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INVESTIGATION OF THE METHODS IN FRESHNESS KEEPING OF PILCHARD

Qiao Qinglin Xu Boliang

(East China Sea Fishery Research Institute, Chinese Academy of Fishery Sciences, Shanghai 200090)

ABSTRACT In this paper, we have studied the effects of iced – storage, iced – salt partial frozen, chilled sea water (CSW) and super – chilling sea water of storing pilchard (*Sardinops melanosticts*) on ship board. Close relationship was found between the TVB – N and FFA (tissue samples) values of fish samples and their organoleptic assessments. The TVB – N value of 24mg/100g and FFA value of 11μmole/g are threshold values for putrefaction of iced – storage and ice – salt partial frozen fish samples, The threshold values of putrefaction of CSW storage and super – chilling sea water storage of fish samples are 14mg/100g TVB – N and 11μmole/g FFA. The effective freshness keeping periods are: iced storage, 7days; ice – salt partial frozen, 17 – 18 days; CSW storage, 6 days and super chilling sea water storage, 11 – 12 days. Bacteria counts of the fish samples were all in the range of $10^3 - 10^5$/g during our experiments. Dehydration of sample fish was found in ice – salt partial frozen storage and absorption of water of the fish detected during CSW storage, while in ice – salt partial frozen storage, super – chilling sea water and CSW storage the increase of salt content in fish occurred.

KEYWORDS Pilchard, Freshness keeping

Pilchard (*Sardinops melanosticts*) is a kind of small pelagic fish mainly distributed off the east coats of Japan and also found in waters outside the East China Sea. During recent years, several marine fishing companies in China have been greate successful in capturing this species. Tender in flesh, bloodful, low muscle connection, high activity of enzyme, full of putrefactive feed in stomach and with the autolysis of fish after death, the specis may become putrefied readily. So far chilled sea water (CSW) storage is the predominant method used in freshness keeping period is only 4 – 6 days[1]; with iced storage the period is about 4 days. Ir order to find methods suitable for the commercial fishery of our country, experiments of iced storage, CSW, super chilling sea water and ice – salt partial frozen storage for pilchard were carried out and organoleptic assessment, TVB – N, FFA, salt content, moisture content and bacteria counts were used for estimations of freshness keeping effects. Results were shown below.

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1 MATERIAL, EQUIPMENT AND METHODS

1.1 Material

Fish: Japanese pilchard caught by the purse seiner of Dalian Marine Fishing Company in April of 1987 and 1988 in areas of 33°31′ – 34°N, 128°30′E and 34° – 34°30′N, 129°30′ – 130° E respectively. Length of fish: 17.5 – 22cm, in average, 19.49cm; weight of fish: 55.7 – 100.5g, in average, 71.42g.

Ice: crushed ice.

Salt: edible salt.

1.2 Equipment

Vessels: No, 52 and No.53 CSW fish transporter of Da lian Marine Fishing Company.

Equipment on shore:

GFRP (glass fiber reinforced plastic) CSW containess with a capacity of holding about 200kg of fish and water for use in CSW and super chilling sea water experiments.

GFRP iced storage container with a capactity of holding about 100kg of fish for use in ice salt partial frozen experiments.

Insulated plastic container having a capacity of holoding about 100kg of fish for use in iced storage experiments.

1.3 Methods

4 groups of sample fish were taken for small scale experiments and productive experiments were also conducted. Details were as the following.

Iced storage group: Fish caught at sea were packed into insulated plastic container with ice of ration 1:1 to maintain the fish at 0℃. When the vessel returned to fish port, continued keeping the fish at 0℃ for some time for inspection.

Ice – salt pactial frozen group: The experiment was done on NO.52 vessel, using a whole fish hold of the vessel. Fish were packed with ice of ratio 1:1 in the manner of layer – ice and layer – fish respectively. The ice was premixed with 6 – 7% of salt to keep the fish to a temperature of −2℃ −4℃. The total weight of fish in the fish hold was about 30 tons. Fish were packed into insulated GFRP container immediately after the arrival of vessel at fish port and removed to the ice room of about 2℃ to be inspected later.

