Fishery Technology
1999, Vol. 36(1) pp : 32 - 35

Kinetics of Desorption of Water and Absorption of Salt During Blanching of Prawn

D.R. Choudhury and R. Chakrabarti*
Department of Food Technology and Bio-Chemical Engineering
Jadavpur University, Calcutta - 700032, India

During blanching prawn desorbs water, absorbs sodium chloride from the surrounding blanching solution and undergoes denaturation. The rate of desorption from the muscle tissue was directly proportional to time, temperature and concentration of NaCl in blanching brine and the kinetics of desorption followed the first order reaction. Variation in the concentration of NaCl in the blanching liquor did not alter the mechanism of desorption. The bonding reaction involving ions was disfavoured at high temperature so that the rate constant became independent of ionic strength.

Key words : Prawn, blanching, reaction mechanism, first order reaction

Blanching is one of the important steps in canning. During blanching dressed prawns are boiled in 7-10% sodium chloride solution. During this process the muscle tissue desorbs water and absorbs sodium chloride from the surrounding blanching solution and at the same time undergoes denaturation as evidenced by the hardening and curling of prawn. Prawn muscle in the natural condition may be regarded as a bio-gel. The bio-gel in the living system contains 0.15 M salt for maintenance of osmotic balance (Hamm, 1968). This bio-gel, when dipped in comparatively higher concentration of NaCl for blanching, desorbs free water according to the osmotic law. An attempt has been made here to study the mechanism of the reactions associated with blanching.

Materials and Methods

Sodium chloride content of blanching solution and temperature used for the experiments were 7.2%, 9.2%, 11.1%, 15.4% w/v and 34°C, 60°C and 80°C respectively. Beakers containing NaCl solution of desired concentration were kept in different incubators adjusted to different temperatures (thermostatistically controlled to ±0.1°C). As soon as the NaCl solution attained the desired temperature, dressed prawn of uniform size was added to the salt solution and immediately covered with petri-dishes. The ratio of the quantity of dressed prawn and the volume of brine was adjusted in such a way that there was no significant drop in temperature of the brine while the prawns were added. Samples were removed at regular intervals and moisture content of muscle tissue was determined at 100±1°C (AOAC, 1975).

Results and Discussions

The rates of moisture loss from prawn during blanching at different temperatures are represented in Fig. 1a, b and c. It can be seen that log of moisture loss varied linearly with time (t) at a given concentration of NaCl and temperature. These findings are in agreement with the observations of Wisterich *et al.* (1959) and Sanderson & Vail (1963). This means that the kinetics of desorption from protein gel follows the first order reaction, $\log c = -(^1/_{2.303})\ Kt + \log a$

* Present address : Central Institute of Fisheries Technology, Visakhapatnam Research Centre, Visakhapatnam-530 003, India

where a and c are the moisture content in the system at time '0' and 't'. The values of rate constants (K) at each concentration of NaCl used for blanching at temperatures 34°C, 60°C and 80°C, were evaluated from Fig. 1a, b and c by using the integrated Arrhenius equation (Fruton & Simmonds, 1965).

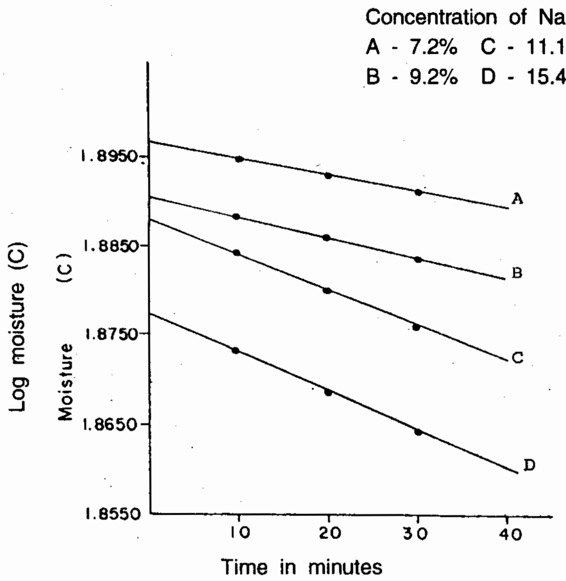

Fig. 1a. Rate of loss of moisture from prawn meat during blanching in NaCl solutions of different concentrations at 34°C.

