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SAFETY AND QUALITY ASPECTS OF REDUCING SALT CONTENT IN FOODS

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ABSTRACT

Salt has been used since ancient times as an additive with many benefits such as preservative and antimicrobial agent and for impacting desirable sensory attributes in foods. Reports from various organisations shows that its consumption in recent times has been above the recommended daily intake and this has been linked with the rising cases of high blood pressure leading to cardiovascular diseases. Salt reduction strategies have been developed by various organisations and governments to ensure significant salt reduction while not compromising the safety and quality purposes of its use in foods.

Keywords: recommended daily allowance, safety, salt reduction

INTRODUCTION

Salt is defined as a pure white crystalline dietary mineral use as a condiment on the dining table (Jacobson, 2005). Salt is the most popular seasoning found in many foods occurring either naturally or added during food processing to give the desirable taste and texture (Shee *et al.*, 2010).

Nutritionally, salt is a regulator of extracellular volume, maintain acid-base balance, neural transmission, renal functions, cardiac output and mycotoxic contractions (Dotsch *et al.*, 2009). Chloride and sodium ions form the two major constituents of salt and are needed by living creatures in trace amounts for regulating fluid equilibrium of the body and sodium itself is useful in the nervous system for electrical signalling (Caldwell *et al.*, 2000).

The use of salt for food preservation was an empirically developed practice dating back thousands of years (Stringer and Pin 2005). Salt acts as a food preservative which inhibits growth pathogenic and spoilage microorganisms allowing the nutritional value of foods such as meat, fish and vegetables to be prolonged from times of abundance to times of shortage [Stringer and Pin 2005; Centre for Disease Control and Prevention of United States (CDC) 2009].

However, the consumption of salt has been on the increase in this modern time and concerns have risen over the years on the health risks associated with its high intake which includes increase in blood pressure to the consuming individuals. Some health authorities such as American Heart Association (AHA) (2010) looking at the increasing trend in salt intake have recommended a reduction of dietary salt to avoid the aforementioned health risks.

The United States Department of Health and Human Services (USDHHS) (2010) recommends a daily intake of not higher than 3750-5750mg of salt (1500-2300mg of Sodium) while in the UK it is targeted at not more than 6g/day [Scientific Advisory Committee on Nutrition (SACN) 2003].

The reduction of salt content in foods has been a topic of extreme international interest discussed under various platforms by the world health organisations to review its link with the health related issues (WHO, 2007; Dolye and Glass, 2010). The aim of these strategies was to make sure that member countries are aware of the prospects and constraints of the use of salt in foods and to take measures which will alleviate the perceived negative effects. It is very crucial however to understand that all efforts aiming at reducing salt content in foods must be balanced with novel purpose of salting in many foods.

The purpose of this review is to critically overview the effects of salt reduction on food safety and quality with a view of finding suitable approach to follow to achieve the desired objectives. It will also look at various policies and strategies formulated by governments and stakeholders to ensure that the perceived health effects of high salt intake in foods has been minimised while not compromising the safety and quality of foods.

Effects of salt reduction in foods to human health

There has been a renewal of interest in recent times in the reduction of salt in foods driven by convincing evidence that its excessive intake is a major cause of high blood pressure (Karppanen and Mervaala 2005; Dickinson and Havas, 2007; He and MacGregor, 2008) and by decreasing intake of salt in the diet, hypertension which lead to cardiovascular disease could be prevented (Cutler and Roccella, 2006; Cook *et al.*, 2007; Liem *et al.*, 2011)

It has been estimated that, 62% of Cardiovascular Disease and 49% Schaemic Heart Disease was reported to be caused by high blood pressure (WHO, 2006; He and MacGregor, 2010). High salt consumption has also been connected with other health effects like gastric cancer (Tsugane *et al.*, 2004); decrease of bone mineral concentration (Devine *et al.*, 1995) and certainly obesity (He and MacGregor, 2008).

