Salt reduction – a technical overview

M. Cobcroft, K. Tikellis and J. L. H. C. Busch

International and Australian authorities advocate salt reduction in food as a cost-effective strategy to improve population public health. Reducing salt gradually is achievable by the food industry and consumer taste preference for high salt foods can be shifted. An action plan for salt reduction includes: auditing against salt targets to determine potential reductions; setting priority products for salt reduction; identifying sodium sources; and using sensory research to benchmark and test consumer acceptance. The product developer's toolbox for salt reduction includes flavours, lower salt ingredients and salt substitutes. For consistency, the word "salt" is used in this article as a general word for sodium and salt. Salt (NaCl) consists of 40% sodium and 60% chloride; 2.5 g salt is equivalent to 1 g sodium.

The conclusions of a recent World Health Organization report highlight the adverse effects of high salt intakes on health particularly blood pressure, leading to cardiovascular disease (WHO 2007). Thirty percent of Australians have high blood pressure. This figure rises to 70% in adults aged 60–70 years. Data is limited but it is estimated that Australians consume approximately 9 g salt per day (Beard & others 1997). Australian authorities advocate a salt target of 6 g per person per day (NHF 2006, NHMRC 2006, AWASH 2007a). In the past, the majority of salt was consumed as table salt. Today, approximately 75% of salt in the Western diet is likely to come from processed foods such as breads, cereals and ready prepared foods (James & others 1987). For this reason, all sectors of the food industry should engage in a salt reduction program as a cost-effective strategy to improve population public health (WHO 2007).

Consumer understanding

A recent Australian consumer survey reported nearly 75% of survey participants being concerned about salt in their diet (AWASH 2007b). However, they ranked saturated fat and sugar as greater concerns. This is in contrast to the UK where concern about salt is now ahead of fat and sugar, presumably as a result of a large government salt education campaign (FSA/COI 2005). Claiming 'reduced salt' on products may therefore not be particularly motivating to consumers (Galaxy 2005), so that food manufacturers may decide to choose a 'silent' salt reduction route rather than making any overt claims. Furthermore, given increasing consumer interest in 'natural' foods (Health Focus International 2004), reducing salt gradually may be more acceptable to consumers than use of some salt substitutes.

Salty taste perception

Salt along with sweet, sour, bitter and umami, make up the sense of taste which is experienced during ingestion. The salt taste is unique and is mainly elicited by the Na^+ ion (Lindemann 1997) with some contribution by the anion component, in particular the chloride ion (van der Klaauw & Smith 1995). Presumably, salt specific receptors on the tongue initiate perceived saltiness. However, mechanisms of salt taste remain speculative and controversial (Chandrashekar & others 2006). As for all taste modalities, saltiness can be affected and altered by both the properties of the food and the mouth environment (Keast & others 2003). The total sensory perception is thus determined by the integration of the different sensory modalities in the brain (Calvert & others 2004, Taylor & Roberts 2004). Preference for salty taste depends on the individual's habitual salt intake and can change across the life span. Salt preference has a strong environmental component and does not appear to be hereditary, so will therefore be dictated by the salt concentration in the foods we consume (Wise & others 2007). Studies have shown that the preference for salty taste is flexible, with repeated exposure to lower salt foods shifting preference towards these foods (Blais & others, 1986, Girgis & others 2003). Therefore, if manufacturers simultaneously reduce salt within a product category, a downward shift in salt taste preference should occur.

Taste is arguably the most important function of salt in food products today, although some products require salt for food preservation or structuring purposes (eg in sausages). Salt contributes more than simply saltiness by intensifying overall flavour and suppressing bitterness (Keast & others 2001, 2002, 2004). Large reductions in salt can thus affect the complete sensory profile (Gillette 1985).

Small gradual reductions in salt in the order of 5–10% are likely to result in minimal flavour impact. Larger reductions will require use of additional ingredients and/or reformulation to ensure changes to the flavour and aroma profile are minimised (Figure 1).

