

Drying Characteristics of Shrimp Head Waste

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Drying characteristics of shrimp head waste were studied under constant drying conditions with an objective of obtaining rate and design data for the drying process. Experiments were conducted with the whole shrimp head waste and the head waste without shell at dry bulb temperatures of 50, 60 and 70°C, keeping relative humidity at 40% and drying air velocity at 1.965 m/s. Results showed that the shell cover hindered the drying process considerably and the head waste without shell required less time to dry under a particular drying condition. There was no constant rate period during drying of samples without shell. Both constant and falling rate periods were observed in the whole head drying. Drying of both types of sample would be preferable at 70°C air temperature.

Key words: Shrimp, head waste, drying rate.

The head portion (cephalothorax) of marine shrimp is removed and usually discarded as waste in shrimp processing plants and peeling centres, or onboard in large trawlers (Wood *et al.*, 1991). Shrimp head waste is a good source of carotenoid pigments, chitin and as a flavour enhancer (Fox *et al.*, 1994). Shrimp head meal, processed from the waste, is also a valuable component in shrimp feed (Tacon, 1993).

Although shrimp head constitutes 35-40% of the body weight, it contains about 75% of the bacterial load (Novak, 1973). Immediate preservation and processing of this valuable resource can lead to its proper utilisation in various ways. Based on the assumption that head waste account for about 38% of the body weight and the quantity of shrimp exported from India (MPEDA, 1994), availability of shrimp head is estimated to be about 40,000 tons in 1994. Shrimp head waste is utilised to a limited extent due to its logistical difficulty of collection

from various processing plants (Nandeesh, 1995). Shrimp head waste is processed by small scale processors by sun drying, and large scale processors by mechanical hot air drying (Fox *et al.*, 1994). Shrimp head waste may be processed by mechanically separating the shell from the meat. Separated meal has been found to contain higher levels of n-3 polyunsaturated fatty acids and greater quantities of essential amino acids than the meals processed from the whole head waste (Fox *et al.*, 1994). It appears that the technology of shrimp head processing by separating into meat and shell and drying into meal would supply a better quality meal. In the present paper studies on drying characteristics of shrimp head waste - whole and separated from shell cover (carapace) - have been reported. The objective of the study was to obtain the drying rate and design data for the drying process for both the whole waste and the head separated from shells.

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Materials and Methods

Samples of marine shrimp (*Penaeus monodon*) of length 8-10 cm were procured from the market, and heads were removed, washed, packed in polyethylene pouches and stored at -20°C for 2-4 weeks before use. Size of head varied from 3 to 5 cm.

The experimental setup consisted of a constant temperature cabinet for drying and an air saturator for supply of air at saturated condition into the cabinet. The saturation temperature was determined from the desired relative humidity and the drying air temperature to be maintained inside the cabinet, and was controlled to the set point within $\pm 1^\circ\text{C}$ (Kannan & Bandyopadhyay, 1995).

Two types of samples of shrimp head - one, the whole waste and the other, from which the shell cover was manually separated, were used for drying experiments. The sample was placed in a wire-mesh basket and was suspended inside the drying cabinet from a precision balance kept outside at the top of the cabinet. A chain attached at the bottom of the left pan of the balance was used for suspension of the basket. The weight of the basket and chain was 48.76 g.

The sample size varied between 32.8 and 48.8 g. Air at a constant dry bulb temperature, velocity and relative humidity, was passed cross - flow over the sample. Changes in weight as a function of time were recorded under the experimental conditions given in Table 1. Relative humidity was kept constant at 40% and air velocity at 1.965 m/s.

Results and Discussion

Figure 1 shows the drying curves plotted as moisture ratio M^* versus time, at dry bulb temperature of 60°C with 1.965 m/s air velocity and 40% relative humidity, for the whole and without shell samples. The moisture ratio has been defined as $M^* = (M - M_e)/(M_o - M_e)$, where M denotes total moisture (kg) and subscripts 'e' and 'o' stand for equilibrium and initial moisture respectively. Drying curves were plotted in this way in order to overcome the effect of difference due to initial moisture contents of samples at the starting time. The data revealed that the shell cover hindered the drying process considerably and at a given temperature samples without shell cover required less time to dry to a particular level when compared with samples with shell. Results of drying under various conditions are shown in Table 1.

