

Freeze Drying of Fishery Products: Part I—Drying Characteristics of Some Common Indian Food Fishes

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The amenability to freeze drying preservation of prawns [*Penaeus indicus* (Milne-Edwards)], oil sardine [*Sardinella longiceps* (V.)], killimin [*Nemipterus japonicus* (Bl.)], Mullet (*Mugil* sp.), Cullawah (*Epinephelus* spp.) and golaree [*Otolithes argenteus* (C.)] has been studied. The effects of prefreezing, evaporative freezing, presence of fat in the fish on the drying rates and reconstitution behaviour of the freeze dried stuff have been assessed. Prawn and lean fish lend themselves well to freeze drying both in fresh and cooked forms, yielding products with good reconstitution and organoleptic properties. High fat contents in the fish retard both dehydration and rehydration. The product obtained by prefreezing is superior to that obtained by evaporative freezing in respect of reconstitution behaviour and organoleptic properties.

FREEZE drying has come to stay as an accepted method of food preservation, and commercial scale production of such foods is becoming a common practice in some of the western countries. Because of several advantages of these products, such as easy and instantaneous reconstitution, light weight, nearness in properties to fresh material on reconstitution, retention of almost all the nutrients present in the fresh material, and above all the convenience they offer regarding preparation for the table, they are likely to become more and more popular. Studies on the freeze drying of tropical fishes landed in the Cochin area have been taken up at this Institute using a laboratory model freeze drying plant (Atlas Freeze Drying Unit, Laboratory Ray 1). The results of preliminary studies are presented in this communication. A report on this work has already been submitted to FAO by one of the authors¹.

Experimental procedure

Materials — Freshly landed prawns and fishes were secured from various sources and brought to the laboratory in ice. Prawns [*Penaeus indicus* (Milne-Edwards)] were handpeeled, veins removed and washed. This material has been subsequently referred to as 'fresh prawns', and the material obtained after cooking the fresh prawns in 5 per cent boiling brine for 15 min. and drained on wire mesh as 'cooked prawns'. Sardine [*Sardinella longiceps* (V.)] and killimin [*Nemipterus japonicus* (Bl.)] were split open ventrally, their heads, viscera and backbones removed, thoroughly cleaned and used. Mullet (*Mugil* sp.) was eviscerated, its head, scale, tail and fin removed, cleaned and cut into 2 cm. thick slices at right angles to the backbone. Cullawah (*Epinephelus* spp.) was filleted from both sides of the

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backbone, cleaned and cut into 2 cm. thick slices. Cooked and flaked *golaree* [*Otolithes argenteus* (C.)] was prepared by removing heads, tails and viscera, cleaning and cooking in steam for 10 min. The edible flesh alone was then flaked out and used.

Freeze drying procedure — The material was spread in trays in a single layer with thermocouples introduced at appropriate points, frozen in a contact plate freezer to -30°C . and charged into the freeze dryer. For evaporative freezing experiments, the material after being arranged in the trays with the thermocouples in proper positions was straightway loaded into the dryer. The equipment was then started and the heating plates were switched on when the vacuum came down to 0.1 mm. of Hg and the temperature came in the range -15° to -20°C . (except that of the heater plate). The heat input was adjusted in such a way that the material remained always in the frozen condition, cutting it down if the material temperature showed sign of rising. The drying operation was allowed to proceed, keeping the material temperature initially in the sub-zero region as far as possible and then allowing it to rise slowly to $30-50^{\circ}\text{C}$., depending upon the nature of the material. Drying was considered to be complete when the weight remained constant for at least 30 min. After the drying operation, the vacuum in the cabinet was broken with nitrogen and the material packed in hermetically sealed tin cans under nitrogen.

