ISOTHERMS IN PORK MEAT AT DIFFERENT TEMPERATURES AND SALT CONTENTS.

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INTRODUCTION

Many pork meat products are salted and dried. The stabilization of these products is mainly achieved by lowering the water activity. The temperature and the NaCl/H_2O ratio changes along the process. Although in drying of foodstuff several mechanisms are involved (molecular diffusion, capillarity,...), it is generally accepted the diffusion model as a good approach to the drying process. The equilibrium water content of the product at the relative humidity of drying air is one of the factors controling the diffusion, therefore it is necessary to know this parameter in order to model the drying process. The relative humidity of the air in equilibrium with the product is equivalent to water activity. The sorption isotherms relate the equilibrium water content of the product and the water activity at a given temperature and pressure. The objective of this study was to determine the desorption isotherms of pork meat at different temperatures and NaCl contents.

METHODOLOGY

The moisture sorption isotherms were determined gravimetrically by exposing the samples to several atmospheres of known relative humidities. Thin slices (4 mm thick) were obtained from the *Gluteus medius* muscle of five different pork hams. The slices were salted by immersion during 24 hours in three different NaCl solutions: 2%, 5% and 8% of NaCl. The sodium chloride content was determined from a sample of each salted slice using the Charpentier-Volhard method (A.O.A.C., 1980). Small square samples (8x8 mm) were cut from the rest of the slices and introduced into recipients where relative humidity was controled by different salts according to the COST 90 method (Wolf *et al.*, 1985). The recipients with the samples were sterilized by irradiation at 3 kGrey and placed to three different chambers at 5°, 13° and 26 °C (± 0.2 °C). After 54 days of equilibration, the water content of the samples was determined by drying at 103 ± 2 °C until constant weight (A.O.A.C., 1980). Sorption data were obtained by duplicate.

RESULTS AND DISCUSSION

The means of the NaCl content of the samples inmersed into the three different NaCl solutions were 0, 8, 20 and 31 g/100 g d.m. The meat desorption isotherms of meat with different NaCl contents at different temperatures are showed in Figure 1. Each point on the isotherm represents an average of two determinations. Over an a_w of 0.75, the water content at each a_w increased when NaCl content increased. However below this a_w there was only a slight effect of NaCl content. Similar effect of NaCl has been found in another meat experiment (Lioutas *et al.*, 1984,) and also with other foodstuff and solutes (Bussiere and Serpelloni, 1985; Curme *et al.*, 1990). Below its saturation a_w (0.75), the crystalized NaCl sorbed little to no water. However, above its saturation a_w the NaCl sorbed large amounts of water, thus the meat water content is modified. This could explain why there was a breaking point in the isotherm at a_w 0.75. The isotherm could be divided into two parts, below and above this point. However, at 5° and 13 °C, the water content at the a_w 0.70 was also increased by NaCl. This could be due to the fact that the samples did not reach the equilibrium. At higher temperature (26 °C) the water content was not affected by the NaCl content, and therefore, at this temperature the a_w of 0.70 could be included into the first part of the isotherm, as it was expected. To avoid fitting problems with this particular a_w (0.70) the isotherm data have been fit to a theoretical model (G.A.B.) in the a_w between 0.11 to 0.57, and to an empirical two parameter model (Mujica *et al.*, 1989) to the a_w above 0.75.

