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Review

Salt reduction in baked products: Strategies and constraints

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ABSTRACT

Background: Increased consumption of processed foods especially baked products containing high amounts of sodium directly relates to the higher prevalence of hypertension and other related diseases. So, the urge to salt reduction in baked products while conserving the quality, taste and functional attributes of products has received noteworthy consideration.

Scope and approach: Main focus of this review is to highlight different strategies which are being used for salt reduction, their possible constraints and resulting impact on the physico-chemical and sensory attributes of baked products.

Key findings and conclusion: Gradual reduction in salt level is the simplest approach but the possible constraint of this strategy is that only limited amounts of salt can be reduced over a longer time span. Salt reduction in short time period can be achieved by using suitable salt replacers and taste enhancers with an aim to maintain the product's physicochemical and sensory characteristics. At industrial level the most widely used salt replacer is potassium chloride (KCl). A relatively new technique for salt reduction is to create contrasting salt levels throughout the product and use of larger size encapsulates which increases the saltiness perception at lower concentrations. Government organizations and industries should initiate an integrated strategy by adopting suitable salt reduction technique along with public awareness and regulations in order to attenuate the daily salt intake nationwide.

1. Introduction

Non-communicable diseases (NCDs) are one of the main reasons for mortality and morbidity around the globe (WHO, 2012). Dietary sodium intake has received immense attention in response to its direct relationship with hypertension (high blood pressure) that contributes to 49% of all cardiovascular diseases, 62% of all strokes, congestive heart failure, renal diseases, gastric cancer, osteoporosis and kidney stones (He & MacGregor, 2010; Henney, Taylor, & Boon, 2010). Hypertension is prevailing all over the world affecting more than 26% adults (Kearney et al., 2005). Whereas, the disease intensity of hypertension in Pakistan has increased from a level of 17% in 1980 to 35% in 2008 in adults (18 years) and older individuals (Danaei et al., 2011). Habitual dietary sodium intake far above the evolutionary norms (0.25 g salt per day) increases the acidity in body fluids resulting in loss of calcium which eventually leads to osteoporosis (Frassetto, Morris, Sellmeyer, & Sebastian, 2008; He & MacGregor, 2009).

Common dietary salt is chemically called sodium chloride and as the name indicates, sodium and chlorine are the chemical constituents that make up the commercially available table salt (CDC, 2014; WHO, 2012). One teaspoon (6 g) of salt has 2400 mg of sodium since one gram of salt contains about 0.6 g (600 mg) chlorine and 0.4 g (400 mg) of sodium (Barr, 2008). According to WHO guidelines on sodium intake for adults and children, the approximate amount of sodium content in table salt, baking soda and baking powder is 38 g/100 g (WHO, 2012). Reportedly, the daily salt intake is exceeding the WHO recommendations (Brown, Tzoulaki, Candeias, & Elliot, 2009). Whereas, the maximum recommended intake level of salt is < 5 g/day (<2 g/day of sodium) (Samapundo, Deschuyffeleer, Van Laere, De Leyn, & Devlieghere, 2010; WHO, 2012). Social and cultural differences greatly influence the average daily intake of salt. Apparently, the intake of salt is higher in Asian countries (12.0 g/day) as compared to other regions such as United States (8.2–9.4 g/day) and United Kingdom(~9.4 g/day, Table 1) (WHO, 2007).

1.1. Role of salt

Salt is universal food preservative (Bidlas & Lambert, 2008;

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Table 1
Average daily intake of NaCl in different countries/regions.

Average sodium intake	NaCl g/day	References
United States	8.2–9.4	Cordain et al., 2005
United Kingdom	9.4	Brown et al., 2009
Asian Countries	12.0	WHO, 2007
WHO Recommendations	Less than 5.0	WHO, 2007

Samapundo et al., 2010) and is associated with several functional properties. When consumed under the recommended tolerable upper intake level (the highest daily intake level of a nutrient), salt does not pose any health risks. However, the risk increases by exceeding the recommended level (Doyle, 2008). The amount of sodium required for carrying out physiological functions in human body is approximately 180–230 mg/day (WHO, 2007). Sodium, if consumed within the recommended level is helpful in the maintenance of plasma volume, membrane potential of cells, neural transmission, myocytic contraction, renal function as well as transport of nutrients (e.g., glucose and amino acids) across the cell membrane (Barr, 2008).