Results and discussion

The curves for weight loss (kg. water lost per 100 kg. dry matter) and drying rate (kg. water lost per 100 kg. dry matter/hr) drawn by the method of Perry² in the case of fresh prawn are given in Fig. 1. The drying rate remains constant for the first 2 hr and then falls rapidly. Similar curves obtained in the case of sardine and *kilimin* are shown in Fig. 2. It is evident from the curves that the weight loss, drying rate and constant rate period are low in the case of sardine (fat content, 36.1 per cent, dry wt basis) compared to those for *kilimin* (fat content, 2.4 per cent, dry wt basis). This may be attributed to the higher fat content in the former, which retards free vapour movement during the drying process. When there is a higher fat content, the amount of water to be driven off is proportionately less on gross weight basis, giving a lower weight loss and drying rate than with a low-fat material. The corresponding curves for *mullet* (fat content, 14.8 per cent, dry wt basis) and *cullawah* (fat content, 0.8 per cent, dry wt basis) are given in Fig. 3. The differences observed are given attributable to the difference in their fat contents. Data on weight loss and drying rate in the case of cooked prawns dried by the pre-freezing and evaporative freezing techniques are given in Fig. 4. A constant rate period is observed in both the cases, the only difference being that whereas there is a rapid fall in drying rate in the evaporative freezing method in the first few minutes,

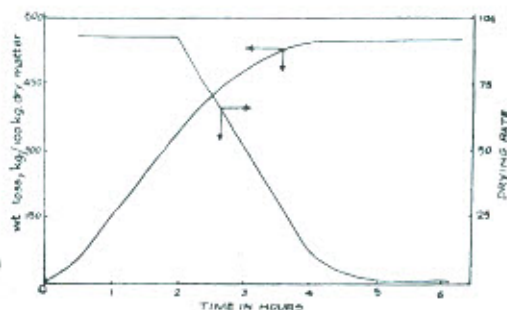


Fig. 1 — Weight loss and drying rate curves for fresh prawns

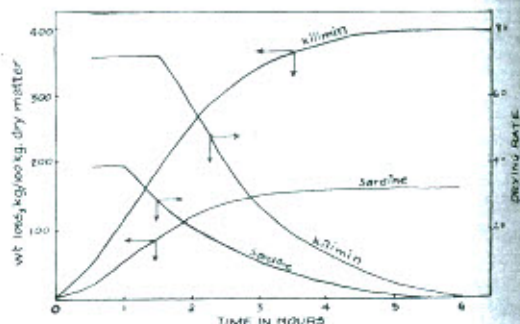


Fig. 2 — Weight loss and drying rate curves for sardine and *kilimin*

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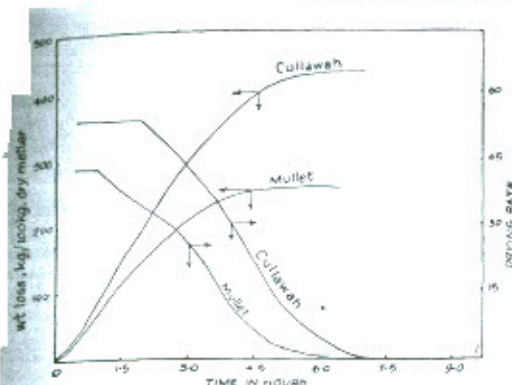


Fig. 3 — Weight loss and drying rate curves for mullet and cullawah

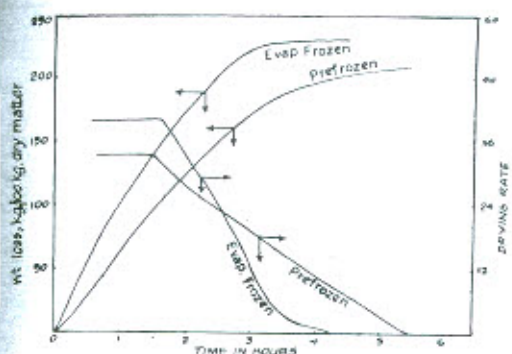


Fig. 4 — Comparison of weight loss and drying rate curves for cooked prawns by prefreezing and evaporative freezing methods

a rapid increase is observed during the same period in pre-frozen material. The results of similar experiments with cooked and flaked *golaree* subjected to freeze drying after pre-freezing and evaporative freezing are given in Fig. 6. Here also the curves follow the same pattern as in the case of cooked prawns.

