Studies on the storage of iced mackerel (*Scomber japonicus*). 2. Effect of delayed icing on the storage life

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SUMMARY

Freshly harvested mackerel were exposed at ambient temperatures on the deck for 6 and 9 h respectively before icing. The quality and storage life were compared to those of control samples which were iced on capture. Results indicated that control samples were superior in quality to samples which were held at ambient temperatures before icing. Delays of 6 and 9 h at ambient temperatures were equivalent to losses of 3 and 5 storage days respectively. Though there was some loss in storage life, mackerel could still have an extended storage life of about 2 weeks if iced within 9 h after capture.

Original scientific paper. Received 1 Nov 77; revised 12 Jun 79.

RÉSUMÉ

BONSU (Mme Lydia A.) & SUTCLIFFE (Melle Penelope J.) : *Etude sur la conservation des maquereaux congelés* (Scomber japonicus). **2,** *Effets du délai entre la capture et la congélation, sur la durée de la conservation.* Des maquereaux fraîchement capturés ont été exposés sur le pont du bateau, à la témperature ambiante, respectivement pendant 6 et 9 heures avant la congélation. La qualité et la durée de conservation de ce matériel ont été comparées à celles de maquereaux témoins congelés dès leur capture. Les résultats ont montré que les témoins étaient de qualité supérieure à celle des maquereaux congelés après un certain délai d'exposition à la température ambiante. Les délais de 6 et 9 heures d'exposition à la température ambiante ont été équivalents respectivement à des pertes de 3 à 5 jours de conservation. Bien que la durée de leur conservation ait subi une certaine diminution, les maquereaux congelés 9 heures aprés leur capture ont été acceptables encore après 2 semaines environ.

Introduction

It was shown, in a previous study (Bonsu & Sutcliffe, 1979), that icing of mackerel (*Scomber japonicus*) immediately after capture extended the storage life to 19 days. Being a very sensitive fish, mackerel would have become completely inedible within 24 h at ambient temperatures.

Other workers have also reported extensions in the storage life of tropical fish by the early application of ice (Disney *et al.*, 1969; Aldrin, Ambroggi & Pony Assemien, 1970; Amu & Disney, 1973; Hoffman *et al.*, 1973).

In most tropical areas, it is not practicable to ice fish on capture because of lack of facilities on the fishing vessels. Where facilities exist, the process of sorting the fish into species and sizes makes it impossible to ice immediately after capture. The present study was, therefore, undertaken to determine the effect of prolonged exposure on the quality and storage life of iced mackerel.

In part 1 of this study (Bonsu & Sutcliffe, 1979), two objective methods, Rank-Torry freshness values and hypoxanthine levels, were found to have potential for use as measures of quality during storage. These methods, as well as bacterial counts and organoleptic tests, have been used to assess the effect of delayed icing on the subsequent storage life of iced mackerel.

Materials and methods

Mackerel (*S. japonicus*) were caught by purse seine at a depth of 55 m. About 210 fish of similar size (average weight 100 g, ranging from 90 to 120 g) were selected from the catch and divided into three groups. Group 1 was iced immediately while groups 2 and 3 were left on the deck for 6 and 9 h respectively before icing. The ambient temperatures on the deck ranged from 27 to 33°C. The iced fish were stored in insulated containers. The icing procedure and the insulated containers used have been described in part 1 of this work (Bonsu & Sutcliffe, 1979). The quality of the fish was determined by taking samples at regular intervals for sensory and objective assessments.

Sensory methods

Visual and olfactory assessment. Nine fish from each group were examined for signs of spoilage. The time taken to pass each phase of spoilage described in part 1 of this study was noted (Bonsu & Sutcliffe, 1979).

Taste panel assessment. Five fish from those used for visual and olfactory assessment were cleaned and cooked in 1 per cent (w/v) brine for 30 min. The over-all acceptability of each group was assessed by a panel of eight on a 11-point hedonic scale from 0 (lowest) to 10 (highest quality).

Objective methods

The over-all freshness as measured by Rank-Torry freshness meter, hypoxanthine levels and total viable bacterial counts were determined on samples containing four fish from each group. The procedures used have been described in part 1 of this study (Bonsu & Sutcliffe, 1979).

Results and discussion

Table 1 shows the time taken by each group to pass the four phases of spoilage. Group 1 which was iced on capture took 6 days to show signs of quality deterioration (phase 1) while the remaining groups, which were left on the deck, passed phase 1 after 6 h. Generally group 1 was of better quality during storage than groups 2 and 3. Although the initial rates of spoilage of groups 2 and 3 were the same, group 3 deteriorated faster than group 2 during the latter phases of spoilage.

