
</tr>
<tr>
<td>Bread and cereal products</td>
<td>sandwich bread (loaf), baguette, biscuits</td>
</tr>
<tr>
<td>Cheese products</td>
<td>Cheddar, feta (ongoing), esrom (ongoing)</td>
</tr>
<tr>
<td>Extruded &amp; pelleted snacks</td>
<td>Potato crisps</td>
</tr>
<tr>
<td>Cakes, pastries, fruit pies</td>
<td>Puff pastry</td>
</tr>
<tr>
<td>Pesto &amp; thick sauces</td>
<td>Instant soups</td>
</tr>
<tr>
<td>puddings</td>
<td>n.a.</td>
</tr>
<tr>
<td>Canned fish</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

5. Please provide an indication of the level of interest your solution(s) have received from industry so far.

Many positive feedbacks worldwide


Both, professional application tests externally

7. Accreditation status of labs doing the work. Please state.

Silleker and Eurofin ISO/IEC 17025:2005
8. Can reports/results be available, if requested? Please indicate.

Yes, for bread, cheese and meat in general, more specific reports will be available by the end of this year.

9. Some information on experimental details covering the following aspects are required:

- Please provide an overview of the methodology used in each type of trials (Sensory & Consumer)

  Expert panels or/and consumer test.

- Please indicate the types of control trials conducted in each case

  Comparisons with normal salted applications, and/or applications with similar sodium levels as the sodium reduced applications by OneGrain

- Please indicate the number of participants (trained panel & consumers) involved in each case

  Expert panels 10-20 participants or/and consumer test >90 participants.

- Please indicate the number of replicates set up in each case

  n.a.

- Please indicate the use of any palate cleansers during the trials

  Water

- Please confirm the statistical package/process used in the analysis of the data obtained

  Analysis executed by professional parties. Details of analysis not available (at the moment)
- **Please confirm the relevant claims that you are making for your solutions**

  You can achieve a sodium reduction of 50% by maintaining taste and texture.

10. **Please confirm that you are happy for us to include the above information within our final report.**

    Yes
Company: Cargill
Product: SodiumSense™ and FlakeSelect™

1. Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.

   - FlakeSelect™ – patent pending process that physically modifies single or multiple ingredients to add functionality
   - SodiumSense™ – a cost effective sodium reduction product formulated to provide similar liking as full salted food products
   - Ongoing research to understand the functional role of salt in various food applications in order to devise reduced sodium solutions
   - Ongoing research to understand particle size and crystal morphology on salty taste perception in various food applications.
   - In addition to sensory/consumer evaluation, Cargill is also using non-destructive analytical techniques, such as x-ray tomography and energy dispersive spectroscopy to understand all the functional roles of sodium chloride. Cargill's research goal is to correlate the functional roles of salt, as measured from these cutting edge analytical techniques, to overall sensory perception. This type of research approach will catapult the science in the direction required to make an impactful breakthrough in the reduced sodium space.

2. Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technologies.

   - Replacement,
   - Physically modified
   - Alternative flavour technology
   - Combination of all three listed above

3. Sensory analysis Vs Consumer acceptability trials. Please indicate the type of analysis you have conducted.
- Difference Testing: Triangle Tests with employees (consumers)
- Acceptance (Liking/Preference) Test with employees where we use 9-point hedonic scales for liking attributes, and Just About Right (JAR) questions for some attribute related questions e.g. Saltiness, Flavor Strength.
- SIMS package for designing our tests. The experimental designs from SIMS allow us to serve samples in a random balanced order to each panellist.
- In addition, trained and QDA panels are used for more specific analysis such as screening samples for the consumer panel and specific attribute testing, e.g. bitter tasting

4. Types of products per sector tested in each type of trials:

<table>
<thead>
<tr>
<th>Meat and meat products</th>
<th>Completed and ongoing trials for ham, hotdogs, bacon, pepperoni and chicken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bread and cereal products</td>
<td>Completed and ongoing trials for breads and tortillas</td>
</tr>
<tr>
<td>Cheese products</td>
<td>Completed and ongoing trials Natural cheddar, mozzarella and cottage cheeses</td>
</tr>
<tr>
<td>Extruded &amp; pelleted snacks</td>
<td>Completed and ongoing trials for cereals</td>
</tr>
<tr>
<td>Cakes, pastries, fruit pies</td>
<td>Cookies</td>
</tr>
<tr>
<td>Pesto &amp; thick sauces</td>
<td>Marinara sauce, chicken broth</td>
</tr>
<tr>
<td>Puddings</td>
<td></td>
</tr>
<tr>
<td>Canned fish</td>
<td></td>
</tr>
</tbody>
</table>
5. Please provide an indication of the level of interest your solution(s) have received from industry so far.