Table 1. Results of shrimp head drying under different conditions

Sample	Dry bulb Temp.(°C)	Moisture, kg/kg, dry basis			Time taken for moisture reduction (h)		
		Initial	Equilibrium	Free	25%	50%	75%
Whole	50	3.02	1.18	1.84	1.16	3.16	5.38
Head	60	6.23	1.86	4.37	1.24	2.85	4.25
	70	3.21	0.53	2.68	1.38	2.56	3.95
Without shell	50	3.04	1.05	1.99	1.11	2.58	5.15
	60	2.17	0.08	2.09	0.98	2.27	3.73
	70	1.92	0.11	1.81	0.83	1.90	3.48

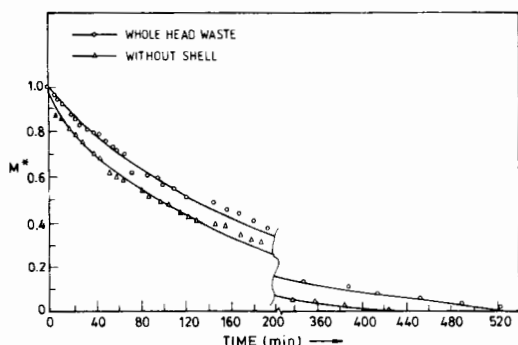


Fig. 1. Drying Curves of Shrimp head waste at 60°C (Air Velocity = 1.965 m/s and R.H. = 40%)

Drying rates expressed as kg/kg (dry basis)/h has been calculated by numerical integration of the drying curves (free moisture content versus time) and plotted against free moisture content for temperatures 60 and 70°C (Figs. 2 and 3). Two types of curves were obtained, one with both constant and falling rate periods (in samples of whole waste) and the other with only falling rate period (in samples without shells). The trend was similar at all temperatures with both types of samples. Samples of whole waste showed three consecutive short but distinct constant rate periods at 50° and 60°C, but only one at 70°C. Samples without shell showed no

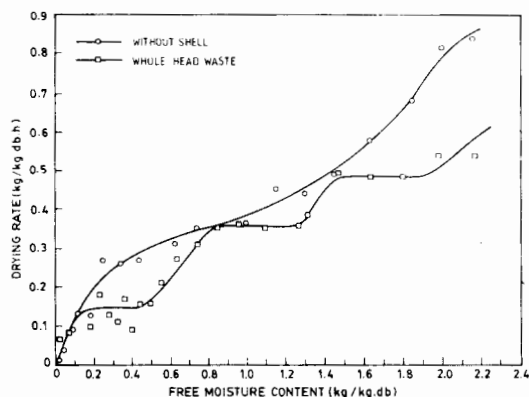


Fig. 2. Drying Rate Curve (Temp. 60°C, Air Velocity = 1.965 m/s and R.H. 40%)

constant rate period but two falling rate periods at all temperatures. Shrimp head samples without shell showed drying behaviour similar to that of fish and shrimp samples, which dry mostly in falling rate period (Jason, 1965; Kannan & Bandyopadhyay, 1995). However, unlike fish drying, major portion of shrimp head meat drying takes place in the first phase of falling rate drying, which is called "unsaturated surface drying". In the second falling rate period, the rate of internal moisture movement decreases and the rate of drying falls even more rapidly than before (Treybal, 1981).

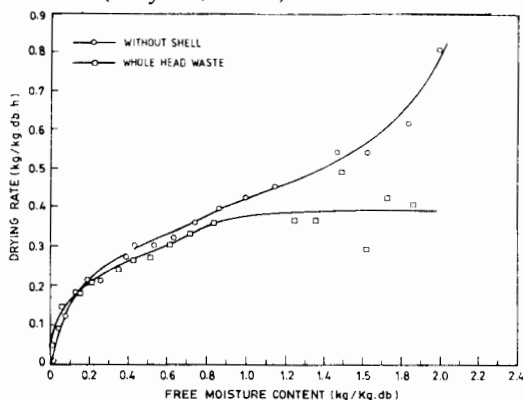


Fig. 3. Drying Rate Curve (Temp. 70°C, Air Velocity = 1.965 m/s R.H. = 40%)

Constant rate period of drying was probably due to low rate of drying when the head samples were under shell cover. The reason for more than one constant rate period during drying of whole shrimp heads was however, not fully clear. It might be due to the difference in local rates of evaporation resulting from the difference of shrimp head shape along the length and presence of residual tail meat at the joint of carapace. The end of the first constant rate period occurred when the surface of the leading edge of the head dried. The second constant rate period ended when rest of

the surface dried, and the third constant rate period might be due to drying of residual meat at the carapace joint. Jason (1965) noted similar behaviour during drying of cod. Occurrence of one constant rate period only at 70°C was due to the higher rate of drying of head samples even under shell cover. Therefore drying of both types of shrimp head waste would be preferable at an air temperature of 70°C.

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