TABLE 1

Effect of Delayed Icing on the Sensory Spoilage Pattern of Mackerel

Treatment of fish	*Days taken to pass spoilage phase*			
	*Phase 1**	*Phase 2***	*Phase 3****	*Phase 4*****
Group 1 (iced on capture)	6	12	19	23
Group 2 (iced after 6 h)	6	6	15	19
Group 3 (iced after 9 h)	6	6	12	15

* Phase 1. Fish were in *rigor mortis*; the eyes were slightly sunken and turning opaque; gills were red to dark red in colour and odour was fresh.

**Phase 2. All fish passed out of *rigor mortis;* the eyes were sunken, contracted and opaque with the iris fading in colour and turning black, the skin was dull and pale.

*** Phase 3. Characteristic mackerel markings and colour were faded. The skin was wrinkled and a yellow slime was formed. The belly was soft and broken in some fish.

**** Phase 4. Body slime increased in quantity, the odour was putrid and nauseous; the flesh was soft with the belly broken in all fish.

Fig. 1 shows taste panel scores for the groups during iced storage. Group 1 was of superior eating quality to the remaining groups. Groups 2 and 3 were very similar in quality up to 6 days beyond which group 2 was slightly superior. All groups were completely spoiled after 23 days. A score of 5 on the 11-point hedonic scale indicated the limit of acceptability and a score of 2 represented the point of condemnation of the fish. On this basis, group 1 was acceptable up to 19 days while groups 2 and 3 reached the limit of acceptability on the 16th and 14th days of storage respectively.

The over-all freshness values are shown in Fig. 2. There were great differences in the over-all freshness values of the three groups of fish after a day's storage in ice. The initial differences in freshness related to the length of exposure at ambient temperature; since group 1, which was iced alive, had the highest freshness value while group 2, which was iced after an exposure of 9 h, had the lowest value. As storage progressed, group 1

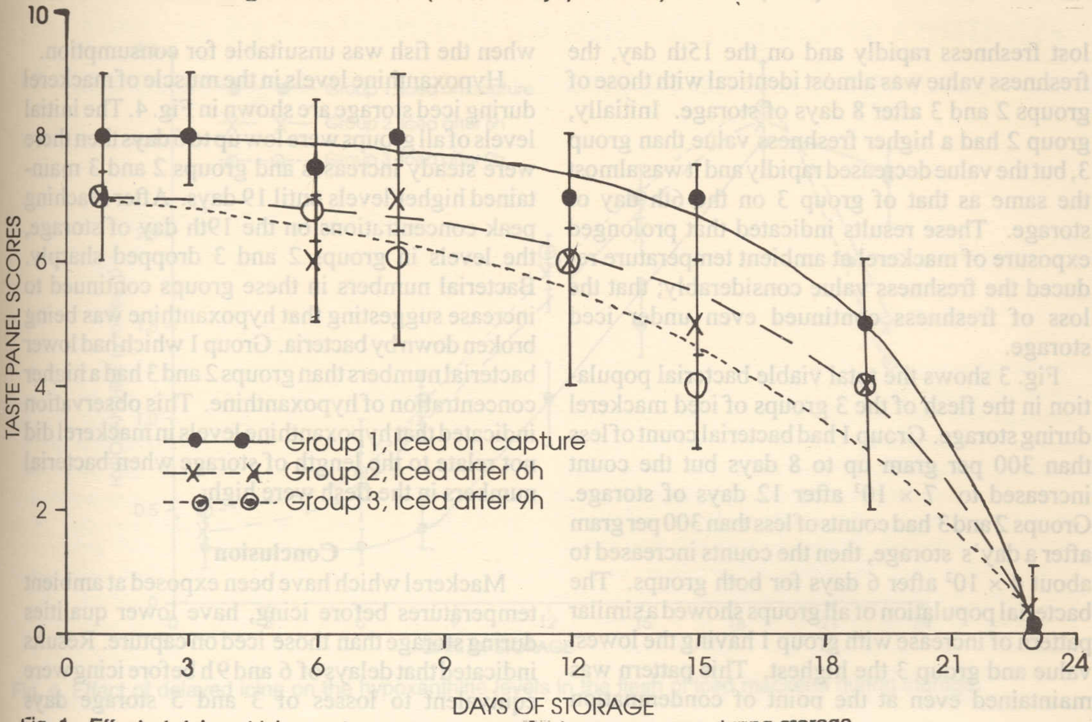

Fig. 1. **Effect of delayed icing on taste panel scores for iced mackerels during storage.**