Technical principles

The rate and degree of salt reduction achievable without detection by the consumer will vary from food to food. Greater reductions may be easier to achieve for products with a higher initial salt content. Table 1 highlights some reductions that have already been achieved within the Australian food industry. Working with competitors to reduce salt levels across a product category is one strategy for optimal sodium reductions with minimal market impact (to minimise consumers switching to another brand). Alternatively, individual companies can progressively remove salt in a stepwise manner, allowing time for consumer taste adaptation between each reduction step. This has been demonstrated in bread (Girgis & others 2003). When salt levels cannot be further reduced by progressive reduction, alternative

Megan Cobcroft is Corporate Nutritionist, Unilever Research & Development, Unilever Australasia, Sydney; Kim Tikellis is Corporate Nutritionist, Coles Supermarkets, Coles Group Ltd, Victoria and Dr Johanneke Busch is a flavour scientist in the Unilever Food and Health Research Institute, Unilever Research & Development, Vlaardingen, the Netherlands.

approaches such as use of salt substitutes are required. It is, however, important to note that use of salt replacers will not change consumer preference for high salt foods.

Currently available approaches to salt reduction are outlined in Table 2. These approaches can result in salt reductions in the order of 10–30%. New technologies, including identification of bitter taste maskers will be required to achieve larger reductions. These are currently being developed by both ingredient and food manufacturers.

Figure 2 outlines a suggested action plan for food manufacturers interested in initiating a salt reduction program.

Next horizon

Currently, research programs are aimed at elucidating salt taste perception mechanisms. Additionally, several companies are searching for salt enhancers via high throughput screening with salt receptor assays. It is expected that these research and screening programmes will progress our understanding in this field and identify next generation salt replacers to aid the further reduction of sodium in food products.