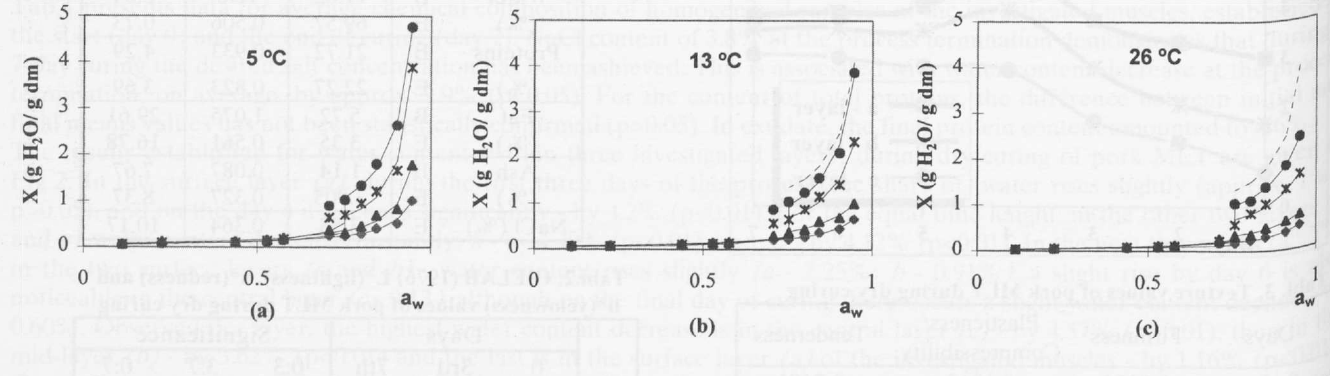

Figure 1. Meat desorption isotherms of meat with different NaCl contents (◆ 0%, ▲ 8%, ✳ 20%, ● 31%, --- theoretical for 31%) at different temperatures: (a) 5 °C, (b) 13 °C and (c) 26 °C.

Theoretical isotherms for mixtures of unsalted meat and 31% NaCl, at 13 and 26 °C, were calculated using the mass balance equation. This states that at any a_w the expected moisture content of the mixture is equal to the sum of the water sorbed by the individual components. Therefore, water contents at each a_w were calculated from the weighted-average hypothesis using experimental data for unsalted meat and standards of Chirife and Resnik (1984) for NaCl solutions. The standards are almost invariant in the range of 15-50 °C (Chirife and Resnik, 1984), but in our study there was an effect of the temperature on the isotherms and the theoretical water contents were higher than the experimental values. The difference regarding these experimental data was higher at 26 °C than at 13 °C (Figures 1b and 1c). There should be an interaction of NaCl with meat, which would reduce the NaCl amount available to sorb water. Therefore this method would not be a good aproximation to the a_w calculation for salted meat. Temperature effect on desorption isotherms of unsalted meat is showed in Figure 2. The temperature effect was higher at higher a_w: the water content at a given a_w increases as temperature decreases. This effect was more intense with salted meat (Figure 3). At a_w of 0.70 the salted meat in this study held more water at low temperature (5 and 13 °C) than at 26 °C. The only explanation we have is that the equilibrium had not been reached at low temperatures or the NaCl solution could have been supersaturated.

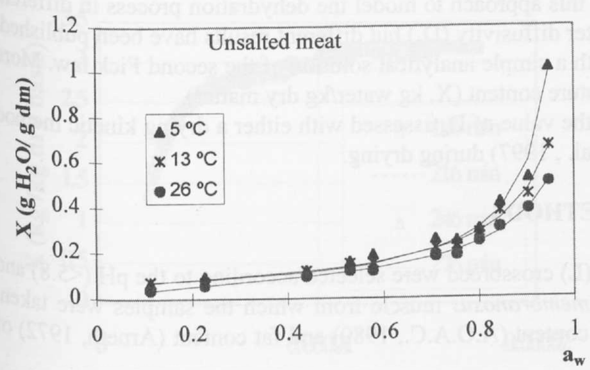

Figure 2. Isotherms of unsalted meat at different temperatures.

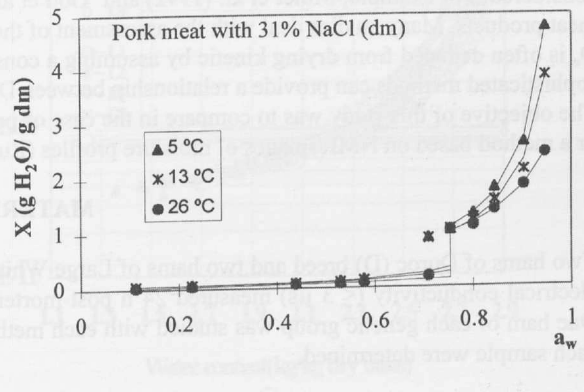

Figure 3. Isotherms of salted meat at different temperatures.

During the drying process of meat products, the relative humidity of the air often ranges from 60% to 80%. In salted products this range includes the two parts of the isotherms. Therefore, it has to be kept in mind that around a a_w of 0.75 there would be an important decrease in water content of the product surface for a slight decrease of relative air humidity. In dry-cured hams, this decrease would be more important just after salting, because at this point the NaCl content in the surface reaches its maximum, and it could lead to a crust formation. For instance, Arnau *et al.* (1995) found that the *Gracilis* muscle, which is an external muscle, achieved a NaCl content of 28.2% (d.m.) just after salting.

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