

EFFECT OF PARTIAL SUBSTITUTION OF SODIUM CHLORIDE ON THE DRYING CHARACTERISTICS OF BEEF SLICES

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Abstract – The aim of this study was to determine the effects of partial replacement of NaCl with KCl in dry salting on drying characteristics of beef. Three drying approaches were analyzed: 1) tray drying (TD), 2) dry salting with NaCl+TD, 3) dry salting with NaCl/KCl+TD. The effective diffusivity (D_{eff}) for tray dried non-salted beef slices was 9.57×10^{-9} m²/s, 8.44×10^{-9} m²/s for NaCl+TD; and 10.02×10^{-9} m²/s for NaCl/KCl+TD. It is the case that the lowest drying time goes to TD alone, but, this is because impregnation time of the salts was included in total processing time. Based on these results, partial substitution of NaCl with KCl seems to be appropriate opening the window to develop good quality products with low sodium content.

Key Words – Beef, Salt replacement, Convective drying

I. INTRODUCTION

There is a direct link between high salt intake and some health disorders such as hypertension, cardiovascular diseases, cancer and kidney diseases. Therefore, a reduction in salt intake in the diet has been recommended and consumption patterns are changing towards reduced-salt foods all around the world. Dried meat cubes and slices are used in the formulations of ready to eat soups, instant pasta and pet foods [1-3]. Convective drying is the most common technique used to process these meat products, i.e. the meat is placed on metal trays allowing hot air to circulate around the pieces for 3-18 hours at 75-80°C [4]. Sometimes, to facilitate preservation, the raw meat is salted as a pretreatment to bring down the water activity [5]. However, the salt content of these dried meat products is relatively high which bring the health issues mentioned above. The most common approach to reduce salt in foods is the partial or total substitution of sodium chloride (NaCl) with other chloride salts such as potassium chloride (KCl) which has been recommended as the most suitable replacer [6-7]. The objective of the current study was to evaluate the effects of partial replacement of NaCl with KCl on the drying characteristics of salted beef slices during tray drying.

II. MATERIALS AND METHODS

Beef *semimembranosus* muscle was used throughout this study. Beef for the three replications was cut into small pieces (3x2x2 cm) which were randomly separated into 3 groups. Three drying approaches until the equilibrium moisture content (<10% dry basis) was attained were analyzed: 1) convective tray drying at 80°C at 0.5m/s air velocity (TD); 2) dry salting with NaCl + tray drying (NaCl+TD); 3) dry salting with a mixture of 50%NaCl and 50%KCl + tray drying (NaCl/KCl+TD). The drying curves for the three treatments were determined, and moisture ratios and effective diffusivities were calculated according to the following equations,

$$MR = \frac{x_i - x_e}{x_0 - x_e} \quad (1)$$

$$MR = \frac{8}{\pi^2} \exp\left(-\frac{\pi^2 D_{eff} t}{4L^2}\right) \quad (2)$$

where MR is moisture ratio, x_i is the moisture content at a given time, x_e is the equilibrium moisture content, x_0 is the initial moisture content, D_{eff} is effective moisture diffusivity (m²/s), L is the half thickness of the meat slice.

III. RESULTS AND DISCUSSION

Drying times to reach moisture equilibrium was very similar for the three treatments as shown in Table 1 and Figure 1, whereas all the diffusion coefficients were also very similar, 9.57×10^{-9} m²/s for TD; 8.44×10^{-9} m²/s for NaCl + TD; and 10.02×10^{-9} m²/s for NaCl/KCl+TD.

Table 1. Drying time and diffusion coefficients (D_{eff}) of different drying techniques applied to beef

Groups	Drying time (min.)	D_{eff} (m ² /s)
Tray drying	650	9.57×10^{-9}
Dry salting with NaCl + Tray drying	700	8.44×10^{-9}
Dry salting with NaCl/KCl + Tray drying	700	1.02×10^{-8}

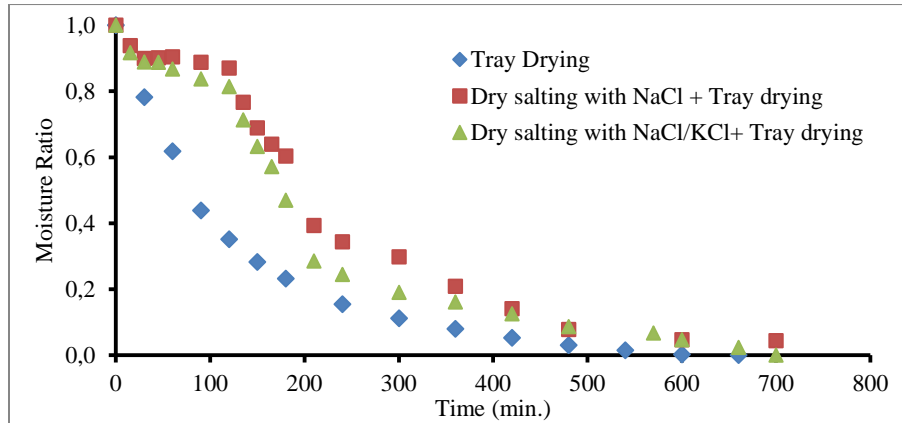


Figure 1. Drying curves of beef slices dried with three different treatments

It is the case that the lowest drying times goes to TD, but, when estimating the treatment time for the other two treatments, salt impregnation time was included as part of the process. These results are very encouraging to keep working on partial substitution of sodium chloride in other proportions and in many other meat products.

IV. CONCLUSION

Since all the treatments showed very similar diffusivity coefficients and in addition the time to reach moisture equilibrium for NaCl+TD and NaCl/KCl+TD was almost the same, partial substitution of NaCl with KCl seems to be very adequate, and thus, facilitate the formulation of healthier meat based food products.

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