

Time Study for the Commercial Production of Block Frozen Whole Squid/Cuttlefish in 2 kg Pack

A. Ramachandran

School of Industrial Fisheries

Cochin University of Science & Technology

Cochin - 682 016, India

A time study to work out the normal time and standard time required for each element or activity in the commercial production of block frozen whole squid/cuttlefish was undertaken. A standard flow chart was developed to minimize the handling and processing time and to minimize exposure of the raw material to higher temperatures. The important allowances to be considered in calculating the standard time were identified as personal, standing and fatigue and process allowances. Filling, setting in trays, glazing and loading in trolleys were considered as an integrated and inseparable activity and was found to consume 112.20 min as normal time and 128.47 min as standard time for producing one batch of 220 slabs of 2 kg each. The process cycle time was estimated to be 305 min for the production and storage of 220 frozen blocks of whole squid/cuttlefish. Process cycle time could be further reduced by introducing modern freezers with shorter freezing time and by introducing automation at the post freezing stations.

Key words : Squid, cuttlefish, time study, normal time, standard time, process cycle time.

In order to adopt HACCP system in seafood plants, the most important step to be followed is the critical examination of the various activities involved in the production process of a product. Another important step is the elimination of the unwanted activities in order to reduce handling, process time and cost (Anon, 1996). The basic requirement for this is to carry out a work measurement of the process using time study analysis as described by Levin *et al.* (1974) and Keith *et al.* (1983). Without reliable and appropriate time estimates, it would be impossible to improve existing methods or effectively plan new ones. Proper time data are a prerequisite for optimising the entire production process.

It is observed that in fish processing plants in Kerala, the production is being carried out in a manner which requires excess work content and man hours. As fishery products are highly perishable, any delay or excess handling will seriously affect the quality of the fish. Ramachandran (1988) reported wide fluctuations in the process cycle time of frozen seafood products. The study showed that the process cycle time varied with very high standard deviation. This was mainly due to lack of standardization of processing methods. Wide variations in the freezing time and freezer temperature during freezing of frozen products were reported by Ramachandran *et al.* (1992). Freezing for a longer period than the required normal

time will dehydrate the product, in addition to consuming more energy and process time. The excess work content in fish processing plants were observed to be due to lack of standardization of processing methods, resulting in fluctuations in the production process, inefficient method of production due to the use of wrong production facilities, wrong layout causing wasted movements etc. (Ramachandran, 1988). Only very few studies have been reported on these aspects.

Ramachandran (1990) has reported a time study for the production of frozen blocks of headless shrimp. The aim of this investigation is to standardize the production process in the processing plants in Kerala for frozen squid/cuttlefish blocks by eliminating excess work and handling.

Materials and Methods

Fifteen plants were initially selected for the time study by stratified random sampling from three production centres in Kerala (Cochin, Quilon and Calicut). Primary data on the production of frozen blocks of squid and cuttlefish were collected from these plants. Observations were made on the processing and sequence of operations for the production of frozen squid and cuttlefish to identify the best factory and qualified workers for carrying out the time study. From the analysis of the flow patterns and sequence of production of these products, it was found that the method of production and sequence of operations were the same for both. Hence work study for both the products were combined. From these observations and the flow charts, unwanted activities were

eliminated and the sequence standardised to have minimum process cycle time. Subsequently, the flow chart for the standardised production method was prepared and time study carried out using this flow chart (Fig. 1).

The common species of squid (*Loligo duvauceli*) and cuttlefish (*Sepia pharaonis*) were used for the study. Time study was carried out by the method described by Levin *et al.*, (1974). The entire process was broken down into divisible activities (elements) as shown in Table 1. The measurements were taken for each activity to the required number of cycles with 95% confidence level and confidence limits (precision) of $\pm 5\%$ using the following formula (Mayer, 1975).

$$N^1 = \left[\frac{40 N}{\Sigma X} \sqrt{\frac{\Sigma X^2 - (\Sigma X)^2 / N}{N-1}} \right]^2$$

Where N^1 = Number of readings required for the stated confidence

X = Activity (element) reading (measurement) of time

ΣX = Sum of activity (element) readings

N = Number of readings actually taken

Results and Discussion

Following types of allowances were found to be required for computing the standard time. Personal allowance, standing and fatigue allowance and process and other allowances. This was based on the special nature of the processing conditions at different stages of processing as observed in the selected seafood plants. The percentage of allowances varied depending on the nature of the activity and is shown in Table 1. The allowances were estimated as per the procedure described by Mayer (1975).