Asaria *et al.*, (2007) estimated that 8.5 million cardiovascular- related death incidences could be prevented globally with 15% decrease in population salt consumption for ten years. Additionally, analysis conducted by the World Health Organisation concluded that salt intake reduction is the most cost effective method of preventing cardiovascular disease world-wide (WHO, 2006; WHO, 2007).

Effects of salt reduction from the food safety point of view

The prevention and control of foodborne disease causing pathogens is mandatory especially for higher risk people such as the young and elderly, pregnant women and immunocompromised. Over 5000 deaths were estimated to occur annually due to foodborne illness (Mead *et al.*, 1999).

Taormina (2010) reported that the microbiological food safety and quality effects of salt reduction in foods obtain little attention in both peer-reviewed literature and media in comparison to that dedicated to cardiovascular health potential impacts. His claim was that food safety could be weakened accidentally as a result of salt reduction in foods which in turn decrease a key barrier against foodborne pathogens. The removal or reduction of salt could have effects that will not be present till after the system is applied (Taormina, 2010).

Antimicrobial function of salt in foods

In addition to flavour and other sensory quality improvement, salt plays a vital role in regulating microbial growth especially in refrigerated “ready-to-eat” (RTE) foods. The shelf-life stability of RTE foods is due to salt and moisture content (Taormina, 2010).The antimicrobial function of salt helps in shelf-life extension of foods by exerting drying effects and as a result water is drawn out of the cells of both microbes and food by the process of osmosis (Doyle and Glass 2010). The amount of salt required for the antimicrobial functions varies with species with *Campylobacter* being highly sensitive (Dolye and Roman, 1982). The minimum a_w for growth of foodborne pathogens and the effect of salt in a_w as before reduction in comparison with the other humectants is presented in Tables I and II, respectively.

Table 1: Approximate minimum water activity (a_w) for the growth of foodborne microorganisms

Microbe	a_w
Campylobacter jejuni	0.98
Clostridium botulinum B	0.94
Clostridium botulinum E	0.97
Escherichia coli	0.95
Listeria monocytogenes	0.92
Pseudomonas fluorescens	0.97
Salmonella spp.	0.95
Staphylococcus aureus	0.86
Aspergillus flavus	0.80
Zygosaccharomyces bailii	0.80

Source: (Dolye and Glass, 2010)

Table 2: Effects of different humectants on minimum (a_w) for microbial growth

Organism	Minimum a_w for growth in Salt	Glucose	Glycerol
Clostridium perfringens	0.97	0.96	0.95
Clostridium botulinum type E	0.97	--------	0.94
Lactobacillus helveticus	0.963	0.966	0.928
Streptococcus lactis	0.965	0.949	0.942
Pseudomonas fluorescens	0.957	--------	0.940
Vibrio parahaemolyticus	0.948	0.948	0.937

Source : (Sperber, 1983)

Table I and II shows the effect of salt in the reduction of a_w looking at the various levels of a_w required for the growth of pathogens in foods compared with other humectants. Salt is been the most effective humectant in the control of a_w in foods.

Effect of salt reduction on food quality

Although high salt intake has been linked to hypertension leading to cardiovascular diseases, there have been deliberations on the effects of salt reduction on the quality attributes of food products. These attributes include taste, texture and consumer acceptability of the products; other quality parameters include moisture, fat and pH; and also processing conditions would be affected (Dotsch *et al.*, 2009).

Salt plays a vital role in the food manufacturing process as an additive which enhances flavours, increases consumer acceptability and performs desirable functions in foods (Kilcast and den Ridder, 2007). These desirable functions can be dough formation in bread production, preservation and binding of water in meats and primarily for sensory improvement in some foods (Hutton, 2002).