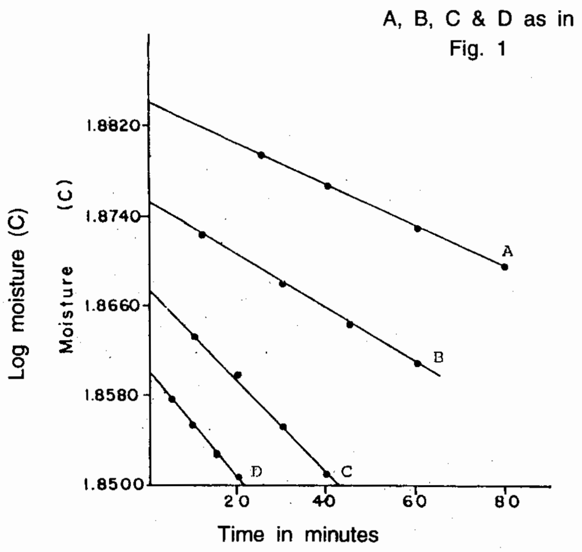

Fig. 1b. Rate of loss of moisture from prawn meat during blanching in NaCl solutions of different concentrations at 60°C.

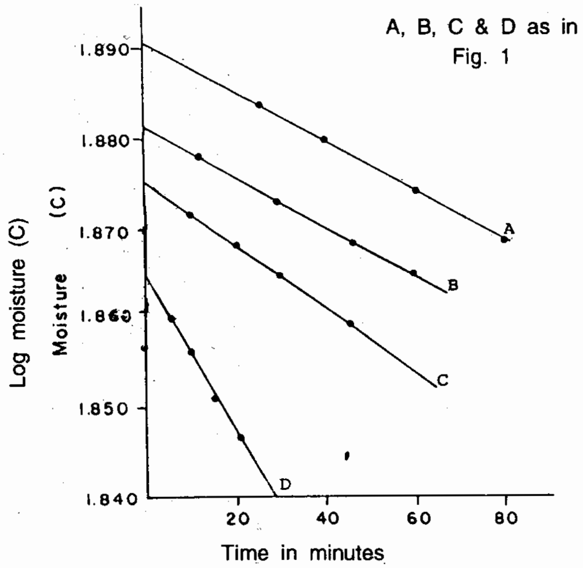

Fig. 1c. Rate of loss of moisture from prawn meat during blanching in NaCl solutions of different concentrations at 80°C.

$K = A\ e^{-E/RT}$

or $\log K = -(E/RT) \log e + \log A$ where K = rate constant, Sec^{-1}; A = collision frequencies, Sec^{-1}; e= base of natural logarithm; E = Energy of activation, Kcal/g Mole; T = Absolute temperature and R = constant, (cc-atm)/gm Mole K°

Plot of log K vs 1/T was found to be linear (Fig.2). E and A at different NaCl concentrations are presented in Table 1. The magnitude of E was of the same order as that for ordinary chemical reaction. Therefore it appears that desorption of water from the bio-gel due to the interaction of NaCl involves steps of simple chemical reactions.

Table 1. Values of 'E' and 'A' during blanching of prawn at different NaCl concentration

Concentration of NaCl % w/v	E (Kcal/Mole)	A (sec^{-1})
7.2	6.24	0.02×10^{12}
9.2	11.24	2.52×10^{12}
11.1	12.49	2.20×10^{12}
15.4	10.89	0.76×10^{12}

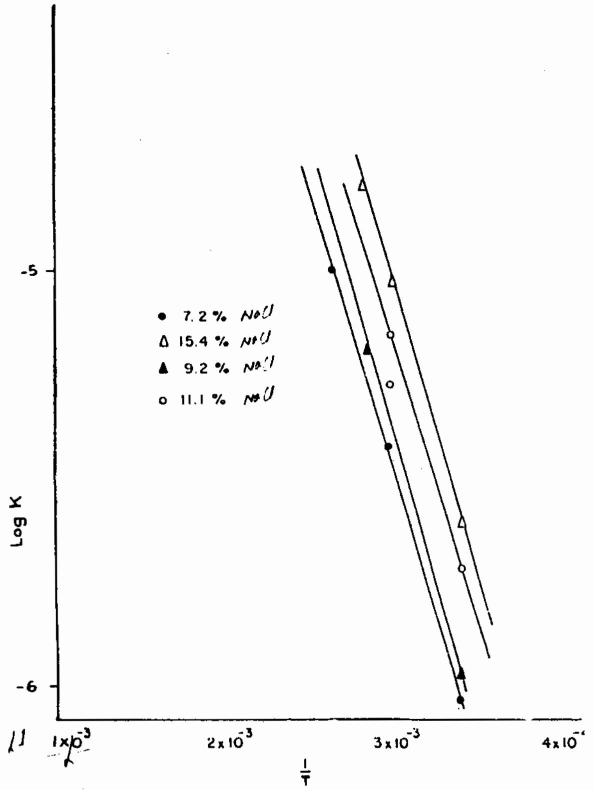

Fig. 2. Changes in rate constant of desorption with temperature during blanching of prawn in NaCl solutions of different concentrations.

