Bull. Fish. Res. Stn., Sri Lanka, Vol. 30, 1980, pp. 63-74.

Keeping Quality of Imported Dried Fish

By

I. S. R. GOONEWARDENE* and S. ETOH*

Introduction

From 80% to 90% of the dried fish consumed in Sri Lanka is imported and, until recently, the Co-operative Wholesale Establishment (C.W.E.), a state-owned enterprise, was the sole importer. On arrival at the Colombo Port the dried fish is transported by road to the C.W.E. Stores at Welisara. There, each bundle is inspected for quality visually, and depending on the moisture content, texture, presence of bacterial pinking, mould growth, etc., the inspector imposes a quality cut.

A series of experiments were carried out to determine (1) whether objective tests could be used to back up the visual inspection system currently used at the C.W.E. store, (2) whether the imported fish meets the proposed Sri Lankan standards, (3) the shelf life of imported dried fish, and (4) whether the storage life of low quality dried fish can be extended by redrying.

Materials and Methods

Fish Samples

The samples of dried fish listed in Table 1 were taken from the C.W.E. Stores on 1.6.78. The quality cut imposed on samples is also shown in Table 1.

The dried fish were produced in Pakistan and shipped to Sri Lanka in two consignments. The first was unloaded at the Colombo wharf on 3.5.78 and arrived at the C.W.E. Stores on 10.5.78, and the second consignment was unloaded on 22.5.78 and arrived at the stores on 23.5.78.

Redrying

Samples were redried in a mechanical kiln at 45° C for 6 hrs.

Storage

Samples were packed in hessian bags, stiched up and stored at ambient temperatures (28–30° C).

Sensory inspection of Quality

The texture and moisture content were assessed by touch and the extent of bacterial pinking and mould attack were recorded. The degree of insect infestation was assessed and in some samples the weight loss was determined. The odour of the samples was also noted.

Salt content

Salt was determined as chloride where the ions are precipitated by silver nitrate and the excess silver ions are determined by titration with potassium thiocyanate (Pearson, 1970). All analyses were performed in duplicate.

*Institute of Fish Technology, Crow Island, Mattakuliya, Colombo 15.

6—A 50175 (80/00)

Miosture content

Duplicate samples (2g) were dried in a convection oven at 105° C/24 h. The weight loss was taken as due to evaporation of water.

Bacteriological analysis

A sample weighing about 10g was chopped aseptically into small pieces and weighed into a sterile blender jar (MSE homogeniser). After the addition of 90 ml sterile saline water (9g sodium chloride and 1g. peptone per 1,000ml), the contents were homogenised for 2 minutes. Sampling was carried out either in triplicate or in duplicate for each species of fish.

(*a*) *Total counts.*—These were made according to standard procedure of serial decimal dilution where diluted aliquots (1ml) were mixed with molten Plate Count Agar (Difco). The plates were incubated at 30° C/72 h.

(*b*) *Coliform counts.*—These were carried out by inoculating in triplicate, tubes of MacConkey Broth with diluted aliquots (1ml) and incubating at 37° C/48 h. The production of acid and gas at 37° C in MacConkey Broth was considered as positive for Coliforms. Enumeration of Coliforms was by the Most Probable Number (MPN) method.

Results

The salt content of the dried fish samples is shown in Table 1. For each fish species the samples on which a quality cut was imposed had a lower salt content than those without a quality cut.

Table 2 gives the proposed Ceylon standard for dried fish (PCSFDF). With the exception of Sprats, which were dried unsalted, the salt content meets the specifications of the standard.

Table 3 and 4 give the moisture content of the various samples before and after redrying and/or storage together with the shelf life. The moisture content of salted dried fish with a quality cut (WQC) was always greater than that without quality cut (WOQC). Comparison with the PCSFDF shows that all the imported dried fish examined except sprats exceeded the stipulated maximum moisture content. Even after redrying, only two samples, viz., Leatherskin (WOQC) and Yellow Fin Tuna (WOQC) met the requirements of the standard.

With the exception of Shark fillets (WQC) the loss in moisture content during redrying was quite small. Although all redried samples took up moisture again on storage, there was wide variation. The moisture content of the non-redried fish on the other hand showed much smaller changes during storage.

The redried fish except shark (WQC) and Leatherskin (WOQC) had a longer storage life than untreated samples. On an average the shelf life of the dried fish samples was prolonged by about 12 days on redrying.

Table 5 gives the total plate count (TPC) of dried fish and redried fish at the beginning of the storage period. The results are very variable and it is impossible to draw any firm conclusion.

Table 6 gives a visual assessment of microbial spoilage at end of storage. It may be seen that all samples including those that have been redried show bacterial pinking and/or mould growth at the end of their storage life.

Table 7 shows which of the samples conform with Coliform specifications in the (PCSFDF) All samples on which a quality cut was imposed conform to standard whereas only two of the samples without quality cut do conform to the standard.

Table 8 shows the weight loss in unsalted dried Sprats during storage. This weight loss is mainly due to insect infestation.

DISCUSSION

The subjective inspection system presently used at the C.W.E. Stores has been shown to be reasonably accurate for distinguishing between acceptable and low quality fish. (However none of the samples studied meets the PCSFDF standard in all respects).