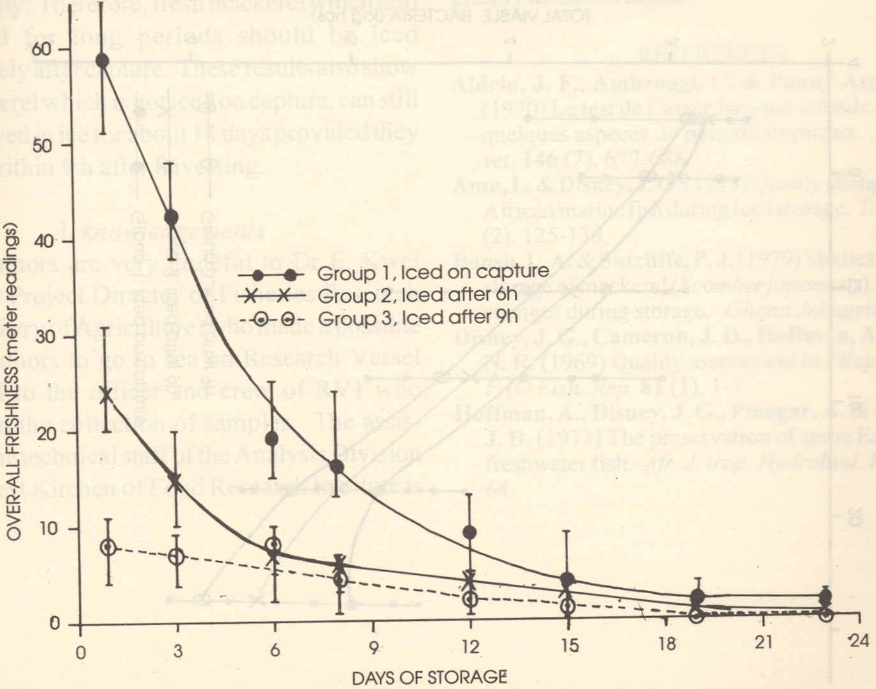

Fig. 2. **Effect of delayed icing on the over-all freshness of iced mackerel during storage.**

lost freshness rapidly and on the 15th day, the freshness value was almost identical with those of groups 2 and 3 after 8 days of storage. Initially, group 2 had a higher freshness value than group 3, but the value decreased rapidly and it was almost the same as that of group 3 on the 6th day of storage. These results indicated that prolonged exposure of mackerel at ambient temperature reduced the freshness value considerably; that the loss of freshness continued even under iced storage.

Fig. 3 shows the total viable bacterial population in the flesh of the 3 groups of iced mackerel during storage. Group 1 had bacterial count of less than 300 per gram up to 8 days but the count increased to 7×10^3 after 12 days of storage. Groups 2 and 3 had counts of less than 300 per gram after a day's storage, then the counts increased to about 4×10^2 after 6 days for both groups. The bacterial population of all groups showed a similar pattern of increase with group 1 having the lowest value and group 3 the highest. This pattern was maintained even at the point of condemnation when the fish was unsuitable for consumption.

Hypoxanthine levels in the muscle of mackerel during iced storage are shown in Fig. 4. The initial levels of all groups were low up to 6 days then there were steady increases and groups 2 and 3 maintained higher levels until 19 days. After reaching peak concentrations on the 19th day of storage, the levels in groups 2 and 3 dropped sharply. Bacterial numbers in these groups continued to increase suggesting that hypoxanthine was being broken down by bacteria. Group 1 which had lower bacterial numbers than groups 2 and 3 had a higher concentration of hypoxanthine. This observation indicated that hypoxanthine levels in mackerel did not relate to the length of storage when bacterial numbers in the flesh were high.

Conclusion

Mackerel which have been exposed at ambient temperatures before icing, have lower qualities during storage than those iced on capture. Results indicated that delays of 6 and 9 h before icing were equivalent to losses of 3 and 5 storage days