It was also noted that the values of E and A did not depend on the concentration of the NaCl solution used for blanching. This means that changes of sodium chloride level in blanching brine do not alter the mechanism of desorption reaction. Increase in the rate of reaction due to increase in NaCl concentration in blanching brine is thus controlled by diffusion for the attainment of osmotic equilibrium. With increase in the concentration of NaCl, concentration gradient within and outside the gel material will increase and as a result of which the rate of desorption will increase. The results of the study showed that moisture loss increased with time, temperature and concentration of sodium chloride in the blanching medium. The reasons for the variations of the values of the rate constants (K), for the desorption process with increase in concentration of NaCl at constant temperature have also been examined. Equation for primary salt effect in ionic reaction using Debye-Huckel-Bronsted theory (Fruton & Simmonds, 1965) can be written in the form, $\log_{10}K = \log_{10}K_0 + Z_a.Z_b.\ \mu$ where, μ = molar concentration of NaCl in the system; Z_a, Z_b = valency of the ions involved in reaction occurring in the system and K_0 = constant at zero value of μ. log K vs. μ was found to be linear (Fig.3). Since the slope is positive it appears that along with desorption of water from the bio-gel, absorption of both monovalent cations and anions from the surrounding also takes place, with the resulting net effect of negative charge in the bio-gel. It can be seen from Fig. 3 that the rate constants became independent of ionic strength at high temperatures. This indicates that such kind of bonding reaction involving ions is disfavoured at high temperatures.

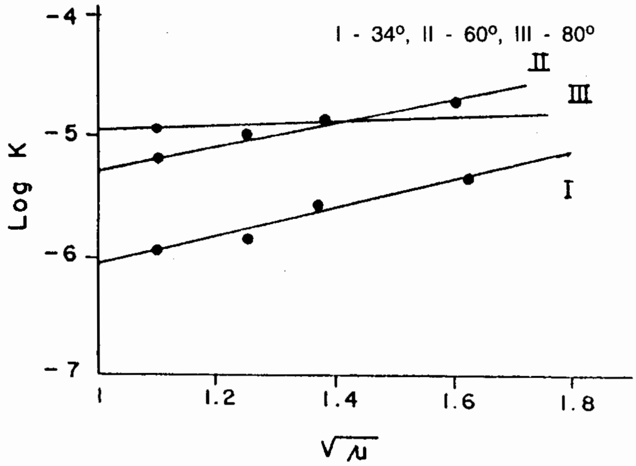

Fig. 3. Changes in rate constant of desorption of water with NaCl concentration at different temperatures during blanching of prawn.

The equilibrium moisture values depend on the temperature of stored canned prawn muscle and the final concentration of NaCl retained by the tissue after canning. On an average, NaCl content of canned prawn varies between 0.34 to 0.68 molar concentration (ISI, 1968). Therefore equilibrium vapour pressure of the canned meat under air tight condition is in the range of 0.992 to 0.974 only. The canned prawn, when kept under constant temperature and relative humidity conditions will have some what constant moisture content (Henry, 1971). Therefore the moisture content of commercially canned prawn will be more or less constant, irrespective of the blanching conditions.

References

AOAC (1975) *Official Methods of Analysis*, 12th edn., Association of Official Analytical Chemists, Washington DC, USA

Fruton, J.S. & Simmonds, S. (1965) *General Bio-chemistry*, First Indian edn, p.86, 265, Asia Publishing House, Bombay

Hamm, R. (1968) *Fleischwirts*, **18**, 856

Henry, B.B. (1971) *An introduction to physical Biochemistry* p.161, F.A. Davis Company, Philadelphia

ISI (1968) *Prawn (shrimp) canned in brine*, IS:2236, Indian Standards Institution, New Delhi, India

Sanderson, M. & Vali, G.E. (1963) *J. Food Sci.* **28**, 590

Wistreich, H.E., Morse, R.E. & Kenyon, L.J. (1959) *Food Technol.* **13**, 441