All fish for which a quality cut had been imposed had higher moisture and lower salt content than similar samples with no quality cut. This shows that salt contributed to protecting dried fish from fungal and bacterial growth. But generally the salt content of imported salted dried fish appeared to be moderate although the Standard of the exporting countries Pakistan and India, prescribes a much higher salt content with a minimum of 25%.

Mould and bacterial growth depend on water activity, which is a measure of the free or available water in a food. This water is thus free either to react chemically or, in spoilage, to support the growth of micro-organisms. The water activity of pure water is assigned a value of 1, and the water activity in a food is expressed as a fraction relative to that of pure water. Most spoilage bacteria will cease to grow in a food whose water activity is below 0.9, the growth of moulds is inhibited below 0.8 and halophilic, that is salt-loving bacteria, do not grow below 0.75. The water activity of a foodstuff can be lowered by addition of common salt, (Sodium Chloride) and by dehydration. Therefore for maintaining the quality of dried fish it is obviously more economical to import dried fish with less salt, as long as there is enough salt to keep the water activity of the cured product sufficiently low to inhibit bacterial and mould growth. When purchasing heavily salted fish the consumer is perhaps paying much for salt rather than for fish protein e.g., Rs. 6.50 per lb. for imported salted Leatherskin fish as against Rs. 0.38 per lb. for local washed salt.

With the exception of shark fillets WQC (21%) the loss in moisture content during redrying was quite small (4.9–11.4%) cf. Table 4. This shows that the reduction in moisture content is probably dependent on species, style of dressing and initial mosture content. For example, the moisture content of filleted dried fish was reduced to a greater extent than other styles such as round, dressed and semidressed (gills and gut removed).

From Fig. 1 and Table 3 it is clear that the moisture content of imported dried fish seems to be almost constant or even decreases slightly with storage time. This shows that the dried fish in the C.W.E. stores had reached saturation point (40–50%). It also indicates that when the shipment was unloaded the dried fish had already reached saturation point, and had moisture content even higher than this level. Therefore it is possible that the imported fish had (*a*) not been processed properly in the exporting country, (*b*) absorbed moisture during storage in the country of origin, (*c*) absorbed moisture during transport by sea, and (*d*) absorbed moisture during storage at the wharf in Colombo Port. Hence the uptake of moisture is perhaps not likely to have occurred in the C.W.E. store.

The storage conditions inside the C.W.E. store from 22nd to 28th June, 1978, are :

Relative humidity	..	64%–80%
Temperature	..	26.6° C–34.4° C

The atmospheric conditions in Colombo during this period were :

Relative humidity	..	78%–88%
Temperature	..	25.2° C–29.6° C

Table 3 shows there is little water intake in non-redried fish during storage, especially in that with quality cut. But there is considerable water intake in the redried fish (Table 4). Also the mositure content of redried fish when discarded at the end of experiments is equal to or higher than that of non-redried fish. This shows that redrying alone is not very effective in wet zone areas such as Colombo with too high relative humidity.

It may be observed, as indicated in Tables 3 and 4, that generally redried fish have a longer storage life than untreated fish except in the case of non-redried Leatherskin WOQC. Also in the case of shark fillets WQC the storage life of redried and non-redried fish was found to be the same (63 days). The shelf life of Mackerel Tuna WQC has been greatly improved by redrying (storage life increased by 38 days). But on an average the shelf life of dried fish has been prolonged only by about 12 days on redrying. Therefore redrying of fish at 45°C for 6 hrs is not economical. However this process is quite effective for small fish which are packeted in polythene or similar material after redrying (Etoh and Goonewardene, 1980). This is therefore one of the possible ways of prolonging Storage shelf life of dried fish.

The moisture content of unsalted dried Sprats hardly changes during 50 days of storage (Fig.1). This is probably due to loss in weight by insect attack, as gradually the flesh is devoured by the beetles leaving only the bony parts which contain less moisture.

From Tables 2 and 5 it is clear that generally dried fish with quality cut meet requirements of the proposed standard for total bacterial counts when microbiological testing was carried out However, dried fish without quality cut except shark fillets do not meet the requirements of the standard

Hence the sensory inspection of quality carried out at the C.W.E. Stores does not conform to microbiological specifications in the PCSFDF. However the medium used for total counts in this experiment was Plate Count Agar without any salt added while the PCSFDF specifies Zobell's sea-water medium for total counts. The latter medium has about 3% salt, while the former had none. But as Zobell's medium does not have a high percentage of salt and also as saline water was used for making up dilution solutions of samples, the counts on both media should not be very different.

There seems to be a general tendency for the total plate count of untreated dried fish (non-redried) to increase slightly with storage time and that of redried fish to decrease slightly with storage time (Figs. 6 and 7). The TPC of unsalted dried Sprat increases consistently with storage time. The accuracy of dried Sprat analysis in comparison with that of other species of fish analysed seems to be due to the fact that uniform sampling is possible in sprats unlike other large species of fish.

The visual assessment of microbial spoilage at end of storage life (Table 6) indicate that all samples including those that have been redried show bacterial pinking and/or mould growth at the end of their storage life. Also in the case of non-redried fish the spoilage pattern is clearly represented by either white fungal or pink bacterial attack and not due to both. This shows that pink bacteria and white fungi are generally found growing alternately and very rarely grow together in the same fish. This feature may be supported by the fact that moulds and bacteria have different water activities for growth. Also experimental results have shown that the pattern of spoilage caused by these micro-organisms largely depends on the species of fish and perhaps the country of origin.

