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A novel process for obtaining smoke-flavoured salmon using water vapour permeable bags

Arantxa Rizo, Verónica Máñes, Ana Fuentes *, Isabel Fernández-Segovia, José M. Barat

Departamento de Tecnología de Alimentos, Universitat Politècnica de València, Camino de Vera s/n, 46022 Valencia, Spain

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ABSTRACT

We aimed to optimise a new smoking–salting method using water-vapour permeable bags to obtain smoke-flavoured salmon. This involved a smoking–salting process with three salt doses (4, 6, 8 g salt/100 g fresh salmon) and two packaging types: high barrier (HB) bags and water vapour permeable bags (WP) with different humidity levels (50%, 60% and 70% RH). The salting and vacuum packaging combination increased the salt concentration in the final product versus WP bag packaging. The lower the RH for WP-packed samples in the drying chamber, the lower the moisture and a_w values. The 8% salt dose/60% RH samples came closer to the a_w, salt content and moisture levels determined in commercial samples. In WP samples, 50% and 60% RH completely evaporated the water released by muscle. Sensory attributes of the new product obtained similar scores to the commercial product. The new methodology is suitable to obtain smoke-flavoured salmon with similar physico-chemical characteristics and consumer acceptance to a commercial smoked salmon reducing processing steps and brine wastes.

1. Introduction

Smoking is a preservation method that has been employed since ancient times. The preservative effect of smoking is due to a combination of different factors, including addition of salt, partial dehydration of tissues which occurs throughout the different stages of the process, and the preservative action of the smoke components. The smoking process slows down the biological processes and oxidative damage, and confers the final product sensory characteristics that consumers greatly appreciate.

The traditional smoking process involves different stages such as salting, drying and/or smoking. There is increasing interest in modifying the traditional smoking and salting processes according to industrial demands. Producers seek new methods to reduce processing times, minimise salt waste, reduce overall weight loss and/or improve the hygienic quality of the final product. Hence the salting step is especially critical. Currently, salting process improvements focus primarily on reducing processing times and using alternative techniques, such as direct brine injections (Thorarinsdottir et al., 2010), simultaneous salting–thawing (Barat et al., 2005) or vacuum impregnation (Chiralt et al., 2001).

A new salting process in which the exact amount of salt to be absorbed by the fish is directly dosed has been proposed by Fuentes et al. (2008). This procedure has been demonstrated capable of reducing waste and obtaining homogeneous products. The combination of this controlled salting process, by using smoke-flavoured salt, and vacuum packaging has also been studied with a view to obtaining smoked salmon with similar characteristics to currently marketed products (Rizo et al., 2013). This methodology was able to accelerate NaCl absorption and dehydration, and can therefore cut the total processing time without affecting physico-chemical parameters and sensory traits as compared with traditional smoked salmon. Other studies have been focus on the use of smoke condensates and liquid smoke as an alternative to the traditional smoking process (Muratore and Licciardello, 2005; Muratore et al., 2007; Suñen et al., 2003). The use of smoke flavourings apart from providing the typical smoke flavour to this type of products, can also avoid the occurrence of harmful components for human health and the environment generated by traditional smoking techniques (Martinez et al., 2007).

Recently, materials with high water vapour transmission rates have been investigated. Currently there are very few applications for these new materials in food technology, being these focused mainly on dry ageing of beef (Ahnström et al., 2006; DeGeer et al., 2009; Dikeman et al., 2013; Li et al., 2013). The use of highly water vapour-permeable bags (WP) facilitates the control of product dehydration by managing the temperature and humidity conditions, as with the traditional methods (unpacked). Yet at the same time, it minimises the risk of microbial contamination.

* Corresponding author. Tel.: +34 96 387 70 07x73664; fax: +34 96 387 73 69.
E-mail address: anfuelo@upvnet.upv.es (A. Fuentes).

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DeGeer et al. (2009) stated that this type of bags helps obtain higher meat yields and lower microbial counts as compared with the traditional dry ageing processes, and does not affect the sensory traits of the meat product. For this reason, we considered that a combination of a one-step smoking–salting process with WP bags would help obtain smoke-flavoured fish with similar sensory traits to smoke products obtained by traditional methods and would optimise yields, reduce waste, speed up processes, maintain the hygienic quality during processes, and facilitate transportation and distribution at the same time. This could improve the methodology previously described, in which a controlled salting process was combined with vacuum packaging.

The aim of this study was to establish the optimal processing conditions (salt dose, type of packaging and RH of drying) to develop a new smoking–salting procedure using water vapour permeable bags in order to obtain smoke-flavoured salmon.

2. Material and methods

2.1. Materials

Aquacultured salmon (*Salmo salar*) fillets ($n = 9$) from a land-based farm in Norway (Marine Harvest, Bergen, Norway), of the commercial size 1.4–1.8 kg were purchased from a local market in the city of Valencia (Spain) and were transported to the laboratory under refrigeration. Upon arrival at the laboratory, the fillets were trimmed to remove bones, fins and any visible adipose tissue. Then salmon fillets were cut into 4 cm portions to obtain six portions per fillet (54 samples in all were obtained). Average weight of fish portions was 151 ± 35 g and thickness between 2 and 3 cm.