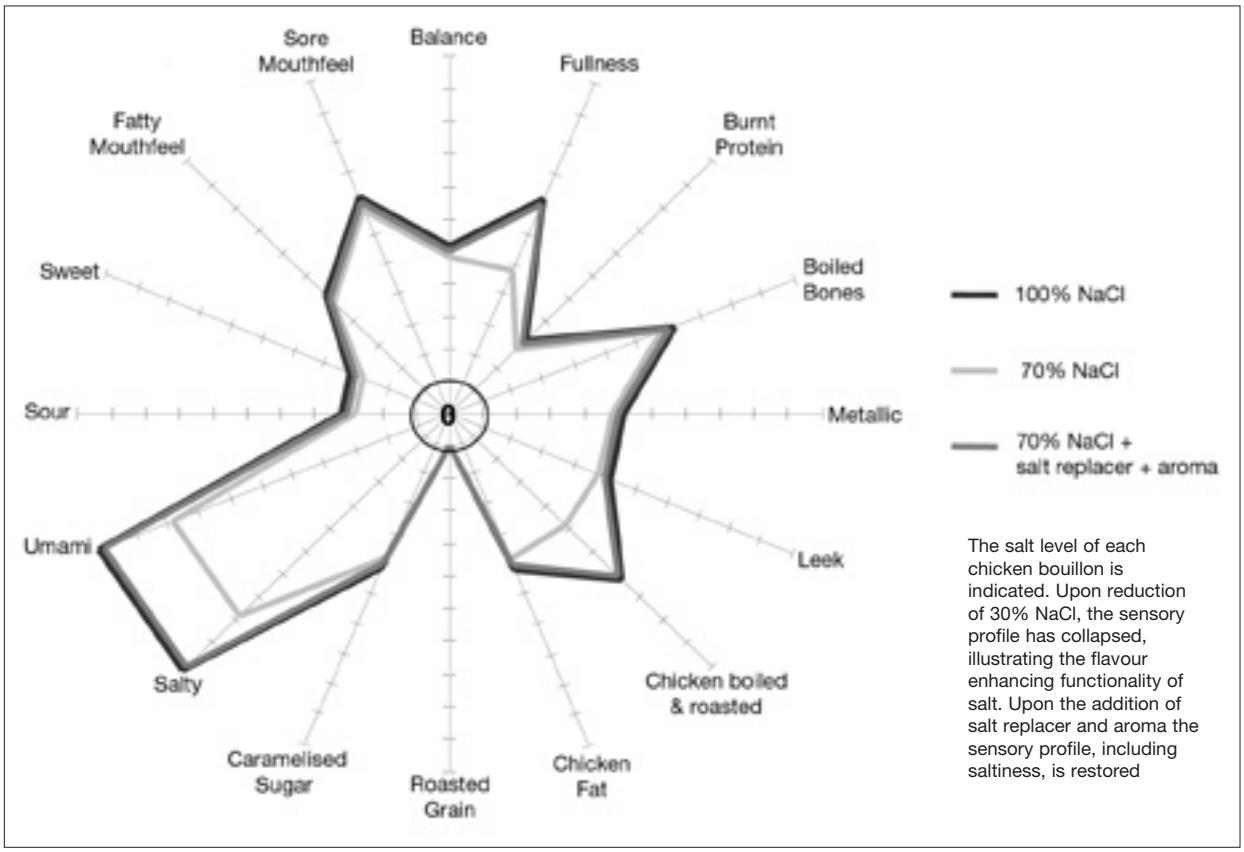

Figure 1. Function of salt in food products. Trained descriptive panel for chicken bouillon, ADL consensus method (Meilgaard & others 1999)

Table 1. Examples of salt reduction in the Australian food industry.

Company	Products	Average sodium reduction	
		%	mg/100g
Unilever Australasia[1]	20 *Continental* pasta and sauces side dishes		As consumed:
2001–2004		40%	200 mg
2005–2006		10%	30 mg
Kellogg (Aust) Pty Ltd[2]	12 breakfast cereals	40%	85–469 mg (range)
McDonald's Australia Ltd[3]	9 meals including *Deli Choices*	28%	88 mg (range, 11–168 mg)
Nestlé Australia Ltd[4]	38 *Lean Cuisine* frozen meals		
1990–1995		25%	100 mg
2005–2007		12%	32 mg
National Heart Foundation of Australia Tick Program[5]	Breads in the Heart Foundation Tick Program where the sodium criteria was lowered	12%	50 mg

[1] Cobcroft (2006) [2] Williams & others (2003) [3] Monaghan (2007) [4] Small (2007) [5] National Heart Foundation (2007)

Further reading

Further information on this topic is available in *Reducing salt in foods: Practical strategies* (Kilcast & Angus 2007); *Guidance on Salt Reduction in Meat Products for Smaller Businesses* (British Meat Processors Association 2007); from the AWASH (Australian Division of World Action on Salt and Health) website (*www.awash.org.au)* and from that of the Food Standards Agency, UK (*www.food.gov.uk/healthiereating/salt/)*.

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Table 2. Technical approaches to salt reduction.

Approach	Use	Tools
Adaptation Educating the palate so consumers adapt to less salt over time	Gradual reduction of added salt: 5–10% per year. The level of reduction achieved will depend on: 1. Initial salt level. Higher salt products should achieve greater reductions. 2. The salt content of similar products in the market – working with competitors to reduce salt across a food category is likely to achieve the largest reductions.	
Flavours	To compensate for the reduction in salt, improve the overall taste profile and boost overall mouthfeel.	Yeast extracts, ribonucleotides, sugars (fructose, trehalose), organic acids, creamers, spices, herbs, amino acids, aroma compounds.
Lower salt ingredients	Companies can partner with suppliers to use lower salt ingredients permitting greater formulation flexibility. Additional salt reductions of up to 5–10% may be possible.	Examples include lower salt cheese powders, flavours, yeast extracts, soy sauce powders, herb and spice preparations.
Salt substitutes Use of mineral salts to enhance saltiness	Use is limited by adverse taste notes described as bitter and metallic. However, flavours can be used to help mask this aftertaste. Product reformulation may also be required to address any adverse taste issues. Reductions of 10–30% possible.	Minerals salts, eg KCl, Mg salts (Cl_2, SO_4), low sodium sea salt, amino acids, organic acids. Ingredients that combine salt replacers and flavours are also available. Commercially available ingredients include *Salt Print* (Firmenich), *Impaq* (Givaudan), *Salt Boost* (Danisco), *Sub4Salt* (Jungbunzlauer), Salt enhancers based on fermented milk/whey/wheat protein (Givaudan, PTX, Fonterra) or flavours based on protein/peptide technology (Conagra *Amplify*), *Pansalt* (Oriola *Oy*).