Reconstitution ratios of some of the freeze dried products were determined³ and the results are given in Table 1. Rehydration ratios are expressed as the percentage of the original water reabsorbed on reconstitution. It is seen from the data that the reconstitution ratio for cooked prawn is 82.5, while that for the corresponding raw prawn is only 63.5. Similarly lean fish rehydrates better than fatty fish, as the latter has a high fat content, retarding water absorption.

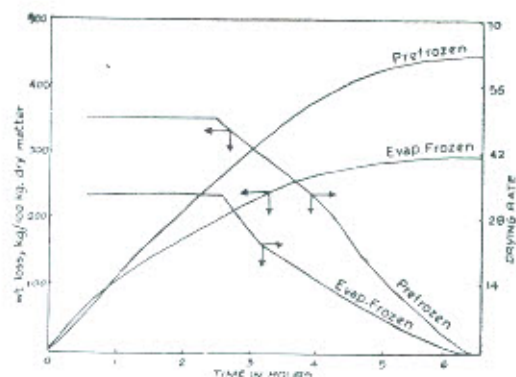

 Fig. 5 — Comparison of weight loss and drying rate curves for cooked *golaree* by prefreezing and evaporative freezing methods

Table 1 — Rehydration ratios of some freeze dried products

Fish	Fat %	Rehydration ratio
Fresh prawns	—	63.5
Cooked prawns (prefrozen)	—	82.5
do (evaporatively frozen)	—	55.7
<i>Kilimin</i>	2.5	76.5
<i>Sardine</i>	32.6	35.0
<i>Cullawah</i>	0.8	68.8
<i>Mullet</i>	14.8	49.6
<i>Golaree</i> cooked (prefrozen)	—	97.6
do (evaporatively frozen)	—	69.2

At the end of the drying cycle, when the vacuum is broken, the fat is in liquid form and tends to flow into the cavities left in the dry tissue from which the water has evaporated. The presence of fat in the fish is therefore disadvantageous at both stages—dehydration and rehydration. Rehydration ratio is higher for pre-frozen material than for evaporatively frozen material because of the liquid phase drying occurring in the initial stages of evaporative freezing. It, therefore, follows that liquid phase dehydration should be avoided as far as possible for getting a product with higher reconstitution properties.

The results of the present study indicate that prawns and lean fish lend themselves well to freeze drying both in fresh and cooked forms, yielding products with good

reconstitution and organoleptic properties. The high fat contents of the fish retard both dehydration and rehydration. The drying rates are characterized by a constant rate period in the beginning, the length of which depends upon the material, followed by a falling rate period. Prefreezing gives a better product than evaporative freezing, having better reconstitution and organoleptic properties.

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Screw Pressing of Ajowan (*Trachyspermum ammi* Linn.) Seeds

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Ordinary oil expellers fail to extract oil from the seeds of *ajowan* (*Trachyspermum ammi* Linn.) due to the slippery nature of the meal obtained. A method is reported in which *ajowan* seeds and groundnut cake are mixed in equal proportions, cooked together and then subjected to the oil expelling treatment in ordinary expellers. The resulting cake is firm enough to allow smooth recovery of the oil. The method is suitable for the recovery of oil from original as well as spent seeds. The oil obtained has the characteristics of the normal *ajowan* seed oil.

IN an earlier paper¹, it was reported that it is not possible to crush *ajowan* (*Trachyspermum ammi* Linn.) seeds in expellers following the methods applicable to other oil seeds owing to the slippery nature of the meal obtained. The present paper reports the development of a method for crushing *ajowan* seed in an expeller giving normal anticipated oil yields.

The method consists in mixing *ajowan* seed and groundnut cake in equal proportions by weight, cooking and crushing the mixture

in a Rosedown Maxoil expeller in the usual manner. Both spent and unspent *ajowan* seeds are amenable to crushing by this method.

Experimental procedure

Spent seed was dehusked, flaked, cooked and crushed. In the case of unspent original seed, the dehushing step was omitted.

The spent seed (moisture content, 5 per cent) was moistened to about 35 per cent moisture