- We are active (through sales or research products) in the following food categories: meats (beef, pork, and poultry), dairy (e.g. natural cheese, cottage cheese), bakery (breads, tortillas), cereals, snacks & seasonings, canned vegetables, beverages (e.g. tomato juice)
- Food Processing and Foodservice channels


- Internal – Cargill has a global sensory program
  1. Employee base program. Each satellite has access to a pool of employees ranging in size from 800 – 2000 consumers.
  2. Local school programs (after school day care programs located in a large metropolitan area (~3 MM)
- External
  1. Third party consultants – testing geographies distributed across the US
  2. Research facilities (e.g. Center of Dairy Research)

7. Accreditation status of labs doing the work. Please state.

- Internal labs have trained panels, consumer panels, QDA

8. Can reports/results be available, if requested? Please indicate.

- Suitable reports may be generated for Leatherheads needs

9. Some information on experimental details covering the following aspects are required:

- Please provide an overview of the methodology used in each type of trials (Sensory & Consumer)

  1. Environment
     • Panellist are in an isolated booth containing
• Samples, water and crackers presented through sliding door

• Instructions (e.g. taste order, rinse between samples, answer questions before moving on to next sample, etc.) and questions are presented and responses captured on a computer

• Samples are consistently prepared (e.g. center of bread, 1” cube of cheese) at appropriate serving conditions (e.g. temperature)

2. Tests

1. Difference Testing: Triangle Tests with employees (consumers)

• Acceptance (Liking/Preference) Test with employees where we use 9-point hedonic scales for liking attributes, and Just About Right (JAR) questions for some attribute related questions e.g. Saltiness, Flavor Strength.

2. Example – reduced sodium mozzarella cheese

• Liking Test: Panelists were served a shredded 7g portion of each sample at ~40F. Samples were served one at a time in balanced rotation. Panelists were instructed to eat enough of the cheese to form an opinion and to rinse well with water in between each sample.

• Difference Test: Panelists were served a shredded 7g portion of the samples at ~40F in a balanced triangle test rotation. Panelists were instructed to taste the samples in the order on the tray and to rinse well with water in between samples and the pick the sample that is different from the other two.

- Please indicate the types of control trials conducted in each case

1. In all cases, we use a full sodium control
2. Standard formulations created by Cargill food scientist and represent typical products in the retail market or restaurant offerings
3. Products are produced in application laboratories or pilot plants
4. Control sodium value (targets) determined using USDA nutrient database, consumer product goods or other resources such as tables generated by non-government organizations (e.g. National Sodium Reduction Initiative)

- Please indicate the number of participants (trained panel & consumers) involved in each case

  1. Trained panels, our target is n = 5 - 15
  2. For consumer panels, our target is n = 80 – 125, with an average of n = 100.

- Please indicate the number of replicates set up in each case

  1. Target is to perform each testing in duplicate, at a minimum, using different lots of ingredients.

- Please indicate the use of any palate cleansers during the trials

  Depending on the test, the following protocols are followed:
  1. Rinse well with water between samples
  2. Crackers provided
  3. Break between samples ranging from hours to days

- Please confirm the statistical package/process used in the analysis of the data obtained

  1. Sensory Information Management System (SIMS) statistical package to analyze triangle test results
  2. Analyze acceptance test results by applying ANOVA (Analysis of Variance)
  3. Other statistical packages e.g. Statistical Package for the Social Sciences (SPSS)
- Please confirm the relevant claims that you are making for your solutions

1. No statistical difference between control and reduced sodium products (up to 50% sodium reduction) for liking (overall, flavour and aftertaste) and Just About Right (Saltiness, Flavour strength)

10. Please confirm that you are happy for us to include the above information within our final report.

Confirmed.
Company: DSM Food Specialties  
Product: Yeast Extract-derived/ Natural Flavour products

1. Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.

Selection of most efficient yeast extract based ingredients for sodium reduction purposes.
Formulation knowhow, using combinations of a) salt taste donors b) salt taste enhancers c) bitter maskers d) (specific) aroma donors and e) mouth feel components. All yeast extract derived or from natural flavour according (EC) No 1334/2008 developed by DSM.

2. Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technologies.

Salt perception enhancer, alternative flavour technologies

3. Sensory analysis Vs Consumer acceptability trials. Please indicate the type of analysis you have conducted.

According good sensory practise DSM quality standards\* when available according ISO procedures. DSM has trained panel 16 people (tested on sensory capabilities).
4. Types of products per sector tested in each type of trials:

<table>
<thead>
<tr>
<th>Meat and meat products</th>
<th>Process meat products:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ham</td>
</tr>
<tr>
<td></td>
<td>Chicken</td>
</tr>
<tr>
<td></td>
<td>Sausages, Nuggets &amp; burgers</td>
</tr>
<tr>
<td></td>
<td>Marinated meat products</td>
</tr>
<tr>
<td></td>
<td>Pate</td>
</tr>
<tr>
<td>Bread and cereal products</td>
<td>Bread</td>
</tr>
<tr>
<td></td>
<td>Cookies</td>
</tr>
<tr>
<td></td>
<td>Crackers</td>
</tr>
<tr>
<td></td>
<td>Breakfast Cereal</td>
</tr>
<tr>
<td>Cheese products</td>
<td>Spread cheese</td>
</tr>
<tr>
<td>Extruded &amp; pelleted snacks</td>
<td>Snack dusting seasoning</td>
</tr>
<tr>
<td></td>
<td>In dough (extruded snacks)</td>
</tr>
<tr>
<td>Cakes, pastries, fruit pies</td>
<td>(Chocolate) Cookies</td>
</tr>
<tr>
<td>Pesto &amp; thick sauces</td>
<td>Warm sauces, gravies</td>
</tr>
<tr>
<td></td>
<td>Cold sauces &amp; Dressings</td>
</tr>
<tr>
<td>Puddings</td>
<td>?</td>
</tr>
<tr>
<td>Canned fish</td>
<td>Canned fish in tomato sauce</td>
</tr>
</tbody>
</table>

5. Please provide an indication of the level of interest your solution(s) have received from industry so far.

High level of interest, in many cases mentioned to be part of their sodium reduction tool box.

Soups, sauces, dressings, spreads, snack seasonings, RTE meals, bakery and processed meat internally DSM and at customers. Bakery and Meat externally institutes.

7. Accreditation status of labs doing the work. Please state.

NIZO
TNO
CLL-research

8. Can reports/results be available, if requested? Please indicate.

Summary of results can be found in presentation (pdf)

9. Some information on experimental details covering the following aspects are required.

- Please provide an overview of the methodology used in each type of trials (Sensory & Consumer):
  - DSM is following the General guidance of sensory analysis ISO6658 2005-10-01.
  - Difference tests, descriptive tests (QDA), now also Time Resolved Sensory methods, we believe a must in better understand the full organolleptic dynamics of salt reduction in final food products.
  - Liking and preference testing were done in house. Consumer test are handles by our customers.

- Please indicate the types of control trials conducted in each case

Varies between trials

- Please indicate the number of participants (trained panel & consumers) involved in each case
Trained in house panel (16-18 people)

- Trained panel
The panel is selected following the guidance for selection, training and monitoring of assessors ISO8586-1, 1993-03-15.
The DSM savoury panel is trained according to the QDA method. Their task is mainly the profiling of products on a list of attributes (using unstructured line scales ranging from 0 to 100).

- Please indicate the number of replicates set up in each case

All tests are performed following 'Good Sensory Practice'. This means among others that the panelists are seated in separate booths, that the samples are coded with 3-digit codes and that the products are offered following a balanced design. Replicates are always included in one block, but also later tests.

- Please indicate the use of any palate cleansers during the trials

Yes, water and crackers. The sample preparation is in the sensory kitchen which is separated from the tasting room.

- Please confirm the statistical package/process used in the analysis of the data obtained

- Yes

- Please confirm the relevant claims that you are making for your solutions

? No claims
We position our products being part of the tool kit to develop good tasting reduced sodium food products.

10. Please confirm that you are happy for us to include the above information within our final report.

- All data shared can be used
Company: Innophos  
Product: SuperBindTM HB-CT (& others)  

1. Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.

