LWT - Food Science and Technology 93 (2018) 606–612

Contents lists available at ScienceDirect

LWT - Food Science and Technology

journal homepage: www.elsevier.com/locate/lwt

LWT – Food science and technology impact of iodized table salt on the sensory characteristics of bread, sausage and pickle

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ARTICLE INFO

Keywords:
Fortification
Iodized table salt
Iodine retention
Sensory quality

ABSTRACT

The impact of iodized table salt on the sensory quality of wheat bread, bologna sausage and pickled cucumber was studied. Table salt (NaCl) content of the products was 1.7, 1.2 and 1.7 g/100 g, respectively. Iodine, added as potassium iodide (KI), was incorporated at levels 0, 25, 50 and 100 mg per kg table salt. Odor, flavor, appearance, and texture were evaluated using deviation from reference descriptive analysis (12 panelists, 4 replicates). Each sample was rated against the non-iodized reference sample (0 mg iodine). The retention of iodine during processing and storage was determined chemically. The iodine level 25 mg/kg, corresponding to current recommendations, did not cause sensory changes in tested products. In sausage, 50 and 100 mg/kg levels were associated with minor changes in texture and color. The maximum retention of iodine was 83% for bread, 98% for sausage, and 51% for cucumber. We did not find any sensory obstacle to using iodized table salt in industrial food production. Due to loss in manufacturing and inadequate intakes, iodine additions higher than currently recommended should be considered.

1. Introduction

The World Health Organization estimates that globally around one third of the world's population has inadequate iodine intake (WHO, 2004). Iodine status in developed countries shows a decreasing trend (SCF, 2003; Winger, König, & House, 2008). In Finland, the National Nutrition Council (NNC) recommends industrial use of iodized table salt, due to the mild iodine deficiency observed at the population level (NNC, 2015). According to NNC, the deficiency is partly due to the usage of non-iodized salt in food industry, as increased consumption of industrially manufactured food has replaced home-made savory foods that usually contain iodized salt.

The most common iodine salts to be added to food are potassium iodate (KIO_3) or iodide (KI). Fortification levels differ substantially. The range in Europe is from 8 to 69 mg iodine per kg of table salt (NaCl). The typical level of iodine is 20–25 mg/kg NaCl. Netherlands and Greece have one of the highest iodine contents in table salt in Europe, 50 mg per kg, added as KI (Winger et al., 2008). Charlton and Skeaff (2011) report that in some African countries, for example in Kenya, table salt contains iodine 100 mg/kg NaCl as KIO_3.

Food manufacturers are concerned that iodized table salt may impact the sensory quality of their products (Harris, Jooste, & Charlton, 2003). Many food companies were not willing to use iodized table salt for reasons such as increased costs, instability of iodine and misconceptions regarding iodine (Ohlhorst, Slavin, Bhide, & Bugusu, 2012). West, Merx, and de Koning (1995) concluded that food industry is worried about the darkening of color in iodized products.

Previous studies examining the effect of iodized salt on the sensory properties were conducted a relatively long time ago, and the methods used may not be appropriate or sensitive enough for detecting subtle differences between iodized and non-iodized samples. For example, several studies use hedonic ratings for comparison among iodized and non-iodized samples (Amr & Jabay, 2004; Chanthilath, Chavasit, Chareonkiatkul, & Judprasong, 2009; Kojima & Brown, 1955; Pinkaew & Karrila, 2015). Kuhajek and Fiedelman (1973) found no effect of iodized salt in bread, potato chips and sausage. Similarly, Wirth and Kühne (1991) did not find sensory differences between iodized and non-iodized meat products (iodine added as KIO_3 0.3–0.6 mg/kg of curing salt). On the other hand, Winger et al. (2008) detected small differences in the flavor of tomato juice at high iodine level (200 mg/kg tomato juice) compared to the typical iodine content (25 mg/kg NaCl). Amr and Jabay (2004) observed softening of texture and lowering of

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https://doi.org/10.1016/j.lwt.2018.04.009
Received 1 November 2017; Received in revised form 3 April 2018; Accepted 4 April 2018
Available online 05 April 2018

color scores in pickled vegetables when 40 mg/kg NaCl as KIO_3 was added. Pinkaew and Karrila (2015) found higher hedonic scores in iodine, iron and zinc fortified fish crackers compared to non-fortified crackers. Iodine was added as KIO_3 (0.26 mg/100 g dough). Also Chanthilath et al. (2009) found no significant differences in fermented fish sauce prepared with non-iodized and iodized salt (iodine as KIO_3 at 30 mg/kg NaCl).

Most studies related to iodine fortification focus on the loss of iodine (Chavasit, Malaivongse, & Judprasong, 2002; Comandini, Cerretani, Rinaldi, Cichelli, & Chiavaro, 2013; Goindi, Karmarkar, Kapil, & Jagannathan, 1995; Waszkowiak and Szymandera-Buszka, 2008). According to Chavasit et al. (2002) cooking method or pH value did not have an effect on iodine loss for a range of foods, but addition of sugar, table salt, phosphoric or ascorbic acid lowered iodine content in different foods. Cooking increased the loss of iodine compared to steaming (Goindi et al., 1995), while carrots and potatoes did not absorb iodine during boiling but iodine was better absorbed during baking in these products (Comandini et al., 2013).