The tissue of dried fish contaminated by white fungus was hard while those affected by red bacteria had the tissue soft and slimy or moist. This means that low quality dry fish contaminated by white fungus will be much easier to upgrade in quality by redrying and packing than that with red bacteria.

As seen in Table 7 all samples on which a quality cut was imposed conform to standard for Coliforms whereas only two of the samples without quality cut do conform to the standard. Therefore at the outset it seems as though visual inspection at the C.W.E. Stores cannot be endorsed by microbiological analysis. But sampling for Coliforms was not done on the day of grading at the C.W.E.; also Coliform counts seemed to increase with storage time. Hence samples without quality cut too may have met requirements of standard if sampled earlier.

But the results of total plate counts and Coliform counts carried out in this study were inconclusive and it is doubtful whether such analyses are worthwhile in assessing the quality of salted dried fish.

Also it must be noted that in salted dried fish the halophilic (or salt-loving) micro-organisms contribute to most spoilage. Hence it is necessary to bring down the occurrence of halophiles to ensure reduced spoilage. Perhaps a halophilic count will be more significant rather than a total bacterial count in the proposed standard which at present has no provision for a halophilic count.

Salted dried fish such as Leatherskin and Catfish are only slightly infested by beetles (*Dermestes spp.*). But infestation in unsalted Sprats is considerable, so much so that after two months only the bony skeletons were left (Table 8). Large quantities of Sprats are imported each year, e.g., 1955 tons Sprats in 1977. Hence it is necessary to take preventive measures to reduce protein loss in dried fish by insect infestation.

Sachithananthan (1976) found the mineral ash content of Sprats with a moisture content of 32.5% is 18.4%. Using this as the base for calculation it was noted that after 50 days of storage the meat left on dried Sprat is a mere 6.6g. (amount of meat at the beginning is 153.6g.). This is only 12.5% of the 53g. of Sprat left after 50 days of storage ; unsalted Sprats are very quickly attacked by insects and turned into skeleton within 2 months.

The method of calculation is given below :

When moisture content 32.5% Ash contetn = 18.4%

$\therefore$ Moisture content 15.4% Ash content = 23.1%

(When 15.4% is the moisture content of Sprat, Ash in 200g = 46.4 g. and meat = 153.6g.).

Ash in 53g. (after 50 days of storage) = 46.4g.

$\therefore$ Meat remaining in 53g. = 53 — 46.4 = 6.6g.

$$\text{Percentage of meat left} = \frac{6.6 \times 100}{53} = 12.5\%$$

SUMMARY

All imported salted, dried fish samples tested had a salt content below 30% and above 12% and hence met requirements of the proposed standard. Also samples without quality cut tested had a greater salt content than that with quality cut. This indicates that salt contributes to protecting dried fish and hence may be endorsed by sensory evaluation to a certain extent.

Samples with quality cut had more moisture than that without quality cut. But all samples with and without quality cut had a moisture content greater than 35% which is the maximum moisture content for such species specified in the Standard and hence did not meet requirements of proposed standard for moisture.

Microbiological testing for total counts and Coliform contents too showed that good quality dried fish had counts greater than that specified in the standard. For instance dried fish with quality cut tested met requirements for total counts and Coliform counts but that without quality cut did not, showing that sensory evaluation cannot be endorsed by instrumental analysis.

The different species of fish tested had varying lengths of shelf life. But on an average the shelf life of dried fish could be prolonged for about 12 days by redrying at 45°C for 6 hours, i.e., redrying at these temperatures without subsequent packing in polythene bags may not be practical for prolonging the storage life of salted/dried fish.

ACKNOWLEDGEMENTS

The authors are grateful to Mrs. D. V. Perera (nee de Alwis) who participated in the early phases of this experiment, and to the Manager and staff of C.W.E. Stores, Welisara, for providing samples and all necessary information, and to Mr. B. Samaradivakara, Misses C. Jayasinghe and R. Vithanage for technical assistance.

REFERENCES

BAROSS, J. A. (1976)
Halophilic Micro-organisms, In "*Compendium of Methods for the microbiological examination of foods*", (Ed. Marvin L.Speck.) Chapter 12, pp. 194-201.

ETOH, S. and GOONEWARDENE, I.S.R. (1980)
Increase of storage shelf life of locally produced salted dried fish by redrying and/or packeting. *Bull. Fish. Res. Stn., Sri Lanka, Vol 30, pp.* 75–79,1980.

MUNRO, I. S. R. (1955)
The Marine and Fresh water fishes of Ceylon. Department of External Affairs, Canberra.

PEARSON, D. (1970)
The Chemical analysis of foods. 6th edition, Churchill, London, p. 540.

Proposed Ceylon Standard; for Dried Fish (1970). (*Unpublished*)

SACHITHANANTHAN, K. (1976)
Dried fish trade in Sri Lanka. FAO publication (F II : CP/76/5). Rome.

THATCHER, F. S. AND CLARK, D. S. (1968)
Micro-organisms in Foods : I. Their significance and methods of enumeration. University of Toronto Press, Toronto. pp. 74-76.

WATERMAN, J. J. (1976)
Production of dried fish. FAO Fisheries Technical Paper, No. 160. Rome.