   Meat: SuperBind™ HB-CT: Maximizing the protein extraction by optimizing the capability from phosphates, we are able to lower the usage of NaCl needed for protein solubilisation.
   Dairy: Replace current sodium based emulsifying salts by low/reduced sodium emulsifying salts. Emulsifying salts contribute 44-48% of sodium in processed cheese.

2. Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technologies.

   In general, our technology is sodium ingredient replacement, except SuperBind™ HB-CT replaces the physical functionality of salt.

3. Sensory analysis Vs Consumer acceptability trials. Please indicate the type of analysis you have conducted.

   Most of the sensory analysis and general consumer acceptability tests were done in house. Hedonic sensory evaluation is used most of the time. Sometimes, however, triangle test is also adopted.
4. **Types of products per sector tested in each type of trials:**

<table>
<thead>
<tr>
<th>Product Category</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat and meat products</td>
<td>Sausage (pork, beef, chicken); Nuggets; Patties (chicken)</td>
</tr>
<tr>
<td>Bread and cereal products</td>
<td>N/A</td>
</tr>
<tr>
<td>Cheese products</td>
<td>Process cheese (product, sauce, foods)</td>
</tr>
<tr>
<td>Extruded &amp; pelleted snacks</td>
<td>N/A</td>
</tr>
<tr>
<td>Cakes, pastries, fruit pies</td>
<td>N/A</td>
</tr>
<tr>
<td>Pesto &amp; thick sauces</td>
<td>N/A</td>
</tr>
<tr>
<td>puddings</td>
<td>N/A</td>
</tr>
<tr>
<td>Canned fish</td>
<td>N/A</td>
</tr>
</tbody>
</table>

5. **Please provide an indication of the level of interest your solution(s) have received from industry so far.**

   Although these ingredients have been launched only recently, significant Innophos and customer formulation work has occurred.

6. **Work done in-house/externally. Please indicate.**

   Done in house.

7. **Accreditation status of labs doing the work. Please state.**

   N/A
8. Can reports/results be available, if requested? Please indicate.

Yes

9. Some information on experimental details covering the following aspects are required:

- Please provide an overview of the methodology used in each type of trials (Sensory & Consumer)

  General consumer as audience, preference test by hedonic descriptive tests, sometimes triangle tests used

- Please indicate the types of control trials conducted in each case

  Control being the one with traditional sodium ingredient.

- Please indicate the number of participants (trained panel & consumers) involved in each case

  Most of the times, around 15 participants from general consumer

- Please indicate the number of replicates set up in each case

  N/A

- Please indicate the use of any palate cleansers during the trials

  Water, sometimes soda biscuit

- Please confirm the statistical package/process used in the analysis of the data obtained

  SAS GLM

- Please confirm the relevant claims that you are making for your solutions
Don't see statistical difference

10. Please confirm that you are happy for us to include the above information within our final report.

Yes
Company: Jungbunzlauer
Product: sub4salt®

1. Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.

a. Establishment of recipes with our patented sub4salt® specifically towards the American cuisine (e.g. French fries, tacos, burgers and respective sauces), yielding 25-35% sodium reduction.
b. Development of new sub4salt® blends to address improved functionality and taste in certain processed food applications.

2. Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technologies.

3. Sensory analysis vs Consumer acceptability trials. Please indicate the type of analysis you have conducted.

a. New recipes were tested internally by own sensory panel as a comparative tests vs standard product without sodium reduction, sensory consumer tests were done only for sodium reduced products.
b. As for new alternative blends, internal sensory comparative tests vs. standard product without sodium reduction were done.

4. Types of products per sector tested in each type of trials:

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat and meat products</td>
<td>Done (results not available for publication)</td>
</tr>
<tr>
<td>Bread and cereal products</td>
<td>Done (results not available for publication)</td>
</tr>
<tr>
<td>Cheese products</td>
<td>Done (results not available for publication)</td>
</tr>
<tr>
<td>Product Type</td>
<td>Status</td>
</tr>
<tr>
<td>------------------------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Extruded &amp; pelleted snacks</td>
<td>Done (results not available for publication)</td>
</tr>
<tr>
<td>Cakes, pastries, fruit pies</td>
<td>Done (results not available for publication)</td>
</tr>
<tr>
<td>Pesto &amp; thick sauces</td>
<td>Done (results not available for publication)</td>
</tr>
<tr>
<td>puddings</td>
<td>Done (results not available for publication)</td>
</tr>
<tr>
<td>Canned fish</td>
<td>Done (results not available for publication)</td>
</tr>
</tbody>
</table>

5. Please provide an indication of the level of interest your solution(s) have received from industry so far.

a. / b. From producers of meat, bread and cheese products there is a high level of interest because most of salt is used in these applications.