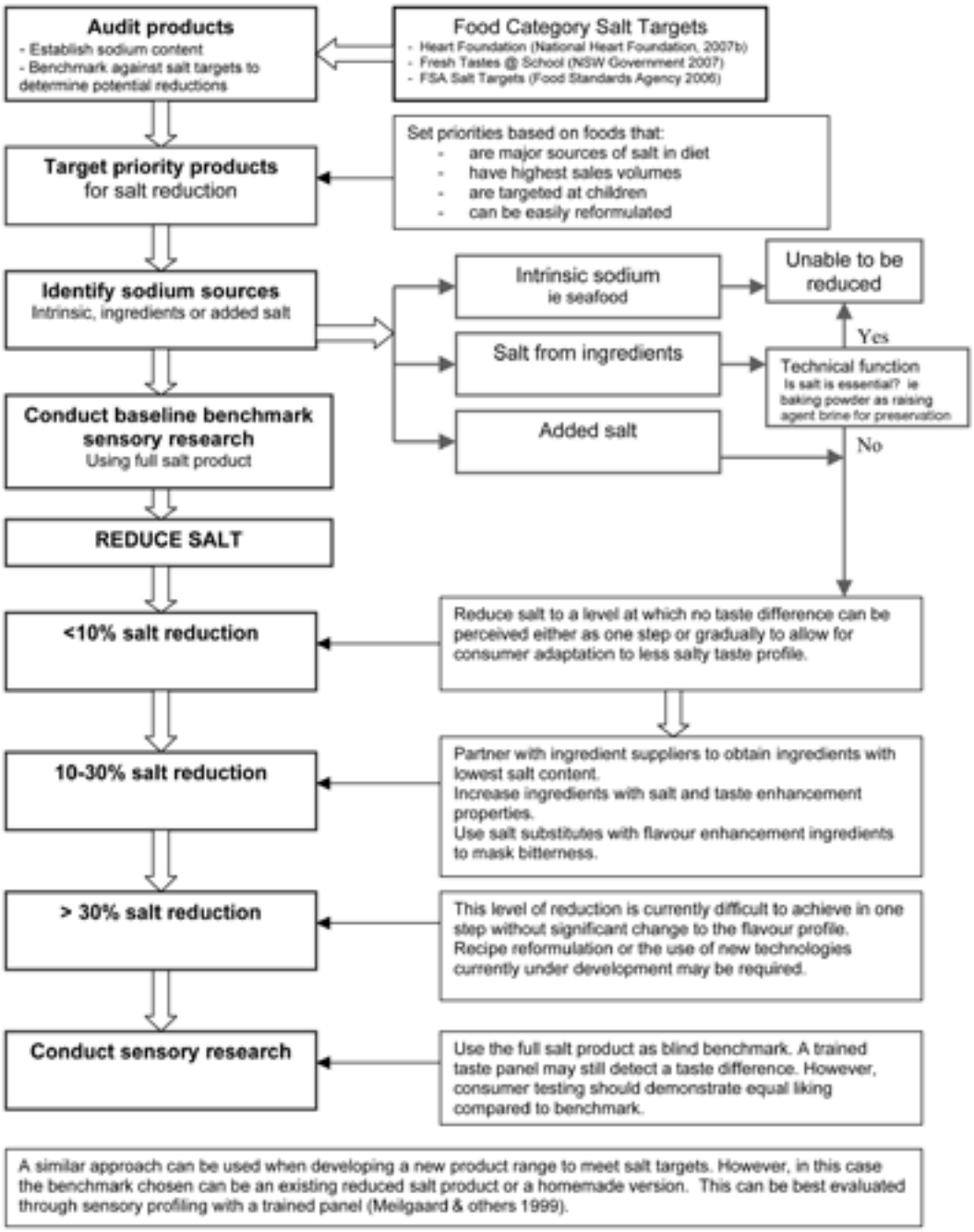

Figure 2. Action plan for salt reduction. Suggested approach for reformulation of existing product range

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