Symbols used in the Graphs

T	=	Tuna
M	=	Magara (Shark fillet).
K	=	Katta (Leatherskin).
C	=	Catfish
S	=	Sprats
D	=	Redried samples
W	=	Dried samples (as brought from Welisara) i.e., Not redried.
Suffix A	=	Fish without quality cut.
Suffix B	=	Fish with quality cut.
W.Q.C.	=	With quality cut.
W.O.Q.C.	=	Without quality cut.
e.g. T_A W	=	Tuna, without quality cut, non-redried.

TABLE 1

SPECIES OF FISH USED IN EXPERIMENT AND THEIR SALT CONTENTS

	Scientific Name	Common Name		Quality	% Salt
		English	*Sinhalese*	*Cut*	*(Dry basis)*
1.	*Chorinemus Lysan*	Leatherskin	Kattava	0%	21.9
				15%	18.1
2.	*Carcharhinus* spp.	Large shark Fillets	Mora	0%	20.6
	Scoliodon spp.	Small shark Fillets	Kirimora	10%	16.7
3.	*Thunnus macropterus*	Yellow fin Tuna	Kelawalla	0%	20.3
4.	*Euthynnus affinis*	Mackerel Tuna	Atavalla	15%	19.0
5.	*Anchoviella* spp.	Sprats	Halmassa	0%	2.0
6.	*Tachysurus* spp.	Catfish	Anguluwa	20%	16.1

TABLE 2

PROPOSED CEYLON STANDARD FOR DRIED FISH

Group	*Description*	*Moistute (%) Maximum*	*Salt (% dry basis)*		*TPC (per g.)*	*Coliform Count*
			Minimum	*Maximum*		
A	Large fish (> 15 cm)	35	12	30	10,000	Less than 10/g
B	Medium fish (7 to 15 cm)	30	10	30	50,000	Less than 10/g
C	Small fish (< 7 cm)	20	4	16	100,000	Less than 10/g

TPC = Total plate count

TABLE 3

CHANGE IN MOISTURE CONTENT DURING STORAGE AND SHELF LIFE OF DRIED FISH

Sample	*Moisture content (%)*			*Shelf life (days)*
	Initial	*Final*	*Moisture*	
Shark WOQC	49.3	51.7	2.4	36
Shark WQC	52.5	47.8	−4.7	63
Leatherskin WOQC	33.4	40.9	7.5	50
Leatherskin WQC	47.1	48.8	1.7	50
Yellow Fin Tuna WOQC	39.4	40.5	1.1	50
Mackerel Tuna WQC	49.0	45.7	−3.3	36
Catfish WQC	48.4	50.4	1.6	36
Average	45.6	46.5	0.9	45.9

WOQC = Without quality cut.
WQC = With quality cut.

TABLE 4

CHANGE IN MOISTURE CONTENT DURING RE-DRYING AND STORAGE AND SHELF LIFE OF DRIED FISH

Sample	Moisture content %			*Shelf life (days)*
	Before drying	*After drying*	*After storage*	
Shark WOQC	49.3	39.3(−10.0)	39.6 (0.3)	47
Shark WQC	52.5	31.5(−21.0)	47.0 (15.5)	63
Leatherskin WOQC	33.4	27.9*(−5.5)	44.3 (16.4)	47
Leatherskin WQC	47.1	40.4 (−6.7)	48.4 (8.0)	63
Yellow Fin Tuna WOQC	39.4	28.0*(−11.4)	49.7 (21.7)	63
Mackerel Tuna WQC	49.0	44.1 (−4.9)	50.0 (5.9)	74
Catfish WQC	48.4	43.1 (−5.3)	52.9 (9.8)	47
Average	45.6	36.3 (−9.3)	47.4 (11.1)	57.7

Figures in brackets indicate changes in moisture content.
* Conforms to proposed Ceylon Standard.

TABLE 5

TOTAL PLATE COUNT OF DRIED FISH AT THE BEGINNING OF STORAGE

Sample	*Fish without quality cut*		*Fish with quality cut*	
	Non-redried	*Redried*	*Non-redried*	*Redried*
Shark fillet	8,366*	230,000	1,617*	7,600*
Leatherskin	93,967	1,733*	1,617*	3,917*
Yellow Fin Tuna	145,500	52,667	—	—
Sprats	53,965	—	—	—
Mackerel Tuna	—	—	913*	14,600
Catfish	—	—	2,217*	117,400

* Confirms to proposed Ceylon Standard.

TABLE 6

VISUAL ASSESSMENT OF MICROBIAL SPOILAGE AT END OF STORAGE LIFE

Sample	*Non-redried fish*		*Redried fish*	
	WOQC	*WQC*	*WOQC*	*WQC*
Shark	P	P	P+M	M
Leatherskin	P	P	P	P
Yellow Fin Tuna	M	—	P+M	—
Mackerel Tuna	—	M	—	M
Catfish	—	P	—	P

P = Pink bacteria

M = Moulds

WOQC = Without quality cut.

WQC = With quality cut.