Trials for meat products and cakes were made externally, all others were handled inhouse.

7. Accreditation status of labs doing the work. Please state.

If not performed by our own R&D personnel's, process evaluations were done in cooperation with well known experts and institutes. The sensory test panels are based on trained experts. Furthermore any microbial and chemical analysis done
8. Can reports/results be available, if requested? Please indicate.

Parts of the results are available in form of recipe formula cards. It is not possible to give details on analysis or sensory panel tests to the report due to patent situation.

9. Some information on experimental details covering the following aspects are required:

- **Please provide an overview of the methodology used in each type of trials**
  (Sensory & Consumer)
  
  a. Internal sensory comparative tests vs. standard product without sodium reduction, consumer test only for sodium reduced products.
  b. Internal sensory comparative tests vs. standard product without sodium reduction.

- **Please indicate the types of control trials conducted in each case**

  All products were compared against the standard product regarding appearance, taste, structure and odor.

- **Please indicate the number of participants (trained panel & consumers) involved in each case**

  (a): internal panel: 10 persons
  consumer panel: 60 persons
  (b): internal panel: 10 persons

- **Please indicate the number of replicates set up in each case**

  N/a for triangle test

- **Please indicate the use of any palate cleansers during the trials**

  Still water, bread
- Please confirm the statistical package/process used in the analysis of the data obtained

- *Please confirm the relevant claims that you are making for your solutions*

All products can be labelled as sodium reduced with a min. reduction of 25%.

10. **Please confirm that you are happy for us to include the above information within our final report.**

We confirm that the above mentioned information can be used by Leatherhead for the report purpose.
Company: Kudos Blends
Product: KUDOS™ Potassium Bicarbonate

1. Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.

Kudos Blends offers sodium reduction solutions for all varieties of low sodium and sodium free baking powders. This NEW, unique, patented grade of potassium bicarbonate makes up an essential part of low sodium baking powders. It is needed to react with the acids in order to liberate carbon dioxide to provide aeration in baked goods.

2. Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technologies.

KUDOS™ Potassium Bicarbonate is a replacement for sodium bicarbonate to help bakers achieve 50% reduction.

3. Sensory analysis Vs Consumer acceptability trials. Please indicate the type of analysis you have conducted.

Taste tests were carried out by Leatherhead food research between pancakes and scones made with potassium bicarbonate and a control made with sodium bicarbonate. In all the tests, there was very little, if any taste difference noticed.

At the FI Salt & Sodium reduction conference, a blind study was carried out on preference of cupcakes made with potassium and sodium bicarbonate. The consensus of opinion was that the cakes made with potassium bicarbonate were preferred by most of the people involved in the tasting session.
4. **Types of products per sector tested in each type of trials:**

<table>
<thead>
<tr>
<th>Sector</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat and meat products</td>
<td></td>
</tr>
<tr>
<td>Bread and cereal products</td>
<td></td>
</tr>
<tr>
<td>Cheese products</td>
<td></td>
</tr>
<tr>
<td>Extruded &amp; pelleted snacks</td>
<td></td>
</tr>
<tr>
<td>Cakes, pastries, fruit pies</td>
<td>Cake batters, pancakes, crumpets, scones, pre-mixes / concentrates, pastries, muffins, fairy cakes.</td>
</tr>
<tr>
<td>Pesto &amp; thick sauces</td>
<td></td>
</tr>
<tr>
<td>Puddings</td>
<td>Sponge puddings,</td>
</tr>
<tr>
<td>Canned fish</td>
<td></td>
</tr>
</tbody>
</table>

5. **Please provide an indication of the level of interest your solution(s) have received from industry so far.**

We have received a large amount of interest in this product – we already supply some of the largest food producers in the UK and the rest of the world with this product to help them meet their 2012 salt guidelines. Kudos Blends is considered a thought leader in this subject area and due to our knowledge and experience have been asked to lecture at many national conferences. Kudos Blends was invited to the House of Commons to attend a parliamentary reception to recognise the work we have contributed towards to the sodium reduction industry.
6. **Work done in-house/externally. Please indicate.**

18 months work of R&D has gone into this product to make it hydrophobic. By nature, potassium bicarbonate is very reactive and is often associated as being unusable due to the fact it compacts into hard lumps / cakes; this unstable nature has often deterred bakers from its use.