CSW group: The experiment was carried out on No.53 vessel, using a whole fish hold of the vessel. The ratio of fish and water was about 6:4. Fish caught were loaded immediately into the fish hold of the vessel which had been filled with CWS of a salinity 3° Be′. Ice and salt were added to maintain the sea water at about −1℃ in temperature and a salinity 3° Be′. Total weight of the fish loaded in the fish hold was about 17 tons. When the vessel arrived at fish port, part of the fish was transferred into GFRP containers with the same condition as those at sea for later inspections.

Super chilling sea water group: The experiment was carried out on No.53 vessel using a whole fish hold of the vessel with 17 tons of fish. Fish caught were immediately put into the fish hold which had been filled with super chilling sea water of salinity 5°Be′. The temperature

of super chilling sea water was maintained at －2℃ ~ 4℃ via refrigerating equipment. After the arrival of vessel at port, part of fish were transferred into GFRP containers, which had been filled with super chilling sea water of the same temperature and salinity as in the fish hold for experiment. The fish were kept for later inspections. The ratio of fish and water was 6:4.

Test and Methods

(A) Organoleptic assessment

Assessed the general appearance, gills, flesh and eyes of fish in the routine way; proceeded panel tests if necessary.

(B) Chemical indices

TVB－N: Steam distillation method[2].

FFA (tissue samples): Titrimetric method[4].

Moisture content: Drying at 105℃[4].

Salt content: Mohr titration method[4].

(C) Microbial index

Total bacteria counts[3].

(D) Physical index

Temperatures of the hold for the experiment at sea were determined with a thermometer D 117－1031 (TAKARA Thermistor Instruments Co. Ltd.) and on shore temperatures were determined with a delicate mercuric thermometer.

Samples were taken every 2－3 days for the determinations of the above indices.

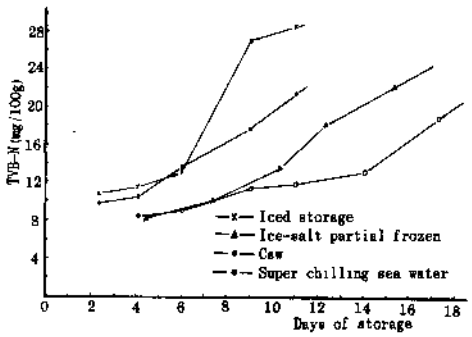

Fig.1 TVB－N changes during storage of the pilchard

2 RESULTS AND DISCUSSION

All data of this report originated from productive experiments (with exception of the iced storage group). Quality assessments of the Japanese pilchard were based on organoleptic tests supplemented with physical, chemical and microbial indices. Effective freshness keeping period of all the four experimental groups were determined by organoleptic indices of their grade 2. The grades of indices of organoleptic assessment were from small scall experiments.

TVB－N values of the pilchard of the four groups of freshness keeping experiments increased with the prolongation of the keeping period (Fig.1). The rate of changes of TVB－N values of the ice－salt partial frozen group was much slower than that of the iced storage group and the rate of changes of TVB－N values of the superchilling sea water group was slower than that of the CSW group. From these results we may get to a conclusion that partial frozen storage is better than ordinary iced storage or CSW storage for freshness keeping of the pilchard.

Table 1 shows relations between TVB－N values and organoleptic assessments of the pilchard. The results seem quite similar to the results reported in Japanese papers[5-6].

Table 1　Relations between TVB－N contents and organoleptic indices of iced storage and ice－salt partial frozen storage of the pilchard

Organoleptic indices	TVB－N (mg%)	Grade
Good overall appearance: Skin, lustrous; flesh, resilient; eyes, clear and bright; gills, bright red and no fishy odour.	＜14	1
Luster of overall appearance fading; little breakage at belly; flesh, moderately soft and weak resilience; eyes, sunken and part of eye, bloody or cloudy; gills gloomy or dark red and a little fish odour	＞14＜24	2
Luster of overall appearance, poor; flesh, soft and no resilience; eyes, sunken, red or cloudy; gills, gloomy red or dark brown red with rather serious fishy odour or off odour, sometimes putrid odour.	＞24	3