This study examined whether, and to what extent, the addition of iodine to table salt has an impact on the sensory characteristics of selected savory products. The materials were wheat bread, bologna sausage and pickled cucumbers. Bread and sausage were included because they are major sources of NaCl in the Finnish diet (Borodulin et al., 2013). Pickle was selected as the results by Amr and Jabay (2004) suggested changes in color and texture due to iodized salt. Iodine was added to each material 0 mg, 25 mg, 50 mg, and 100 mg per kg NaCl. Twenty-five mg per kg NaCl is the level recommended in Finland (NNC, 2015). The 50 and 100 mg were examined as they are typical iodine levels in certain countries. In addition, the iodine content of these foods was studied with chemical analysis. We hypothesized that iodine fortification does not impact the sensory quality of tested products.

2. Materials and methods

Each material, bread, sausage and pickle, was prepared at four iodine levels referred to as batches. The examined iodine levels 0, 25, 50, and 100 mg iodine per kg NaCl in each material are referred to as 0 mg/kg, 25 mg/kg, 50 mg/kg, and 100 mg/kg.

2.1. Chemicals

KI used in this study was from Sigma (Sigma-Aldrich, Helsinki, Finland) and NaCl from Berner Ltd (Helsinki, Finland). NaCl purity level was 99.8% and it contained sodium ferrocyanide (E353) as anticaking agent.

The ultrapure water was obtained from a Milli-Q-system (Millipore Corporation, Bedford, MA, USA). Ammonium hydroxide 4.6 g/L was prepared from 182 g/L ammonium hydroxide (BDH, Prolabo, Normatom for trace metal analyses). The iodide stock standard solution (KI in H_2O) was from Romil (Cambridge, GB) and the tellurium stock standard solution (H_6TeO_8 in HNO_3) from Merck (Germany), both 1000 mg/L.

For iodine determination 0.1, 0.2, 0.5, 2.5, 5.0, 10, 20 μg/L standard solutions were prepared from the iodine stock solution in 4.6 g/L ammonium. Tellurium was used as internal standard at a concentration of 1 mg/L and was prepared from tellurium stock solution in H_2O. Iodine isotope 127 was used for determination of iodine. The LOQ was 0.060–235 mg/kg.

2.2. Salt and brine preparation

A stock solution was used to add the iodide (KI). In bread and sausage preparation, the brine containing NaCl, KI and water was prepared for each batch. In pickle preparation the iodine (as KI solution) and NaCl were added separately to the pickle juice.

Of the stock solution (bread 9.9, sausage 0.8, cucumber 5.1 g KI/L water) 10–40 mL was added into Milli-Q water and filled to 1 L. Added KI content was tied to the NaCl level in each batch (Table 1). According to the labeling, the NaCl concentrations of bread and sausage were 1.7 g/100 g and 1.2 g/100 g, respectively. In the pickle juice NaCl concentration was 4.0 g/100 g and in cucumbers 1.7 g/100 g.

Table 1
Batch sizes, NaCl contents, added iodine contents as KI and added iodine levels (mg per kg of table salt) in bread, sausage and pickle.

	Batch size (kg)	NaCl (kg)	KI (g)	Iodine(mg/kg)
Wheat bread	200 (dough)	3.030	0.0	0
			0.008	25
			0.016	50
			0.032	100
Bologna sausage	15 (sausage mass)	0.248	0.0	0
			0.099	25
			0.198	50
			0.396	100
Pickled cucumber	40 (pickle juice)	1.560	0.0	0
			0.051	25
			0.102	50
			0.204	100

2.3. Preparation of samples

2.3.1. Wheat bread

The ingredients of the bread were wheat flour, rye flour, yeast, wheat gluten, vegetable oil, potato flour, rye malt, emulsifier (E471), acidity regulator (E270), ascorbyl palmitate (E304), NaCl and KI. In bread, the dietary fiber content was 3.5 g/100 g. Bread was prepared in a factory scale in 4 batches by a bakery company Vaasan Oy (Helsinki, Finland). For each level of KI, 200 kg of dough was prepared. The bread was baked in the oven (236°C–273 °C) for 22 min. The bread loaves were sliced, and the next day they were stored in freezer for 5 days in −18 °C. The bread was thawed for 3 h before the evaluations.

2.3.2. Bologna sausage

The ingredients of the sausage were pork, beef, pork fat, water, ice, phosphate mixture, ascorbate (E301), nutmeg, white pepper, coriander, nitrite solution, and the brine containing NaCl and KI. In sausage, the meat content was 74 g/100 g. Four 15 kg batches were prepared in a pilot plant scale at the Department of Food and Nutrition, University of Helsinki, Finland. The meat was ground in a cutter in two 30 kg batches which were both divided into two 15 kg batches and ground again before adding other ingredients. The mass was stuffed in to fibrous casing prior boiling the sausages for 70 min to an internal temperature of 72 °C (RH 100%). The sausages were packed in vacuum and stored at 5 °C for 9 days before sensory evaluation.

2.3.3. Pickle

The ingredients in the pickle juice were water, vinegar, NaCl, sugar, dill aroma and KI. Four batches of pickle were prepared in a pilot plant of Orkla Foods Oy (Turku, Finland). For each batch, 40 L of pickle juice was prepared.

Cucumbers were sliced (6.4 mm thick) and put into glass jars (370 g cucumbers per 500 mL jar). The solution of water, KI and NaCl was heated up to 35 °C prior to adding sugar. The sugared pickle juice was heated up to 62 °C and dill aroma and vinegar were added. The jars were filled with the pickle juice (175 mL), sealed and pasteurized (70 °C for over 15 min). The pickles were stored at room temperature for 38 and 69 days before sensory evaluation.