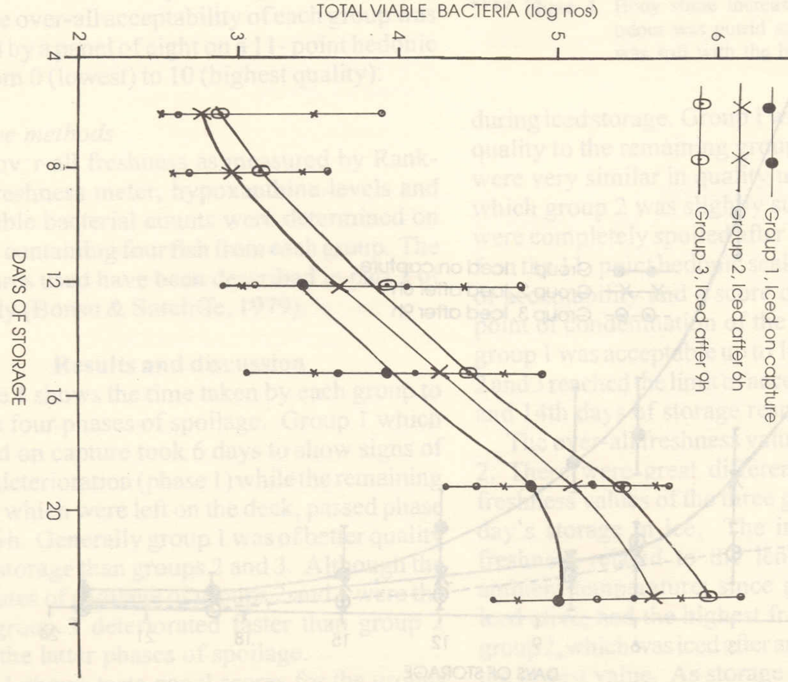

Fig. 3. Effect of delayed icing on the viable bacterial population in the flesh of iced mackerel during storage.

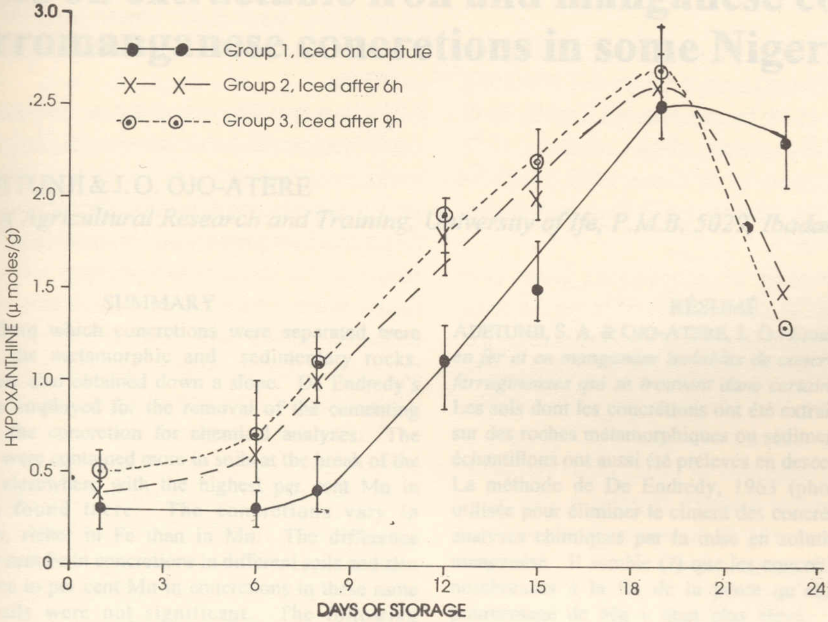

Fig. 4. Effect of delayed icing on the hypoxanthine levels in the flesh of iced mackerel during storage.

respectively. Therefore, fresh mackerel which is to be stored for long periods should be iced immediately after capture. These results also show that mackerel which is not iced on capture, can still be preserved in ice for about 14 days provided they are iced within 9 h after havesting.

Acknowledgements

The authors are very grateful to Dr E. Kwei (formerly Project Director of Fisheries Research Unit, Ministry of Agriculture) who made it possible for the authors to go to sea on Research Vessel RV1, and to the officer and crew of RV1 who assisted in the collection of samples. The assistance of the technical staff of the Analysis Division and the Test Kitchen of Food Research Institute is greatly acknowledged.

REFERENCES

Aldrin, J. F., Ambroggi, C. & Ponny Assemien, F. (1970) Le test de l'azote basique volatile applique a quelques aspeces de poisson tropicaux. *Rec. Med. vet.* **146** (7), 677-688.

Amu, L. & Disney, J. G. (1973) Quality changes in West African marine fish during iced storage. *Trop. Sci.* **15** (2), 125-138.

Bonsu, L. A. & Sutcliffe, P. J. (1979) Studies on the iced storage of mackerel (*Scomber japonicus*). 1. Quality changes during storage. *Ghana Jnl agric. Sci.* **12.**

Disney, J. G., Cameron, J. D., Hoffman, A. & Jones, N. R. (1969) Quality assessment in *Tilapia* species. *FAO Fish. Rep.* **81** (1), 1-7.

Hoffman, A., Disney, J. G., Pinegar, A. & Cameron, J. D. (1973) The preservation of some East African freshwater fish. *Afr. J. trop. Hydrobiol. Fish.* **1**, 59-64.