Table 1. Normal time, number of workers involved, turnover quantity and standard time for processing of 220 slabs of frozen whole cuttlefish/whole squid

Act No.	Name of the activity	Turn-over Qty.	Normal time (Min.)	Personal allowance		Standing & fatigue allowances		Process & other allowances		Std. time (Min.)	No. of workers
				%	Time (Min)	%	Time (Min)	%	Time (Min)		
1.	Raw material transportation from the chill room to washing site	500 Kg.	23.35	2	0.467	3	0.701	2	0.467	24.99	2 M
2.	Washing & cleaning	"	38.86	5	1.943	10.0	3.886	17	6.606	51.30	1 F
3.	Grading	"	28.20	5	1.410	10.0	2.820	17	4.794	37.22	4 F
4.	Rechecking draining	"	18.80	5	0.940	10.0	1.880	17	3.196	24.82	1 F
5.	Weighing	220 slabs	28.16	15	4.224	15.0	4.224	30	8.450	45.06	1 F
6.	Coding	"	28.16	15	4.224	15.0	4.224	30	8.450	45.06	1 F
7.	Filling, setting in trays glazing and loading in trolleys	"	112.20	2	2.244	2.5	2.805	10	11.220	128.47	2 F
8.	Transporting the material to the freezer	"	2.81	2	0.056	2.5	0.070	-	-	2.94	1 M
9.	Loading into the freezer	"	5.19	10	0.519	30.0	1.557	40	2.076	9.34	1 M
10.	Freezing	"	180.00*/90.00	-	-	-	-	16.5	29.700/14.850	209.70/104.85	-
11.	Unloading	"	13.00	10	1.300	10.0	1.300	35.0	4.550	20.15	**
12.	Master cartoning	22 M. C	18.48	10	1.850	10.0	1.850	35.0	6.468	28.64	1 M
13.	Sealing of master carton	"	25.12	5	1.254	5.0	1.254	25.0	6.270	33.86	2 M
14.	Storing	"	28.95	5	1.450	5.0	1.450	20.0	5.790	37.64	1 M

* Freezing time depends on the type of freezers used;

** For unloading the frozen blocks the same worker who is engaged for loading into the freezer is used.
M - Male, F - Female

The process cycle time for the production of 220 slabs were worked out based on the standard time required to complete the preceding activity in sufficient quantity to start a particular activity and so on, till the final or end activity was completed. For this study, a batch of 220 slabs of 2 kg each was selected for the reason that majority of the freezers available in the plants studied have this capacity per load. The quantity at each work station and the standard time consumed

for completing that much quantity are given against the respective activities in Table 1.

Analysis of the flow charts of the production of block frozen squid and cuttlefish in the 15 selected factories showed that these varied widely even though the basic method of processing was the same. The main observation was that in 66.7% of the factories studied, the raw materials were temporarily kept in the processing hall

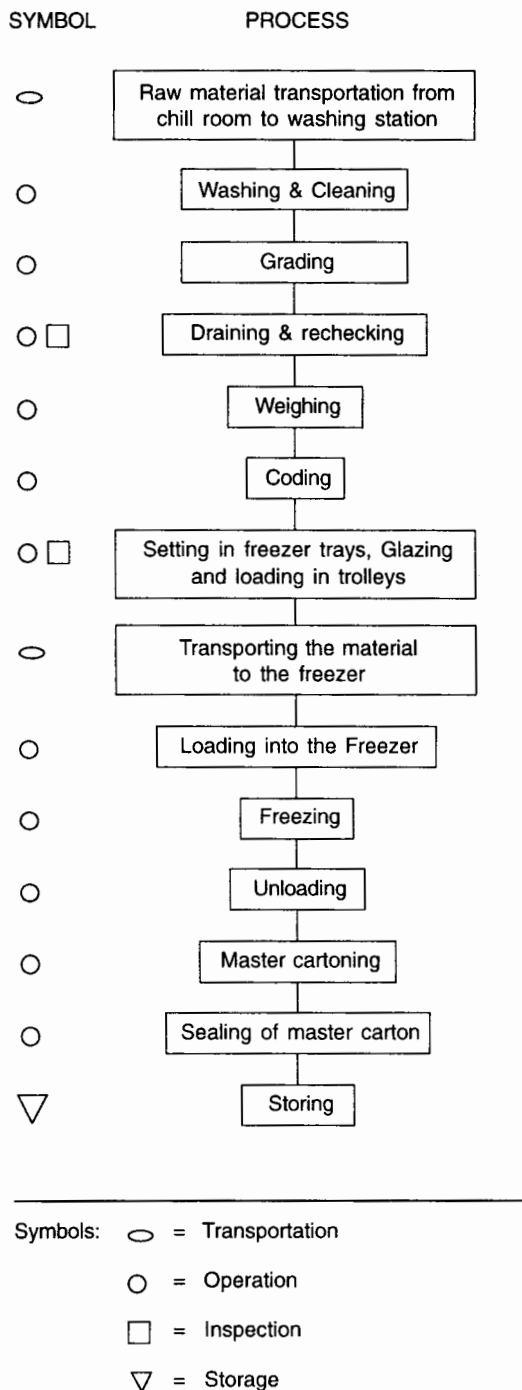


Fig. 1. Flow chart for the production of frozen whole squid/cuttle fish

itself instead of in the chill room. This practice may contaminate the in-process material. This is against the HACCP concept and European Commission Directive (EEC, 1991). 33.3% of the factories were found to skip the rechecking activity after the grading process. 26.7% of the factories did not use duplex carton while setting the material in the freezer trays. Instead, the material was frozen in polythene packs and after freezing, they were packed in duplex cartons. This led to the exposure of the frozen blocks to higher temperature during duplex cartoning. Freezing for more than the stipulated time was noticed in some plants with defective cooling systems (Ramachandran *et al.*, 1992).