In food, salt plays an important role in the creation of specific flavor and taste profile (Liem, Miremadi, & Keast, 2011). Flavor is a combination of taste, smell and chemical sensation. Removal of a single component may leads to considerable change in the flavor profile. The origin of salty taste belongs to taste receptors located in the entire oral cavity. The evolutionary importance of sodium can be explained through detection threshold or recognition threshold. Recognition threshold is the amount of sodium needed to activate epithelial sodium channels on the taste receptors resulting in production of electrical impulse in form of afferent signal to the brain. The strength of signals and ultimately the sense of salty taste mainly depend on the concentration of sodium (Keast & Roper, 2007). While the level of sodium needed for saltiness perception depends on the type of food matrix. For example, easier detection of 50 mM sodium chloride is possible in case of aqueous solution as compared to bread.

Salt plays an important role in bread formulation as it helps to control the rate of yeast fermentation and insufficient salt levels may cause excessive fermentation. It also has significant impact on gluten development thereby making the dough less sticky and easy to handle. Sodium salts like sodium sulfite, benzoate and erythorbate are being used as preservatives as it has the ability to reduce microbial growth through lowering the water activity of food products (Man, 2007).

1.2. Sources of sodium in the diet

The main source of dietary sodium depends on the dietary habits of population (Brown et al., 2009). Sodium is found in a variety of natural (lesser extent) as well as processed foods (about 70–75% of daily intake) such as bread, crackers etc. (Mhurchu et al., 2011; Webster, Dunford, & Neal, 2010). A diet rich in processed foods and deficient in fresh fruits and vegetables is considered as high in sodium (Webster et al., 2010). So the type of diet is directly linked with the amount of salt and in turn the amount of sodium. Salt contribution from different food sources varies and is presented in Table 2. In our daily routine, 13% of sodium comes from bread and bakery products, 5% from cereal products, 29% from other processed foods and 23% from herbs, salt and spices (Daugirdas, 2013). Average sodium content of different baked items is given in Table 3.

Table 2
Percentage salt contribution from different food sources.

Foods	Salt %
Processed and restaurant foods	77%
Naturally occurring	12%
While eating	6%
Home cooking	5%

Centre for disease control and prevention (CDC) (http://www.cdc.gov/salt/food.htm).

1.3. Why reduce salt?

Sodium is an essential nutrient for normal physiological functions in human body. As the daily intake of sodium is beyond the optimal level recommended, thus reduction in salt consumption needs immediate attention (Girgis et al., 2003; Samapundo et al., 2010). If daily sodium intake is reduced to 6 g/day, it will result in 2.5 million lesser deaths annually attributed to heart attack and strokes worldwide (He & MacGregor, 2003). In a recent study, it was estimated that by lowering daily intake of salt from 10 g to 5 g, rate of stroke and cardiovascular diseases can be reduced by 23% and 17%, respectively (Tucker & Maher, 2012). It is highly cost effective to treat hypertension by lowering daily salt intake as compared to medications (Bibbins-Domingo et al., 2010).

According to SACN report (2003), major contribution (nearly 40%) of sodium in the diet comes from cereal products especially bread, biscuits, breakfast cereals, pastries and cakes. Increased consumption of baked products containing high levels of sodium may results in various metabolic ailments (Doyle, 2008). Therefore, by reducing sodium in the bread and other bakery items, significant health benefits can be obtained. However, due to the important technological roles of salt in the baking process, it is difficult to reduce NaCl without affecting sensorial, qualitative and physicochemical properties of baked goods (Girgis et al., 2003; Noort, Bult, & Stieger, 2012). Research studies have been carried out to develop and evaluate strategies for salt reduction. There are some possibilities to compensate the salt reduction either by adjustment of processing operation, the choice of quality ingredients or by using additives or replacers (Noort et al., 2012).

2. Salt reduction strategies: pros and cons

Different techniques can be utilized to reduce salt in baked products.

2.1. Reduction by stealth

The simplest approach also referred as small step reduction involves the reformulation of product through gradual reduction of salt content within few months or even years that remains unnoticed by the consumers (Girgis et al., 2003; Liem et al., 2011). As the preference for salty taste is greatly influenced by environmental factors rather than the genetic factors so, it can be very easily adjusted through lifestyle modification and management of salt concentrations consumed (Beauchamp & Stein, 2008). Furthermore, from animal and human trials data, it is clear that fondness for sodium (sodium appetite) and salty taste exists and enhances during sodium depletion periods. On the other hand, sodium levels can be gradually reduced during normal conditions (McCaughey, 2007).

This strategy comprises of slow but step by step lowering of salt concentrations in the bakery items. Once the consumer became well adapted to the new salty taste, the level can be further reduced (Dotsch et al., 2009). Previous studies have also shown that the