The unique patented grade of KUDOS potassium bicarbonate, specifically developed for the baking industry, has two key and critical characteristics: a) it is of a particular fine particle size achieved through a totally unique milling process and b) has a hydrophobic component to it, which makes the fine powder water repellent. The water repellent property markedly improves the stability of the powder, thus making shipping, handling and storage very easy. Further, and perhaps of more significance is that the unique technology behind this powder also lends itself to improving the shelf life of any blends of which the KUDOS potassium bicarbonate is incorporated into, such as baking powders, premixes and concentrates. Kudos can now sell potassium bicarbonate as a direct replacement for sodium bicarbonate, with all the functional properties, markedly improved stability and, in turn, a better shelf life whilst delivering a zero sodium option for bakers. This has resulted in Kudos obtaining a worldwide patent on this product for its manufacture and usage in low sodium leavening agents.

7. **Accreditation status of labs doing the work. Please state.**

Work carried out in Kudos Blends own lab by a team of PHD chemists.

8. **Can reports/results be available, if requested? Please indicate.**

Yes – shelf life reports and brochure literature available upon request.

9. **Some information on experimental details covering the following aspects are required:**

- Please provide an overview of the methodology used in each type of trials (Sensory & Consumer)
- Please indicate the types of control trials conducted in each case

- Please indicate the number of participants (trained panel & consumers) involved in each case

- Please indicate the number of replicates set up in each case

- Please indicate the use of any palate cleansers during the trials

- Please confirm the statistical package/process used in the analysis of the data obtained

- Please confirm the relevant claims that you are making for your solutions

*ATTACHED IN A FORM OF A LEATHERHEAD REPORT*

10. Please confirm that you are happy for us to include the above information within our final report.

Yes – happy to include details.
Company: LycoRed  
Product: SANTE  

1. Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.

SANTE is a natural extract from tomato, it delivers Umami and kokumi tastes and mouth feel in savoury food product. By enhancing the taste profile, certain amount of salt can be removed.

2. Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technologies.

SANTE is definitely a salt replacer. SANTE enhances taste and salty taste due to it characteristic

3. Sensory analysis Vs Consumer acceptability trials. Please indicate the type of analysis you have conducted.

Each batch of SANTE is analysed organoleptic by internal small panel taste
The parameters are color, Umami taste, off flavor taste.  
Results are marked as : Pass/No pass.  
The non pass product does not packaged  
We have conducted internal panel taste trials to indicate functionality during shelf life in a specific models which we have developed. There was no influence on the product functionality when process parameters such as temperature, shear, pressure or time, were modified. Nevertheless each use in a food system should be made by trial and error.
4. Types of products per sector tested in each type of trials:

<table>
<thead>
<tr>
<th>Meat and meat products</th>
<th>Sausages, meat loaf, hamburgers, patties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bread and cereal products</td>
<td>Bread, crackers, snacks, pizza.</td>
</tr>
<tr>
<td>Cheese products</td>
<td>Commercial cheese – not tradition cheese.</td>
</tr>
<tr>
<td>Extruded &amp; pelleted snacks</td>
<td>Extruded (puffed) cereal snacks.</td>
</tr>
<tr>
<td>Cakes, pastries, fruit pies</td>
<td>Pizza. Not intended for sweet products</td>
</tr>
<tr>
<td>Pesto &amp; thick sauces</td>
<td>Tomato based sauces, white sauces such as ranch and French, thousand islands etc. Culinary product as well such as instant soups and canned soups</td>
</tr>
<tr>
<td>puddings</td>
<td>No</td>
</tr>
<tr>
<td>Canned fish</td>
<td>No experience so far.</td>
</tr>
</tbody>
</table>

5. Please provide an indication of the level of interest your solution(s) have received from industry so far.

Level 0.2-1% in finished product


Lot of work have been done- please see attached examples in the attached manual
7. Accreditation status of labs doing the work. Please state.

In the past we used a US lab which helps us identify the product.

8. Can reports/results be available, if requested? Please indicate.

Under confidentially agreement.