TABLE 7

SAMPLES WHICH MEET COLIFORM SPECIFICATION IN PROPOSED STANDARD

Species	*Non-redried*		*Redried*	
	WOQC	*WQC*	*WOQC*	*WQC*
Shark fillet	X	O	X	O
Leatherskin	O	O	O	O
Yellow Fin Tuna	X	—	X	—
Mackerel Tuna	—	O	—	O
Catfish	—	O	—	O
Sprats	X	—	—	—

O = Conforms to standard (i.e. <10 coliforms/g)

X = Does not conform to standard

WOQC = Without quality cut

WQC = With quality cut

TABLE 8

WEIGHT LOSS IN UNSALTED DRIED SPRATS DURING STORAGE

Storage Period (days)	4	21	36	50
Weight of Sprats (g)	200.0	160.0	92.8	53.0
Weight loss (g)	0	40.0	107.2	147.0
%	0	20.0	53.6	73.5

7—A 50175 (80/06)

Fig. 1: CHANGE IN MOISTURE CONTENT OF DRY FISH

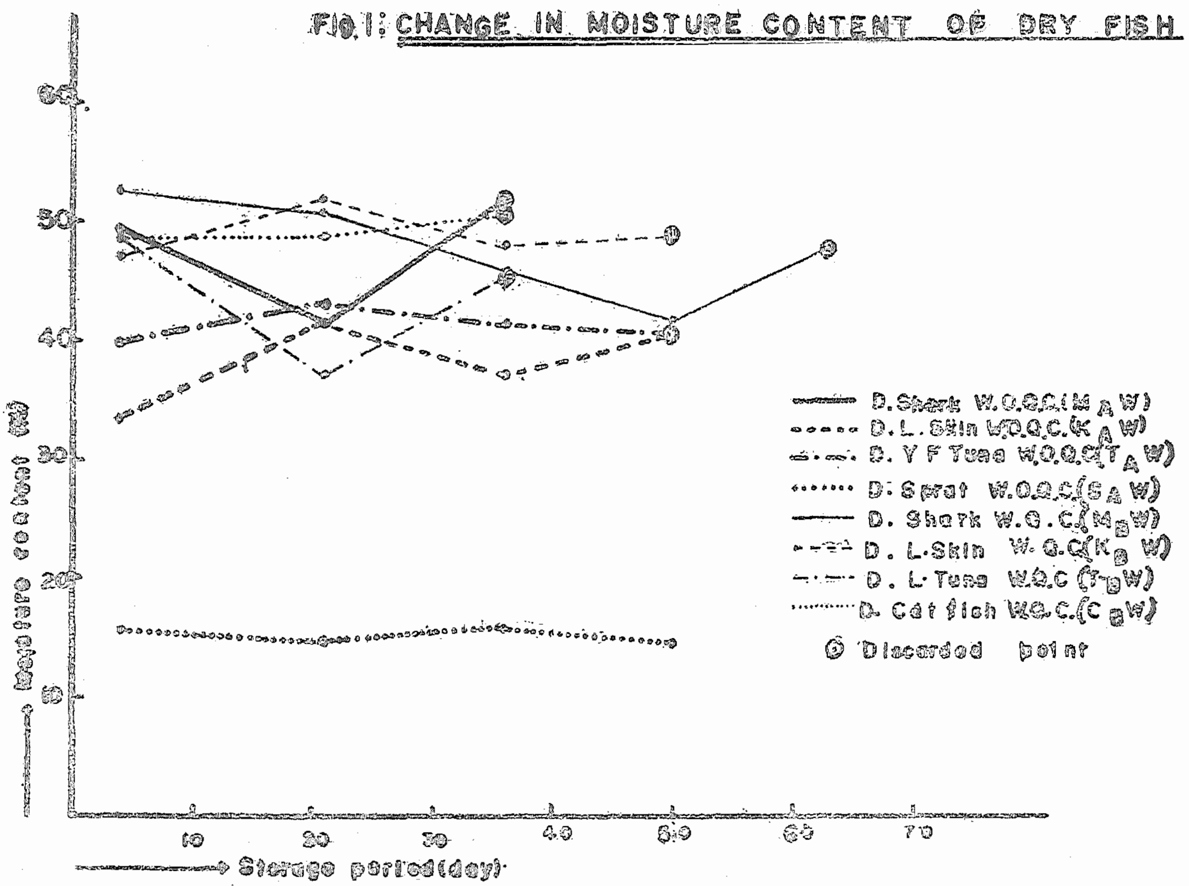
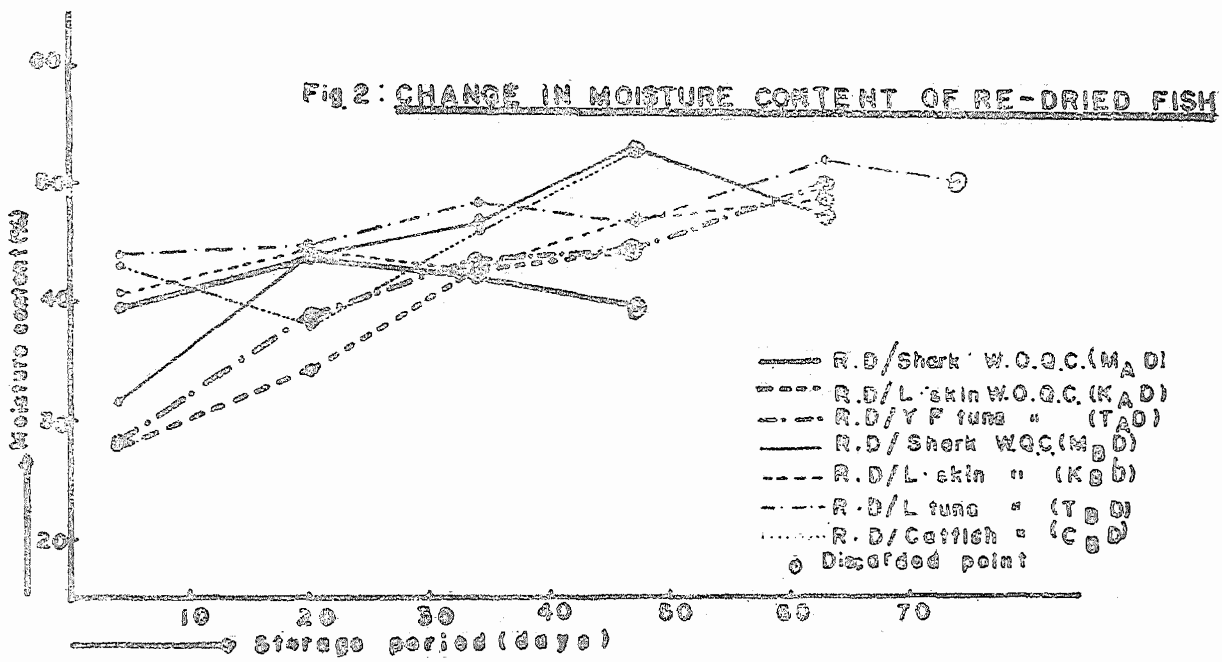