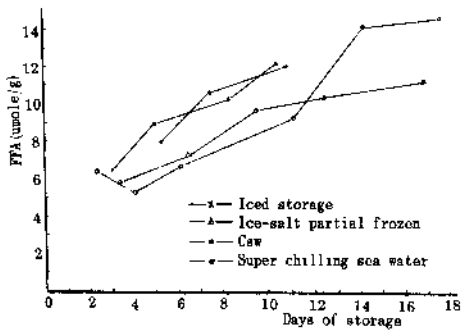

Fig. 2　FFA changes during storage of the pilchard

Being soaked in sea water, the appearance of fish in CSW group and super chilling sea water group became pale with a loss of the original luster after 2－3 days. the skin of the pilcard in CSW group might at last become separated from the flesh, though the TVB－N contents in flesh increased with increase of keeping period, yet because of the dissolution of part of the TVB－N into water, the TVB－N values of pilchard of this group was much lower than those of the iced storage group. We found that when the TVB－N values of the pilchard of CSW group or super chilling sea wsater group exceeded 14mg%, the quality of the pilchard was no more fresh and belonged to grade 3.

The FFA (tissue samples) contents of the pilchard of all the four experimental groups increased with the increase of keeping period (Fig. 2). The rates of changes in FFA values of the pilchard of the two partial frozen groups seemed evidently lower than those of iced storage or CSW group.

The relations between FFA values and organoleptic assessments of the pilchard were: fish of FFA values lower than 8μmole/g belonged grade 1, fish of FFA values 8－11 μmole/g belonged to grade 2 and when the FFA values exceeded 11μmole/g, the fish belonged to grade 3.

The changes of FFA and TVB－N values of the pilchard indicated that temperature had evident effects on them; the higher temperature was, the greater the rate of change would be. Therefore temperature may play an improtant role in affecting the quality and keeping pariod of the pilchard.

The relations between the effective freshness keeping pariod and organoleptic, chemical, indices of the pilchard can be seen in Table 2.

Table 2 The Effective freshness keeping period of different methods and their respective organoleptic and chemical indices.

Methods	Organoleptic grade	TVB · N (mg/100g)	FFA (μmole/g)	Effective keeping fiesh the days
iced storage	2	≤24	≤11	7*
ice salt partial frozen storage	2	≤24	≤11	17－18
CSW storage	2	≤14	≤11	6
super chilling sea water storage	2	≤14	≤11	11－12

* The results of small experiment, in production scale, only 4 days

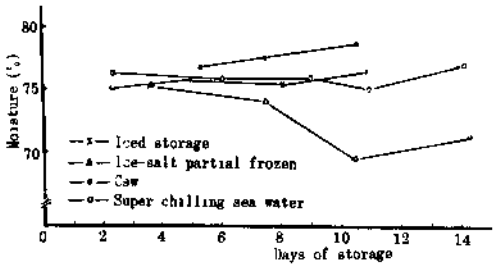

Fig.3 Moisture content changes during storage of the pilchard

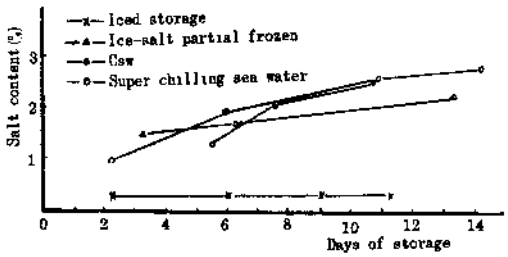

Fig.4 Salt contents changes during storage of the pilchard

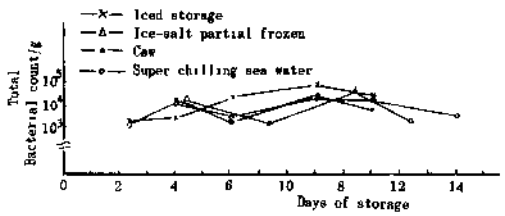

Fig.5 Total bacteria counts changes during storage of the pilchard

During the experiment the changes of moisture contents, salt content and bacteria counts of the pilchard of the experimental four groups were also determined.

Some reports[7-9] pointed out that owing to the increase in permeability of the cell membrane of the fish after death, the moisture and salt contents of the fish would increase if the fish were kept in CSW for freshness keeping.