The sodium chloride used for the smoking–salting process was supplied by Panreac Química, S.A. (Barcelona, Spain), and the natural liquid smoke HARDWOOD AFS 10 was provided by Amcan ingredient Ltd. (Le Chesnay, France). Two types of plastic bags packaging were used for this study: water vapour permeable bags (WP) were supplied by TUB-EX ApS (Taars, Denmark) (size: 200 × 300 × 0.04 mm; water vapour transmission rate: 5000 g/50μ/m^2/24 h (38 °C/50% RH); high barrier bags (HB) (size 200 × 300 × 0.12 mm, water vapour transmission rate 1.8 g/120μ/m^2/24 h (23 °C/85% RH), supplied by Productos Pilarica, S.A. (Valencia, Spain). Two batches of smoked salmon from two different brands were used to determine the target physico-chemical parameters for the new product. Raw material of these products was Norwegian aquacultured salmon and they were processed using traditional cold-smoking techniques (dry salting, followed by smoking in a smoking chamber).

2.2. Experimental design

In order to establish the optimal salting conditions of the new method, the effect of the amount of salt dosed, RH in the drying chamber, and packaging permeability on the physico-chemical properties of the final product were all studied. These conditions were set in order to obtain smoke-flavoured salmon with similar characteristics to currently marketed products. Values considered as reference were obtained from the commercial products analysed (moisture, salt content and a_w).

Salmon portions were submitted to a simultaneous smoking–salting process (Fig. 1). The smoking conditions and salting parameters to be tested were selected based on previous studies with minor modifications (Fuentes et al., 2008). Fish samples were smoked by spraying the fillet surface with liquid smoke that was diluted with distilled water (60 ml/100 ml solution) for 30 s, followed by a salting procedure based on thermodynamic control. Salting was carried out by dosing a previously established amount

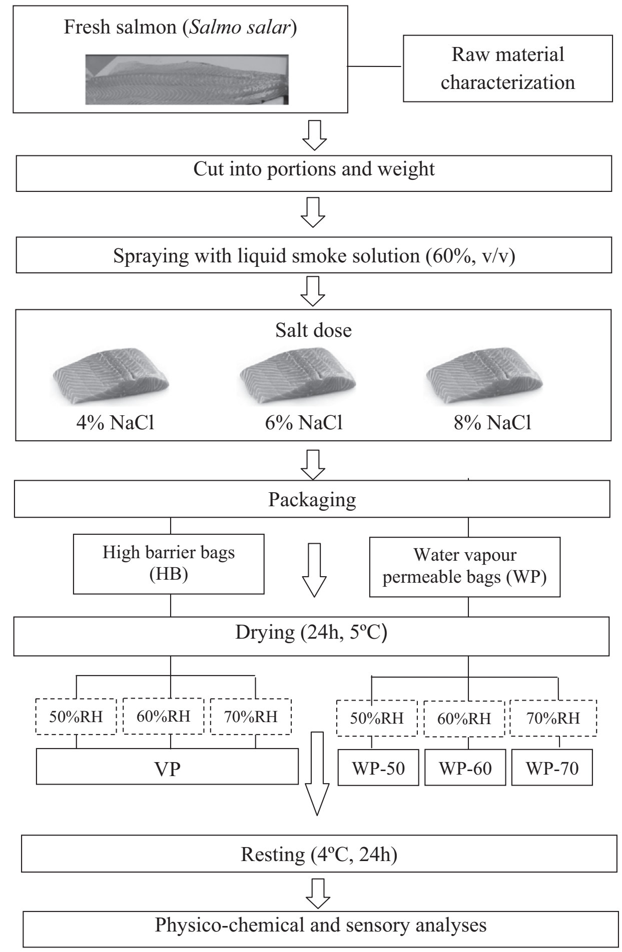

Fig. 1. Smoking–salting process of salmon.

of NaCl over the fillet surface. The amount of salt added to each sample was calculated from the initial weight of the fish portion and the initial water weight fraction (x^w), according to procedure established by Fuentes et al. (2008). In this study, three salt dose concentrations were considered: 4, 6, and 8 g salt/100 g fresh salmon. Then the salmon portions were randomly divided into two groups, one group was packed into WP bags and the other group was packed into HB bags. All the samples were vacuum-packaged with a vacuum packaging machine (Tecnotrip EV-25-CD, Barcelona, Spain). It should be noted that the vacuum conditions for the WP samples were not maintained throughout the process, vacuum packaging was used to ensure the initial contact between fish and the packaging material since air can pass through the bag.

Samples from the two groups were randomly divided into three new batches (6 batches in all); one batch per group of samples (WP and HB) was introduced into a drying chamber at 5 °C for 24 h (Binder mod. KBF Tuttlingen, Germany) with an established RH (50%, 60% or 70%). Afterwards, the salmon portions were removed from the bags and the exudate formed during the process was weighed. Fish samples were introduced into saturated brine under constant stirring for 30 s to remove any traces of salt attached to the surface. Finally, they were dried with absorbent paper, weighed and left at 4 °C for 24 h to ensure a homogeneous salt distribution onto the pieces.

Analyses of moisture, lipid content, NaCl content, pH and a_w were carried out on the fresh salmon and the smoked samples. Three samples were used for each condition ($n = 3$), and the analyses were done on each sample in triplicate, except for pH, which was measured in quintuplicate.