Fig 2: CHANGE IN MOISTURE CONTENT OF RE-DRIED FISH



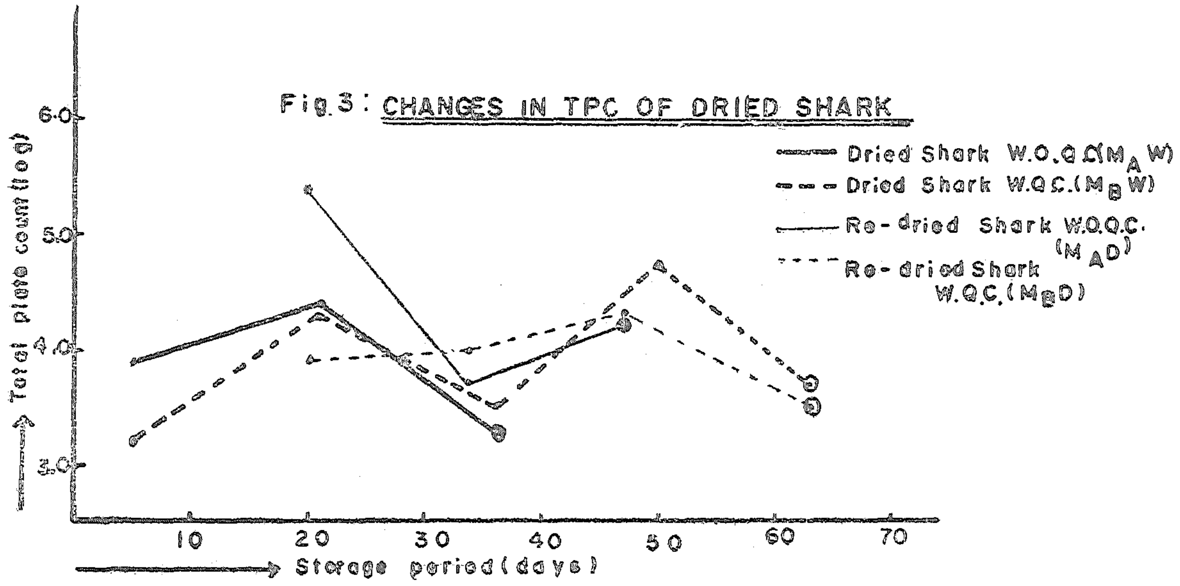


Fig.3: CHANGES IN TPC OF DRIED SHARK

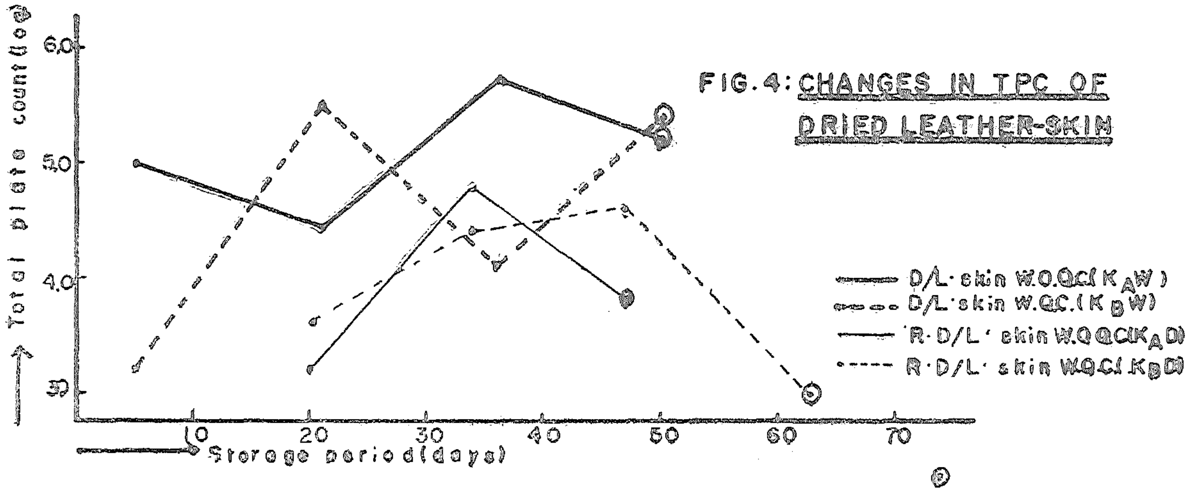


FIG.4: CHANGES IN TPC OF DRIED LEATHER-SKIN

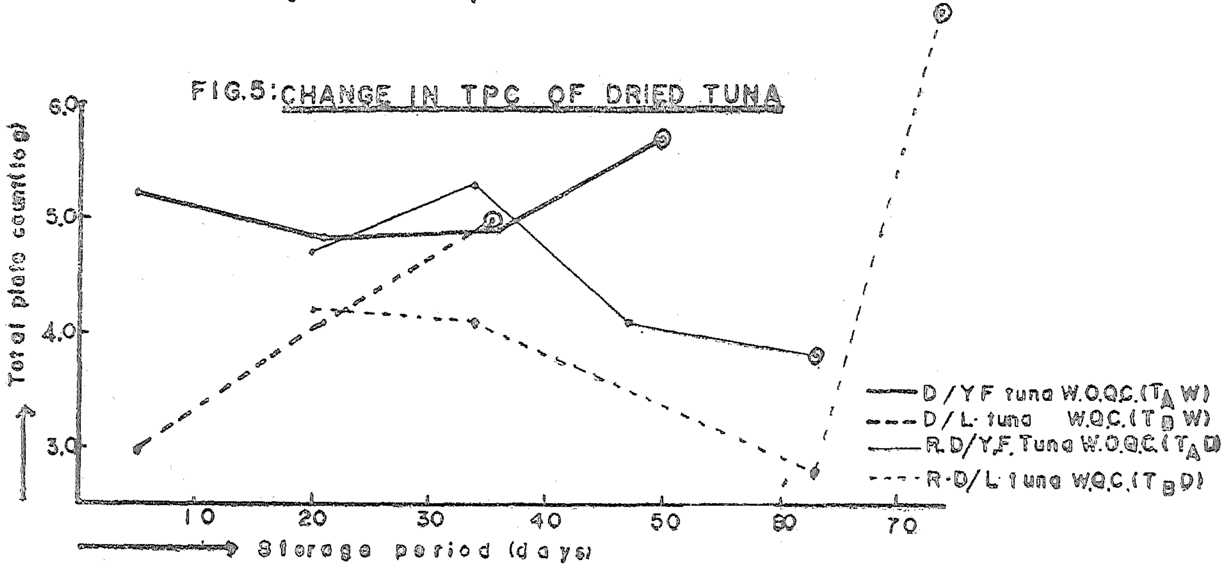


FIG.5: CHANGE IN TPC OF DRIED TUNA

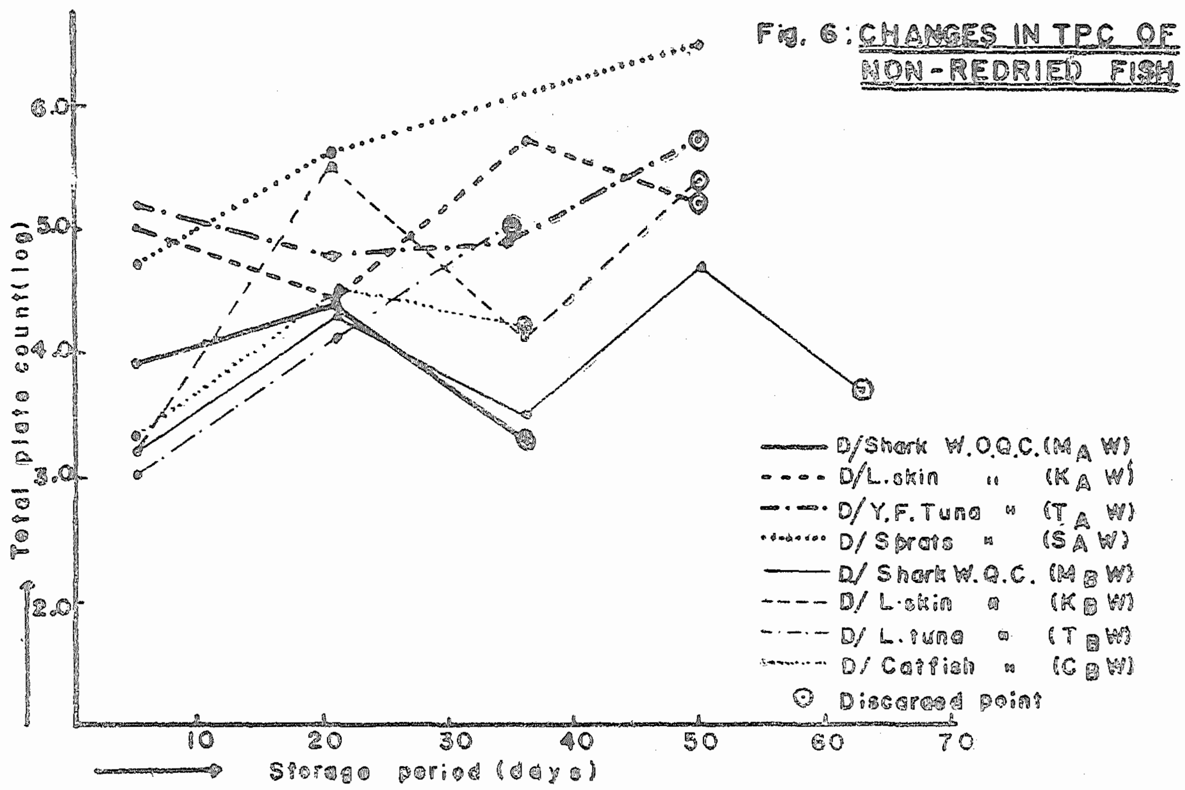