Fig.3 indicates the changes of moisture contents in the pilchard of the four experimental groups. The initial moisture contents of the pilchard were within the range of 75% －76%, but the pilchard CSW group absorbed water and swelled up, resulting an increase in weight and after being kept for 6 days, the moisture content of the pilchard increased to 77%. On the contrary the pilchard kept in ice and salt were in a partial frozen state and directly in contact with salt, so after 6 days the moisture contents of fish decreased to about 74% and after 10 days they were only about 70%; the fish were somewhat dehydrated with a loss of weight. No evident changes of moisture contents in the pilchard of super chilling sea water group were detected and even after 10 days of stuorage the moisture contents still remeimed at the initial level (about 76%). In the iced storage group,

the increase of moisture contents of fish was verey small and within the effective freshness keeping period the moisture content remained almost nuchanged.

Fig. 4 indicates changes of the salt contents of the pilchard four experimental groups. During the experiment not any change of salt contents was detected in the iced storage group. In the other three groups, the salt contents increased as storage period increased. Within the effective freshness keeping period, the salt contents of pilchard of CSW group was as high as 50% of the salt percentage of CSW, i.e. about 1.5%. Thouth the salt concentration of sea water of the super chilling sea water group was greater than that of the CSW group, yet the fish being in a partial frozen state, the rate of permeability of salt into fish was only a little greater and after 7 days, their rates of permeability were nearly the same. Tests indicated that after 5 days of storage the salt contents of the pilchard of CSW group and super chilling sea water group were 1.28% and 1.75% and after 10 days of storage they were 2.48% and 2.52% respectively. In the iced－salt partial frozen group, even though the fish were directly in contact with the salt of the ice, the salt contents of the fish was not higher than those of the CSW group on account of the partial frozen state of the fish; after 10 days of storage the salt contents of the fish were 2% which was lower than those in CSW or super chilling sea water group.

Fig. 5 demonstrates changes of the total bacteria counts of the pilchard of the four experimental groups. Except that the total bacteria counts of the iced storage group were a little higher, those of the other three groups were nearly on the same level, $10^3 - 10^5$ counts/g. These results revealed that the deterioration of the pilchard was mainly due to autolysis of enzymes in the fish and not to bacteria[10]. Varga[11] found that they exist in the digestive organs of the pilchard very active autolysis enzymes which may be liberated through the burst or hurt of the organs after death of the fish and thus rapidly giving rise to autolysis, the flesh would become slimy and lose its original from. In order to reduce the activity and autolysis of the enzymes, the pilchard should be stored at low temperature.

3 CONCLUSION

Partial frozen storage shows a better freshness keeping effect on pilchard than the ordinary iced storage or the CSW storage. The effective freshness keeping periods of the four methods are: icd storage, 7 days (small scale experiment); CSW storage, 6 days; ice salt partial frozen storage, 17－18 days and super chilling sea water storage, 11－12 days.

The putrefaction of the pilchard is mainly due to enzymic autolysis while bacteria effect is only of secondary importance. The enzymic activity may be minimized at low temperatures resulting to render advantageous effect on freshness keeping of the pilchard.

TVB－N and FFA (tissue samples) may be used as quality indices of the changes in the protein and the lipids of the pilchard.

Ice－salt partial frozen storage causes dehydration in the pilchard while CSW storage results an absorption of water by the species; partial frozen storage and CSW storage may increase the salt contents of the species to some extent.

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远东拟沙丁鱼保鲜方法的研究

乔庆林　　徐柏良

（中国水产科学研究院东海水产研究所，上海 200090）

摘　要　本文研究了远东拟沙丁鱼（*Sardinops melanosticts*）海上冰鲜、冰盐微冻、冷海水和冷海水微冻保鲜的效果。结果表明，TVB－N 和 FFA 值的变化与鱼货质量的感官检验结果有密切关系，TVB－N 值为 24mg% 和 FFA 为 11μmole/g，是冰鲜和冰盐微冻保鲜的拟沙丁鱼质量新鲜与否的临界值，而冷海水和冷海水微冻保鲜的临界值为：TVB－N 14mg%，FFA 11 μmole/g。四种保鲜方法的有效保鲜期分别为：冰鲜 7 天、冷海水 6 天、冰盐微冻 17－18 天、冷海水微冻 11－12 天。有效保鲜期内微生物的数量在 $10^3－10^5$/g 之间变化。冰盐微冻会使鱼体产生脱水作用，冷海水保鲜会使鱼体产生吸水作用，而微冻保鲜和冷海水保鲜会使鱼体渗入部份食盐。

关键词　远东拟沙丁鱼，保鲜