9. Some information on experimental details covering the following aspects are required:

- Please provide an overview of the methodology used in each type of trials (Sensory & Consumer)

  Internal panel taste for Umami, Kokumi.
  We use special developed model in which we indicate salt enhancing, overall taste, sourness, bitterness, and sweetness comparing reference product without and with SANTE.

- Please indicate the types of control trials conducted in each case

  A special tomato soup which we developed Or 12% SANTE in water

- Please indicate the number of participants (trained panel & consumers) involved in each case

  5-8

- Please indicate the number of replicates set up in each case

  1-3 depends on the test – hedonic or comparison

- Please indicate the use of any palate cleansers during the trials

  Not Applicable
- Please confirm the statistical package/process used in the analysis of the data obtained

Average with SD, or Pass/No Pass

- Please confirm the relevant claims that you are making for your solutions

Natural flavour and taste enhancer from tomato.

10. Please confirm that you are happy for us to include the above information within our final report.

Yes
Company: Natural Taste Consulting
Product: Salt Enhancer

1. Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.

Two tests were carried out:
Test A: a chicken soup containing 0.5% NaCl (low salt control) vs a chicken soup containing 0.5% NaCl + salt enhancer 1 (0.08%)

This test was to demonstrate the salt enhancing effect of our product. We did not compare this with a full salt control simply because prior experience had taught us that each application is different and the end user is likely to use more than one solution to allow then to enhance saltiness.

Test B: a chicken soup very low in NaCl (0.35%) + KCl (0.45%) vs chicken soup very low in NaCl (0.35%) + KCl + salt enhancer 1 (0.08%)
This test was to demonstrate the reduction of the off notes of KCl.

2. Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technologies.

The product enhances NaCl and masks the undesired off notes of KCl.

3. Sensory analysis Vs Consumer acceptability trials. Please indicate the type of analysis you have conducted.

The above tests were carried out on 50 French consumers with no demographic focus. The tests were carried out by an independent laboratory in France called “Maison de Gout”.

4. Types of products per sector tested in each type of trials:
<table>
<thead>
<tr>
<th>Product Category</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat and meat products</td>
<td>Expert panel only</td>
</tr>
<tr>
<td>Bread and cereal products</td>
<td>Expert panel only</td>
</tr>
<tr>
<td>Cheese products</td>
<td>Isotonic beverages</td>
</tr>
<tr>
<td>Extruded &amp; pelleted snacks</td>
<td>Expert panel only</td>
</tr>
<tr>
<td>Cakes, pastries, fruit pies</td>
<td></td>
</tr>
<tr>
<td>Pesto &amp; thick sauces</td>
<td>Tests described above</td>
</tr>
<tr>
<td>puddings</td>
<td></td>
</tr>
<tr>
<td>Canned fish</td>
<td></td>
</tr>
</tbody>
</table>

5. Please provide an indication of the level of interest your solution(s) have received from industry so far.

Please see other document


Please see other document

7. Accreditation status of labs doing the work. Please state.

COFRAC (comité français d'accréditation) which is specific to sensory analysis labs in France following the norm EN 17025

8. Can reports/results be available, if requested? Please indicate.
yes

9. Some information on experimental details covering the following aspects are required:

- Please provide an overview of the methodology used in each type of trials (Sensory & Consumer)

Please see earlier

- Please indicate the types of control trials conducted in each case

Please see earlier

- Please indicate the number of participants (trained panel & consumers) involved in each case

Please see earlier

- Please indicate the number of replicates set up in each case

- Please indicate the use of any palate cleansers during the trials

The panellists were asked to taste the control at 60°C followed by the test at the same temperature. The panellists rinsed their mouth with water between tests

- Please confirm the statistical package/process used in the analysis of the data obtained

FIZZ

- Please confirm the relevant claims that you are making for your solutions

Statistically proven to enhance preference, roundness and saltiness
Statistically proven to mask the off notes of KCl
10. Please confirm that you are happy for us to include the above information within our final report.

Yes
Company: Purac  
Product: PuraQ Arome NA4

Same as food safety document

1. Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.

2. Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technologies.