In addition, in bread production, salt minimises yeast growth and allow for gluten development and therefore its reduction could lead to increase in yeast growth and negatively affects the texture of bread. However, by changing the mixing and mechanical operations as well as reduction in yeast used, these effects could be reduced to some extent (Cauvain, 2007). Analysis of rheological effects of salt reduction on dough and baking quality or organoleptic attributes showed no significant change at reduced salt concentrations (Cauvain, 2007), but complete removal may result in bad flavours and reduce dough and baking qualities (Lynch *et al.*, 2009). All these facts must therefore be taken into consideration before significant reduction of salt to a safer level becomes possible.

Current improvements in salt reduction and proposed substitute methods

Various governments and other stakeholders in the food industry are highly concerned about salt reduction and these resulted in modelling of various innovative approaches for significant reduction of salt intake by consumers and the development of substitute methods which pose no health risks. These include initiatives on using ingredients such as different mineral salts like potassium chloride, extract from yeast and flavour improvers which give similar organoleptic attributes (Wallis and Chapman, 2012).

Many methods of salt reduction have been developed which may include gradual reduction of salt in foods over a period of time "reduction by stealth", changing the matrix of food or emulsions and introduction of aroma that give an identical salty taste to consumers (Kilcast and denRidder, 2007; Wallis and Chapman, 2012). The strategy for salt reduction by stealth has recorded achievements with significant reduction of salt in processed foods been successful in the past three years by 20-30% and more is expected to meet the target of 6g/day by 2012 (He and MacGregor, 2008). It is also generally effective as no attitudinal change is needed from consumers and this has led to a more significant reduction by approximately 1g/day in the UK population (Kilcast and denRidder, 2007).

Various achievements in salt reduction have been recorded in the UK. This is presented in Table III.

Table 3: Salt reduction achievements for various foods in the UK

Food type	Achievements	Achievement notification date
UK retailers	Met all/ the majority of the 2010 salt reduction targets	Between 2008 and March 2010
	Met majority/ some of the 2012 salt reduction targets	March 2010
Food source	Average reduction in salt	Time period reduction
Pre- packed sliced bread	>30%	Between the late 1980s and 2008 (Federation of Bakers)
Branded breakfast cereals	49%	Between 1998-2007 (ACFM)
Pasta sauces and soups	29% and 25% respectively	Between 2003 and 2005 (FDF)
Sweets and savoury biscuits	45% and 25% respectively	Between 2006 and 2008(BCCC)
Cakes	25%	Between 2006 and 2008 (BCCC)
Pastries	40%	NA
Crips, extruded and Pelleted snacks	13%, 32% and 27% respectively	in 2007

FDF- Food and Drink Federation; BCCC- British Chocolate, Cake and Confectionery; SNACMA- Snacks Nuts and Crisps Manufacturers Association; ACMF-Association of Cereal Foods Manufacturers; N/A: Information not available.
Sources: [European Commission (2008) and Food Standards Agency (2010)]

CONCLUSION

Salt is an essential nutrient and important ingredient for the production of safe foods with an acceptable organoleptic attributes and extended shelf life. However, analysis has indicated that its consumption in recent times has been above the recommended amount and therefore reduction is essential to reduce the occurrence of health related diseases (Dolye and Glass, 2010).

Salt preserves foods by reducing water activity and inhibiting the growth of microorganisms and therefore its reduction in foods may have adverse results on food safety. It is therefore essential to reformulate foods, adjust processing and storage conditions and reduce shelf-life of food products to ensure the safety (Stringer and Pin 2005).

The use of substitutes to replace salt has also been established to be an effective approach to reducing salt in foods. Example is the use of potassium chloride which acts like salt giving the desirable attributes and inhibits the growth of microorganisms such as *Listeria monocytogenes* and *Staphylococcus aureus* in a similar way to salt (Guardia *et al.* 2006).

The importance of salt in ensuring safety and quality of foods is an essential factor to be considered. Hence this review recommends the following:

I. Need for research to identify the real implication of reducing salt in preparation and serving of foods on its shelf life and microbial safety.
II. Determine the efficiency of the proposed substitutes and cost implications on the overall food processing and supply chain. This will give a clear direction to follow without compromising any of the effects of salt reduction on the quality and safety of foods.

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