ABSTRACT

The Osmotic Dehydration and Air Drying of Fish

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The overall objective of this work was to conduct, at the laboratory level, a study of the processes of salting fish and drying salted fish using locally available fish species, shark and catfish. While information on several aspects of the production of salted fish is available, this study was principally dedicated to the scientific study of the process and the basic mechanisms involved in the production of dried, salted fish. These mechanisms are of considerable practical interest in industrial drying operations since they determine the particular variables under the control of the designer and operator which are likely to govern the rate of drying and the quality of the product. Limited data is available on the diffusivity values for moisture and salt during osmotic dehydration of fish.

Experiments in osmotic dehydration were designed to investigate the effects of brine concentration (60°brine, 80°brine, 100°brine), brine temperature (20°C, 30°C, 40°C, 50°C), slab thickness (0.5cm, 1cm, 2cm) and previous freezing time (1-4 weeks) on the osmotic drying behaviour of fish slabs (10cm x 5cm x 1cm). Air drying experiments were designed to investigate the effects of air temperature (30°C, 40°C, 50°, 60°C), air velocity (0 m/s, 0.60 m/s, 0.91 m/s, 1.0 m/s), slab

thickness (0.5cm, 1cm, 2cm), slab shape and geometry (slab, strip, cube), and salt concentration of prior osmotic treatment (60°brine, 80°brine, 100°brine) on drying behaviour.

The osmotic and drying processes can be accelerated when shark and catfish are first filleted and cut into small rectangular slabs (10cm x 5cm x 1cm). Washing in citric acid (5%, 5min) prior to a minimum 4h osmotic treatment in a saturated brine (36% w/v) under continuous circulation at room temperature (30°C) followed by oven drying at 50°C (1.5 m/s, 25% rh) for a minimum of 8h is recommended. This procedure is sufficient to produce salted dried fish of acceptable taste, odour, appearance and texture containing 40-45% moisture and 18-20% salt with a water activity of 0.770. Due to the higher oil content of catfish slabs, this fish tends to develop a yellow colour during oven drying.

The sun/solar drying (direct/indirect dryer) potential of dried, salted fish was investigated. Drying in a direct solar dryer gave products with a pleasing colour and texture and this drying method is a good option in the absence of a mechanical oven, however the use of a fan to improve air circulation inside the dryer is recommended.

Outlined in this study are mathematical models which can provide more information about the rates of salt penetration and water removal, salting and drying times and equilibrium concentrations through the use of a diffusion coefficient. The mass transfer data obtained from the osmotic dehydration and air drying (oven and solar) experiments in this study was modelled mathematically using Fick's Law. The applicability of three (3) mathematical models for one-

dimensional transfer between a plane sheet and a well-stirred solution of infinite volume was tested for the data obtained during osmotic dehydration. Moisture and salt diffusivity values are found to differ depending on both the model used and the way the experimental data is presented, that is, in terms of actual moisture/solute content of the sample or the amount water/solute lost or gained during the osmotic process. The expressions presented by Azuara et al. (1992) based on the model presented by Crank (1975) can be successfully used to predict the equilibrium point and to calculate diffusion coefficients at not only the initial stages of dehydration, but also at different times during the osmotic process.

The mass transfer data obtained from the oven drying and sun/solar drying experiments was successfully modelled using Fick's Law and the solution given by Sherwood (1929). Diffusion coefficients and activation energies for moisture transport were found to compare well with available data.

Dried salted shark can be stored in high density polyethylene bags in an air-conditioned room (24-26°C, 60% rh) for a maximum of 12 weeks. The shelf life of salted, dried catfish slabs is 10 weeks, limited due to the higher oil content of the catfish. The use of black polyethylene bags did not extend the shelf life of stored fish. Drying of slabs in a forced convection oven at 50°C can also be extended to beyond 8h to further reduce the moisture content and water activity of the fish, thereby improving the shelf life.

Keywords: Osmotic Dehydration; Air Drying, Mass transfer; Fick's Law of Diffusion; Salted Fish.