3. Sensory analysis Vs Consumer acceptability trials. Please indicate the type of analysis you have conducted

4. Types of products per sector tested in each type of trials:

<table>
<thead>
<tr>
<th>Product Type</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat and meat products</td>
<td></td>
</tr>
<tr>
<td>Bread and cereal products</td>
<td></td>
</tr>
<tr>
<td>Cheese products</td>
<td></td>
</tr>
<tr>
<td>Extruded &amp; pelleted snacks</td>
<td></td>
</tr>
<tr>
<td>Cakes, pastries, fruit pies</td>
<td></td>
</tr>
<tr>
<td>Pesto &amp; thick sauces</td>
<td></td>
</tr>
<tr>
<td>puddings</td>
<td></td>
</tr>
</tbody>
</table>
Canned fish

5. Please provide an indication of the level of interest your solution(s) have received from industry so far.


7. Accreditation status of labs doing the work. Please state.

8. Can reports/results be available, if requested? Please indicate.

9. Some information on experimental details covering the following aspects are required:
   - Please provide an overview of the methodology used in each type of trials (Sensory & Consumer)
     Initially triangle test performed, followed by testing at more extensive taste panels testing. Finally used 3rd party to gather independent feedback.
   - Please indicate the types of control trials conducted in each case
     N = 15
   - Please indicate the number of participants (trained panel & consumers) involved in each case
     No consumer tests
   - Please indicate the number of replicates set up in each case
2

- **Please indicate the use of any palate cleansers during the trials**

  Standard water and crackers

- **Please confirm the statistical package/process used in the analysis of the data obtained**

  Unknown

- **Please confirm the relevant claims that you are making for your solutions**

  10. Please confirm that you are happy for us to include the above information within our final report.

    No objection
Company: Wild flavors
Product: Sea Salt Trim®

1. Please list the salt reduction strategies/solutions that you will be providing information for. These need to be developed/launched within the last 12-18 months only.

Sea SaltTrim®

2. Please indicate whether your solution(s) is a replacement, salt enhancing additive, physically modified NaCl or alternative flavour technologies.

Sea SaltTrim® is a 1:1 replacement system for common salt. It is comprised of low sodium sea salt, naturally rich in potassium chloride and other minerals, combined with a WILD natural flavouring which overcomes the bitter metallic notes of the potassium.

3. Sensory analysis Vs Consumer acceptability trials. Please indicate the type of analysis you have conducted.

Employee “Consumer” Acceptability (Blind-Coded Samples)
4. Types of products per sector tested in each type of trials:

<table>
<thead>
<tr>
<th>Sector</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat and meat products</td>
<td></td>
</tr>
<tr>
<td>Bread and cereal products</td>
<td></td>
</tr>
<tr>
<td>Cheese products</td>
<td></td>
</tr>
<tr>
<td>Extruded &amp; pelleted snacks</td>
<td>Potato Chips (Not Extruded)</td>
</tr>
<tr>
<td>Cakes, pastries, fruit pies</td>
<td></td>
</tr>
<tr>
<td>Pesto &amp; thick sauces</td>
<td></td>
</tr>
<tr>
<td>puddings</td>
<td></td>
</tr>
<tr>
<td>Canned fish</td>
<td></td>
</tr>
</tbody>
</table>

5. Please provide an indication of the level of interest your solution(s) have received from industry so far.


   In-House Employee Acceptability Testing

7. Accreditation status of labs doing the work. Please state.

8. Can reports/results be available, if requested? Please indicate.

   Yes
9. Some information on experimental details covering the following aspects are required:

- Please provide an overview of the methodology used in each type of trials (Sensory & Consumer)


- Please indicate the types of control trials conducted in each case

Control Full Sodium vs. 35% Reduced Sodium with Sea SaltTrim®

- Please indicate the number of participants (trained panel & consumers) involved in each case

N=60 Untrained

- Please indicate the number of replicates set up in each case

1-Test (No additional Replications)

- Please indicate the use of any palate cleansers during the trials

Water & Bremner Wafers

- Please confirm the statistical package/process used in the analysis of the data obtained

Compusense Software – ANOVA statistical analysis

- Please confirm the relevant claims that you are making for your solutions

Samples Not Statistically different in Acceptability.
Samples Not Statistically different in perceived saltiness on a 100 pt. unstructured line scale.

10. Please confirm that you are happy for us to include the above information within our final report.

Confirmed
Appendix 8: List of Contributors

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Appendix 9: List of Funding Providers

The following companies provided funding for the completion of this report.

and their members: Asda Stores Ltd, Marks & Spencer plc, J Sainsbury plc, Co-operative Group, Waitrose Ltd, Iceland Foods Limited, Tesco Stores Ltd, Boots (UK) Ltd, and Wm Morrison Supermarkets plc.