Fig. 6: CHANGES IN TPC OF NON-REDRIED FISH
Total plate count (log)
6.0
5.0
4.0
3.0
2.0
10
20
30
40
50
60
70
Storage period (days)
D/Shark W.O.Q.C. (M A W)
D/L.skin " (K A W)
D/Y.F.Tuna " (T A W)
D/Sprats " (S A W)
D/Shark W.Q.C. (M B W)
D/L.skin " (K B W)
D/L.tuna " (T B W)
D/Catfish " (C B W)
Discarded point

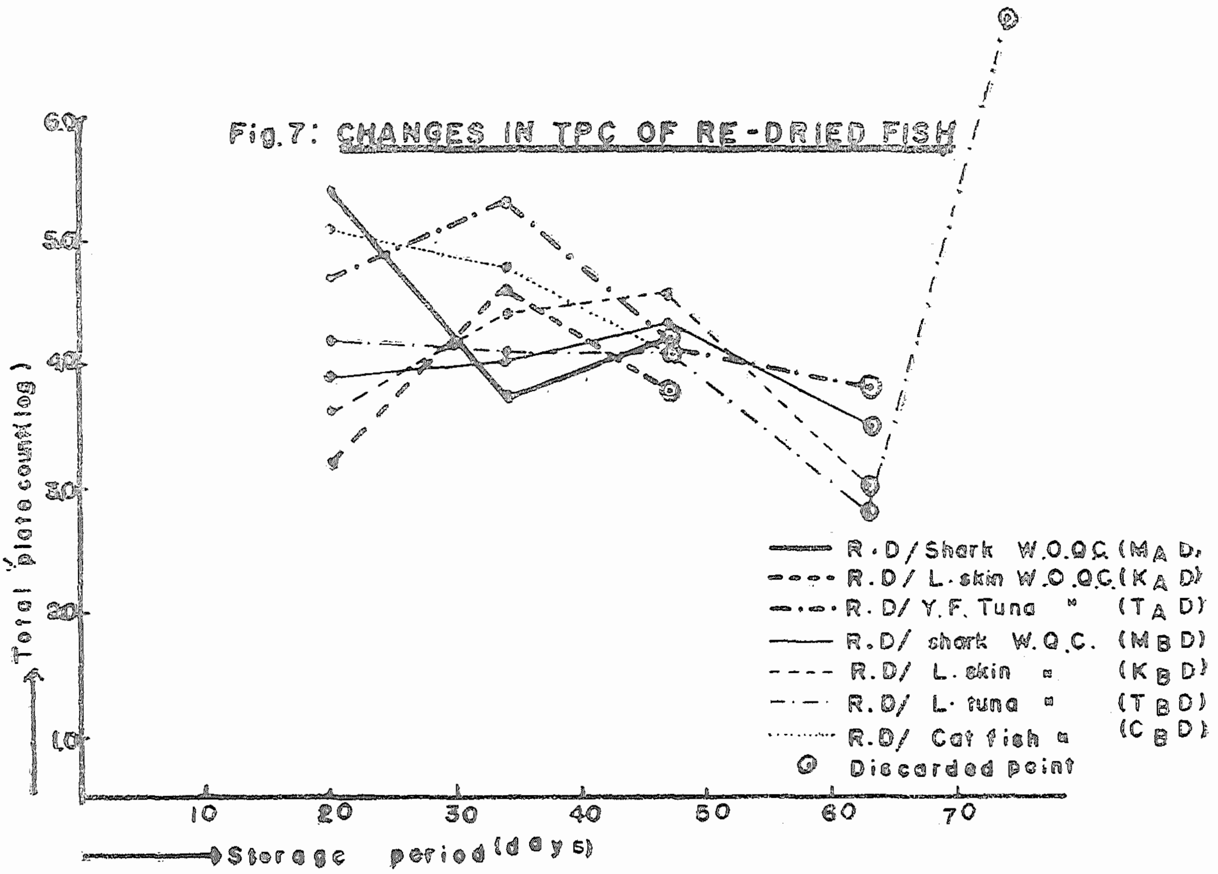


Fig.7: CHANGES IN TPC OF RE-DRIED FISH
Total plate count (log)
6.0
5.0
4.0
3.0
2.0
1.0
10
20
30
40
50
60
70
Storage period (days)
R.D/Shark W.O.Q.C. (M A D)
R.D/L.skin W.O.Q.C. (K A D)
R.D/Y.F.Tuna " (T A D)
R.D/shark W.Q.C. (M B D)
R.D/L.skin " (K B D)
R.D/L.tuna " (T B D)
R.D/Cat fish " (C B D)
Discarded point