The standardized flow chart is given in Fig. 1. The flow chart has been standardized with the objective of reducing the handling time of the product, especially at higher temperature to prevent spoilage and discoloration. Handling was also kept at minimum to reduce chances of contamination. As far as squid and cuttlefish processing is concerned, the pre-processing stage is very important as improper handling will result in discoloration of the material. Storing the material in chilled room is recommended instead of storing the material in the processing hall, as observed in some factories. The standard flow chart stipulates rechecking of the quality of the materials and grades after the grading activity. This is a Critical Control Point. This is not being done in some factories. Similarly the setting of materials without duplex cartons in freezer trays is recommended. This will help reduce production cost by Rs. 2.50 to 3.50 per 2 kg pack and

Table 2. Preceding activity and cumulative process time for production of frozen block of squid/cuttlefish

Activity No.	Activity	Preceding Activity	Quantity turned over	Standard time (min.)	Cumulative time (min.)
1.	Transportation from chill room to washing station	-	100 Kg.	4.998	4.998
2.	Washing & cleaning	1	25 Kg.	2.565	7.763
3.	Grading	2	25 Kg.	1.861	10.328
4.	Draining & rechecking	3	25 Kg.	1.241	12.893
5.	Weighing	4	11 slabs	2.253	15.458
6.	Coding	5	11 slabs	2.253	18.023
7.	Setting in freezer trays & loading in trolleys	6	220 slabs	128.480	146.503
8.	Transporting the material to the freezer	7	220 slabs	2.940	149.443
9.	Loading freezer	8	220 slabs	9.340	158.783
10.	Freezing	9	220 slabs	104.850	263.633
11.	Unloading	10	12 slabs	1.099	264.732
12.	Master cartoning	11	10 slabs	1.302	266.034
13.	Sealing of master cartons	12	10 slabs	1.539	267.573
14.	Storing	13	220 slabs	37.640	305.213

reduce processing time. But if the buyers stipulate duplex packing, it may be used at this stage. The duplex cartoning after freezing, as practised in some factories, is eliminated in the standard procedure.

Table 1 gives a detailed account of the time study of all the activities involved in the production of frozen blocks of whole squid and cuttlefish in 2 kg pack. The table gives the average normal time required for various activities in the actual commercial production situation in Kerala. It also gives the allowances required for different activities and the standard time worked out for these activities for producing 220 frozen slabs of 2 kg each of whole squid/cuttlefish. The single longest activity

was found to be the setting in freezer trays, glazing and loading in trolleys. This activity consumed 128.48 min for producing 220 slabs.

Freezing is the longest single batch activity in the production process. Since it is a batch activity the entire material required for loading into the freezer, i.e. all the 220 slabs must be ready before this activity is initiated. This leads to over exposure of the material set in freezer trays in the beginning to higher temperature before it is loaded into the freezer. Hence proper temperature control at activity number 7 is very important and critical. The average normal time for freezing observed in the factories studied was 90 min, but due to the inefficiencies of the freezers in some of the plants, a

process allowance of 16.5 min was recommended to work out the standard time of freezing. This was to guarantee that the core temperature of -40°C was attained for all slabs produced in all the freezers studied. The standard time for freezing was worked out to be 104.9 min whereas the manufacturer's specification was 90 min. This was necessary to reduce the risk of under freezing the material in the normal production process. This allowance could be reduced if the old freezing systems in the seafood plants in Kerala were replaced with new efficient ones.

An automatic sealing machine is suggested for sealing the master carton as it was found to reduce sealing time considerably. In the case of manual sealing the average normal time noticed was 1.14 min per carton whereas in the sealing machine installed in one of the factories, it was found that the time could be reduced to 0.25 min. The machine was also found to replace a worker with an operational cost saving of Rs. 3454/- per annum (Ramachandran, 1988). In some instances the frozen blocks were found to deform in shape due to thawing when master cartoning and sealing operations were delayed. Storing of products packed in master cartons is to be carried out as quickly as possible to prevent exposure of the frozen products to higher temperature. With the existing facilities in the factories in Kerala, the average normal time required for storing 22 cartons in appropriate places in the store and to complete storing formalities was found to be 28.95 min. Continuous storing of the sealed master cartons through conveyors and mini door provided in the cold store is

recommended to prevent exposure of the frozen material to higher temperature and to reduce frequent opening of the cold store door. This will also reduce process cycle time.

Table 2 shows the preceding activities and the cumulative process time required for processing 220 slabs of frozen whole squid/cuttle fish. The process cycle time was worked out to be 305 min. This was calculated based on the precedence rule suggested by Srinath (1975). In this study, transporting of 100 kg of the raw material (Activity No. 1) to the washing site (Activity No. 2) is considered as the preceding activity of activity 2 and so on. It is assumed that the production at all work stations is continuous and is carried out at the same pace as is used for estimating normal time and standard time. The cycle time could be further reduced by introducing modern freezers with shorter freezing time and by introducing automated master carton sealing system.

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