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Brining of cod fillets: effects of phosphate, salt, glucose, ascorbate and starch on yield, sensory quality and consumers liking

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Abstract

In order to study how triphosphate, salt, glucose, ascorbate and starch, both separately and in mixture, could affect the quality and the yield of brined cod fillets, an experimental design was applied. Salt was the variable with highest pronounced effect on yield and appearance, followed by triphosphate, glucose, starch and sodium ascorbate. By treating skinless frozen/thawed cod fillets with brine consisting of 25 g salt/l, 10 g triphosphate/l, 5 g glucose/l, 5 g sodium ascorbate/l and 5 g starch/l in a vacuum tumbler for 15 min, a 35% weight increase was obtained. The products retained a natural appearance with a homogenous surface. Next, an experiment was carried out to assess the effect of this brining mixture on sensory properties and consumers liking of both fresh and frozen/thawed cod fillets. Sensory analyses showed that the intensity of the sensory attributes cod taste, cod smell, juiciness, whiteness and glossiness could be heightened by brining, while the intensities of old/stale taste and smell could be lowered. The effects were prominent for products subjected to freezing before and/or after processing, while the characteristics of the fresh products were little influenced by brining. Using an in-house consumer panel, it was shown that the frozen/thawed products were the less preferred products. However, brining considerably enhanced the preferences for frozen and thawed cod fillets, obtaining preferences similar to the fresh, nonbrined product (F).

Keywords: Cod; Frozen; Fresh; Brining; Additives; Yield; Sensory properties; Consumers' liking

1. Introduction

According to fish traders and Olsen and Kristoffersen (1999), an increasing demand for fresh fish products is evident in many European countries. A steady and predictable supply of high quality, fresh, wild-captured fish products is however very hard to fulfil, due to seasonal variations, the perishable nature of fresh seafood, the distance between major fishing grounds and the markets, weather conditions, etc. On the other hand, thawed and chilled cod products can be made available throughout the year. Such products are also referred to as freeze-chilled products, and it is expected that freeze-chilling will offer production, logistics and marketing advantages (O'Leary, Gormley, Butler, & Shilton, 2000; Fagan, Gormley, & Mhuircheartaigh, 2003).

Interestingly, it has been shown that the shelf life of chilled thawed cod fillets may be extended compared to fresh cod fillets (Magnusson & Martinsdottir, 1995; Løkken, 1996; Guldager, Bøknæs, Osterberg, Nielsen, & Dalgaard, 1998; Skjerdal, Esaiassen, & Løkken, 1999), allowing greater flexibility for distribution and retail. The amount of frozen cod landed in Norway has increased substantially over the last years. Most of the

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fish frozen onboard Norwegian fishing vessels are only gutted and de-headed prior to freezing. Thus, to make retail or more ready-to-eat products, these fish have to be thawed, processed and often refrozen before distribution. The effects of freezing on the quality of fish and other food items are well documented. Frozen and thawed fish products are in general characterized by having lower eating quality than fresh ones, and especially products exposed to repeated freezing and thawing cycles show evidence of considerable freezing denaturation (Mackie, 1993; Nilsson & Ekstrand, 1995; Hurling & McArthur, 1996; Pham & Mawson, 1997). However, cryoprotective compounds could be added to food products prior to freezing in order to prevent extensive denaturation during freezing, frozen storage and thawing. Other stabilizing agents could also be added during processing in order to improve characteristics reduced by the freezing cycle, and thereby improving the eating quality. A wide variety of compounds have been shown to improve properties like juiciness and texture in different processed dairy-, meat- and fish-products and among these salt, starch, glucose, sodium ascorbate and phosphates (Krivchenia & Fennema, 1988; Dziezak, 1990; Craig, Bowers, & Seib, 1991; MacDonald & Lanier, 1997; Park, Lin, & Yongsawatdigul, 1997; Zheng, Toledo, & Wicker, 1999; Badii & Howell, 2002; Herrera, Pastoriza, & Sampedro, 2002; Qu, Yokoyama, Hayakawa, & Saito, 2003). Several methods could be applied when incorporating additives to fish muscle. According to Esaiassen et al. (2004b), vacuum tumbling is suitable when adding ingredients to fish fillets.

Recent studies have shown that it is possible to enhance the consumers liking of frozen and thawed cod fillets by brining with a commercially available brine mixture consisting of salt, phosphates, sodium-ascorbate and glucose (Esaiassen et al., 2004b). Enhancing the consumer's preferences through brining is one important aspect. In addition, it is important to explore how brining affects the yield. Last, but not least, when using a commercially available brine mixture, with a blurred composition of ingredients, it is not possible to elucidate which components or interactions are being responsible for a given effect. It was therefore considered important to study how the different ingredients in a brine mixture, both separately and in mixture, could affect the quality and the yield of the products.

The present work is a follow-up of the work by Esaiassen et al. (2004b), where a brine mixture with a blurred composition was used. The main purpose of the present work was to study the main effects of the separate brine components on the yield when processing frozen/thawed cod fillets. The interaction effects of the components were also addressed. When interaction effects occur, multivariate experimental designs are powerful tools to reveal which factors affecting the responses mostly, and an experimental design was applied in this work. In order to assess how the brine mixture providing the highest yield affected the sensory properties and consumers' preferences, a study of the sensory changes and consumers liking of both fresh and frozen/thawed products was also included.

2. Materials and methods

2.1. Effects of the different brine components

2.1.1. Experimental design

The effect of various concentrations of triphosphate, salt (NaCl), glucose, sodium-ascorbate and starch on yield after brining was studied by applying a 2^{5-1} fractional factorial design (resolution V). The concentrations of the five different brine ingredients varied between two levels, high (+1) and low (−1). The total number of experiments was 24, including four centre samples and four reference samples. The compositions of the different brines are given in Table 1, and the brining experiments were performed in a randomized order.

2.1.2. Raw material

The cod used in the experimental design was caught in November, and ranged from 1.5–2.5 kg after gutting and de-heading. The fish was stored at −25 °C for 7 months and thawed in still tap water in a cold room at 2–4 °C before filleting and skinning. Standardized samples of 10×4 cm were cut from the loin of the skinless fillet and applied to brining.

2.1.3. Brining

The cod samples, approximately 750 g in each batch, and brine were mixed in 1:1 ratio (w:v) in a Scanio vacuum tumbler Type VTO (Scanio A/S, Denmark), and tumbled for 15 min at 0.1 bar and 4 rpm. After tumbling the samples were left in the brine for 5 min before opening the air inlet and removal.

2.1.4. Evaluation of yield and appearance

The yield was calculated as percentage of the initial, nonbrined weight of the fillet samples. The appearance of the products after brining was evaluated by an expert panel of three persons. The surface was evaluated as homogenous, or nonhomogenous with presence of white precipitation. The panel gave a demerit score of 0–2 points, where 0 point represents a natural, homogenous surface and 2 points represents the presence of several white spots or stripes.

2.1.5. Data analyses

To compute effects and to test their significance, the results were analysed by "Analysis of Effects" using the