J. Sci. Food Agric. 1979, **30**, 911–913

Effect of Storing Hake (*Merluccius merluccius hubbsi*) on Ice on the Viscosity of the Extract of Soluble Muscle Protein[a]

Marcos Crupkin, Carlos A. Barassi, Celina Martone and Raúl E. Trucco

Instituto Nacional de Tecnología Industrial, Centro de Investigaciones de Tecnología Pesquera, 12 de Octubre 4728, 7600 Mar del Plata, Argentina

(*Manuscript received 2 February 1979*)

The viscosity of high ionic strength muscle extract of hake decreases during storage of whole fish on ice. Linear correlation was obtained when log of reduced viscosity was plotted against days of storage on ice and also in the plot of reduced viscosity against sensory scores.

1. Introduction

Considerable evidence has been accumulated that during the storage of frozen fish there occurs denaturation of the muscle proteins, which are extractable with high ionic strength solutions.[1, 2] As a consequence of that, a fall in the viscosity of the extract was observed, which was attributed to aggregation of myofibrillar proteins.[3]

We made the observation that when hake caught from different fishing grounds in different seasons is stored on ice, as whole fish, the viscosity of the high ionic strength muscle extract decreased with storage time. Viscosity decrease correlates with a fall in the sensory score. The results of these studies are presented here.

2. Experimental

Hake (*Merluccius merluccius hubbsi*) was caught from fishing grounds on the Argentinean platform in the South Atlantic Ocean from 36° to 53° (south latitude) during summer, winter and spring. Fish samples were obtained both from commercial vessels and the research vessel 'Walther Herwig'. The samples from commercial vessels were kept on ice after catching until they reached the laboratory. With the samples from the 'Walther Herwig' the whole work was performed on board.

Fish was stored on ice in plastic boxes for different periods of time. From time to time samples were taken for sensory evaluation, which was performed by a panel of at least six trained people.

The scheme generally used in Spain was employed.[4, 5] Score number runs from zero to five, with zero being highest and five lowest degree of freshness. Each score number is the average of the evaluation of eleven characteristics.

For each determination eighteen samples were taken at random from each box, sensorily evaluated and then filleted for viscosity determination. 2.5 g taken from different muscle portions of each fillet sample were homogenised for 2 min in 10 ml of water in a Waring Blender. Homogenised material was centrifuged at 4000 rev min^{-1} for 15 min. The supernatant was discarded and the pellet washed twice with 10 ml of distilled water. It was then extracted three times with 30 ml of 0.6M potassium chloride solution and adjusted to pH 7 with 0.02 M sodium bicarbonate. All steps were carried out at 4°C. After centrifugation, supernatant solutions were pooled and the volume was adjusted to 100 ml with the 0.6M potassium chloride solution.

[a] A partial account of this work was presented at the XIV National Meeting of Sociedad Argentina de Investigación Bioquímica, November 1978.

0022–5142/79/0900–0911 $02.00

Protein concentration was determined on an aliquot of the extract by the Lowry method,[6] which has been adopted for fish protein determination.[7]

Viscosity was measured at 20°C ± 0.01°C using a Ubbelohde viscosimeter. Protein concentration covered a range of 0.1–0.4 g 100 ml^{-1} of solution. Flow time was about 150 s with water.

The reduced viscosity of the solutions was calculated as follows:

$$\frac{\eta_e - \eta_s}{\eta_s C}$$

where: η_e = the apparent viscosity of the muscle extract, η_s = the apparent viscosity of the solvent, and C = the concentration of protein, g $litre^{-2}$.

3. Results and discussion

As can be seen in Figure 1, when the log values of the reduced viscosity are plotted against the days that the hake has been kept on ice, a linear correlation was obtained with a value of $r = -0.950$ highly significant ($P < 0.001$). The low value of the slope in the regression was checked by the Fisher test and a value of $-0.090 < B < -0.047$ was found, which indicated it was different from zero.

