

Salting operational diagrams for chicken breast cuts: Hydration–dehydration

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Abstract

Water and salt transport during osmotic treatment of chicken breast cuts, immersed in salt solutions with different sodium chloride concentrations, were investigated. Salt and water transport was studied empirically by determining water gain (WG), salt gain (SG) and total weight increment (WI) of samples immersed in saline solutions with different concentrations, at 5 °C. It was possible to verify the effect of NaCl solution concentration (C_s) on the direction of the resulting water flow and to quantify water and salt transfer. For values of C_s up to 10% it was verified that the meat samples gained water, while for processes with C_s between 15% and 20%, samples lost water. Linear behaviors of WG and SG parameters with C_s (5–20%) were observed for each process time. Because of the linearity of WG *versus* C_s it was possible to estimate the value of C_s that delimited hydration from dehydration process in chicken breast cuts, for each immersion time. The results obtained in this work showed that C_s and immersion time variables can be manipulated to obtain a product with desired NaCl concentration and moisture. An original Salting operational diagram was proposed to help simulate the different values of C_s and immersion time to be used to achieve given final product moisture and salt concentration.

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1. Introduction

Osmotic treatment (OT) of fruits, vegetables and meats is performed by immersion of a food sample in an aqueous solution containing at least one of the osmotic agents: salts, sugars, phosphates, acids and others (Collignan et al., 2001). During the immersion, treated samples can gain or loose water, as it is the case of raw meat (Le Meste et al., 2002; Offer and Trinick, 1983).

The osmotic treatment of raw meat presents some particularities, because of their natural capacity to gain water under given conditions (Carciofi and Laurindo, 2007; James et al., 2006; Le Meste et al., 2002; Young and Smith, 2004; Offer and Trinick, 1983). The OT of raw meat with salt solutions leads to salt and water transfers, in the same directions or in counter-current, depending on the osmotic

solution concentration. In this way, this process can lead to food hydration or dehydration (Offer and Trinick, 1983; Gallart-Jornet et al., 2007; Schmidt, 2006; Schmidt et al., in press; Volpato et al., 2007). Specifically, osmotic dehydration (OD) is classically defined as a pre-processing technique used to remove part of the solid moisture by immersion in high osmotic pressure solutions. OD has been accepted as a suitable technique to obtain intermediate moisture food and as a pre-processing technique previous to air drying, pasteurization and freezing (Marcotte et al., 1991; Raoult-Wack, 1994; Kaymak-Ertekin and Sultanoglu, 2000, among others).

In the so called marinating process, the objective is to incorporate water and curing agents, through the immersion of meat cuts in relative low concentrated salt solutions. This treatment modifies meat sensory characteristics, producing a characteristic flavor, softness and juiciness to the final product (Le Meste et al., 2002; Lemos et al., 1999; Volpato et al., 2007; Xiong, 2005).

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Nomenclature

a_w	water activity	SOD	salting operational diagram
C_s	brine concentration [g salt/ 100 g solution]	SG	salt gain [g/100 g of non-treated sample]
$C_s^{WG=0}$	brine concentration for null water gain [g salt/ 100 g solution]	w	sample weight after the OT [g]
D	water diffusion coefficient	w_o	weight of non-treated sample [g]
$D_{ }$	water diffusion coefficient parallel to fiber	w_{so}	salt weight in the non-treated samples [g]
$D_{\perp}$	water diffusion coefficient normal to fiber	w_s	salt weight in the sample after the OT [g]
M	sample moisture [g water/100 g of sample]	w_w	sample moisture after the OT [g]
M_0	initial sample moisture [g water/100 g of sample]	w_{wo}	moisture of non-treated sample [g]
OT	osmotic treatment	WG	water gain [g/100 g of non-treated sample]
S	salt sample concentration [g NaCl/100 g of sample]	WI	weight increment [g/100 g of non-treated sample]

The immersion of a muscle *post rigor mortis* in a big volume of NaCl solution 1 M causes muscle swelling, that can increase its volume in up to 80%. This muscle volume expansion depends on the solution concentration (C_s), been accompanied of a correspondent volume of water uptake by the intercellular spaces (Le Meste et al., 2002). Offer and Trinick (1983) reported a detailed investigation of isolated rabbit myofibrils immersed in NaCl solutions with different C_s values. They reported that the diameter and structures of myofibrils presented a few changes when treated with C_s values from 0.55% (0.1 M) until 2.8% (0.5 M). However, at 3.3% (0.6 M) of NaCl, there was significant myofibril swelling and the A band was partially soluble. Maximum swelling was observed over the C_s range from 4.4% (0.8 M) to 5.5% (1.0 M), when the A band was almost completely soluble. For higher C_s values, muscle tends to shrink. Immersion time, temperature, pH, muscle microstructure and other factors can affect salt and water gain or water loss by raw meat immersed in saline solutions (Graiver et al., 2006; Schmidt, 2006). The literature have reported that the higher the temperature, the higher the water and salt uptake by meat (Carciofi and Laurindo, 2007; Chiralt et al., 2001; Mujaffar and Sankat, 2005; Telis et al., 2003), but high temperature increases the microbial risk (Lawrie, 2005).

Many works have reported results on the osmotic dehydration of meats (Chiralt et al., 2001; Collignan et al., 2001; Schmidt, 2006; Telis et al., 2003; among others) and fishes (Barat et al., 2003; Chiralt et al., 2001; Corzo and Bracho, 2006; Mujaffar and Sankat, 2005). However, there are a few works in the literature about the influence of salting process variables (e.g., salt concentration, immersion time and temperature) in the transition hydration–dehydration in meats (Deumier et al., 2003; Graiver et al., 2006) and fishes (Gallart-Jornet et al., 2007; Thorarinsdottir et al., 2004). Moreover, a few works have discussed OT of meats considering the biochemical changes provoked by salting and salt and water transfer

dynamics (Barat et al., 2003; Gallart-Jornet et al., 2007; Graiver et al., 2006).

The objective of this work was to investigate the effects of salt solution concentration (C_s) and immersion time on the osmotic treatment of chicken breast cuts. The C_s values that provoke the transition from the hydration to dehydration regime were investigated, as well as the influence of the immersion time on this critical concentration. From the experimental results, an operational diagram was proposed, in order to predict water gain/loss and salt gain by chicken breast cuts submitted to OT performed with different C_s and immersion times.

2. Materials and methods

2.1. Chicken meat samples and salt solutions

Raw skinless chicken breast, from a single company, was purchased in a supermarket in Florianópolis, SC, Brazil and used to prepare the samples. Chicken samples were cut into $4.0 \times 3.0 \times 1.5 \text{ cm}^3$ parallelepipeds, with weights ranging from 18 to 20 g. The samples' initial moisture was determined by gravimetric method (AOAC, 1990).

Saline solutions were prepared with sodium chloride (NaCl, Analytica, Brazil) and distilled water. A mass ratio of 1:50 of chicken meat samples and saline solution was used in all experiments, in order to avoid significant changes of solution salt concentration (C_s) during the tests.

2.2. Experimental setup

The OT experiments were performed with the device sketched in Fig. 1. This device consisted of a container with the temperature controlled by a thermostatic bath (model MQBMP-01-Microquímica, Florianópolis, SC, Brazil) that circulated water at constant temperature in its jacket. The

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