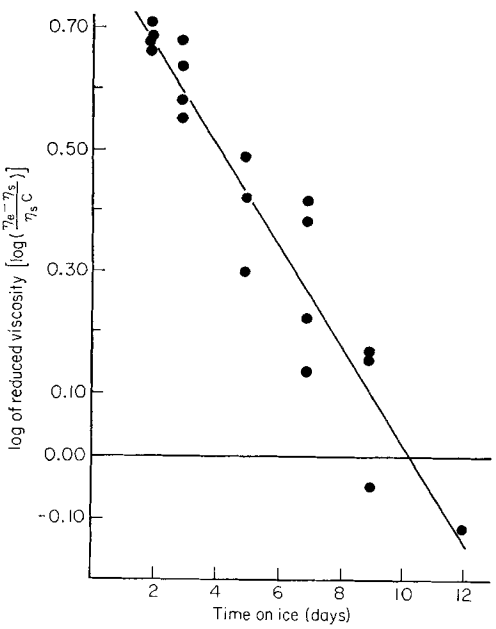

Figure 1. Log of reduced viscosity *vs* days on ice for hake caught in summer. $y = -0.082\ x + 0.847$; $r = -0.950$; $P < 0.001$.

In Figure 2 the reduced viscosity values plotted against the sensory scores. As it is shown a linear correlation with $r = -0.786$ highly significant ($P < 0.001$) was obtained.

The results described in this paper clearly indicate that when hake is stored on ice a good correlation was obtained between the fall with the time of the reduced viscosity of the extract of the muscle soluble proteins and that of the sensory scores.

The nature of the change which led to the fall of viscosity during the time of storage of post-rigor fish on ice is not known at present.

It seems to us that the measure of the viscosity of a high ionic extract of fish flesh could be a good method for the evaluation of freshness of hake.

Acknowledgements

Part of the work was carried out on the German research vessel 'Walther Herwig II'. Sincere

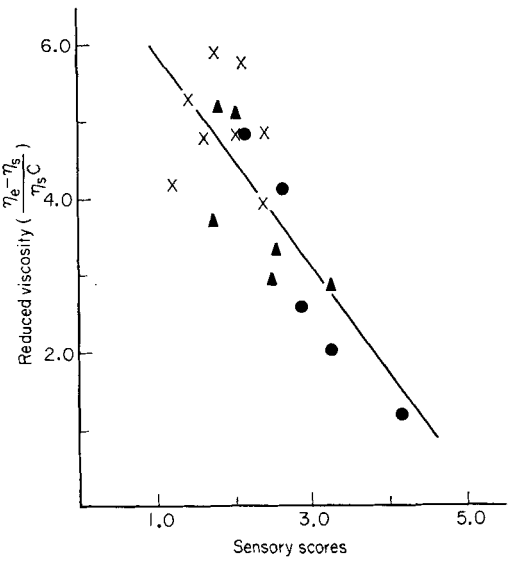

Figure 2. Reduced viscosity *vs* sensory scores for hake caught in: ●, summer; ▲, winter; ×, spring. Each point is the average of at least four determinations. $y = -1.41\,x + 7.42$; $r = -0.786$; $P < 0.001$.

thanks to Cap. de Fragata Federico J. Aragno, Director of the Instituto Nacional de Investigación y Desarrollo Pesquero, for making this possible. The work was supported in part by the Consejo Nacional de Investigaciones Científicas y Técnicas and the Comisión de Investigaciones Científicas de la Provincia de Buenos Aires.

References

1. Dyer, W. J. *Food Research* 1951, **16**, 522.
2. Ironside, J. I. M.; Love, R. M. *J. Sci. Food Agric.* 1958, **9**, 597.
3. Tsuchiya, T.; Tsuchiya, Y.; Nonomura, Y.; Matsumoto, J. *J. Biochem.* 1975, **77**, 853.
4. Tedeschi, C. C.; Kogan, E. *Documento Técnico Preliminar.* 1974, **37**, FAO, Mar del Plata.
5. Constantino da Encarnacao, J. *Documento Técnico Preliminar.* 1974, **39**, FAO, Mar del Plata.
6. Lowry, O. H.; Rosebrough, N. J.; Farr, A. L.; Randall, R. J. *J. Biol. Chem.* 1951, **191**, 265.
7. Martone, C.; Crupkin, M.; Barassi, C. A.; Trucco, R. E. *2nd Simposio Nacional de Ciencia y Tecnología de Carnes*, Buenos Aires, 1978.
8. Connell, J. J. *Biochem J.* 1960, **75**, 530.
9. Oguni, M.; Kubo, T.; Matsumoto, J. J. *Bull. Jap. Soc. Sci. Fish.* 1975, **41**, 1113.