SOFTENING OF THE *CHICOREUS RAMOSUS* FOOT MUSCLE

By M. Xavier Ramesh and K. Ayyakkannu
Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai - 608 502, India

ABSTRACT

Foot muscles of *Chicoreus ramosus* were cooked under different pressures and treated with locally available herbal materials and synthetic chemicals. None of the herbal materials were effective in softening the foot muscle. However, the foot muscle softened after 2-2.5 hours of cooking under pressure of 1 kg/cm^2. Effective softening was obtained with citric acid and dibasic sodium phosphate for 12 hours at low temperature. Foot muscles soaked in 5% dibasic sodium phosphate softened in 30 minutes when cooked at the pressure of 1 kg/cm^2. Foot muscles softened in 10, 15 and 20 minutes when treated with 5%, 4% and 3% citric acid solutions respectively and cooked at the pressure of 1 kg/cm^2. Foot muscles treated with sodium phosphate and citric acid solution took 6 hours to soften when cooked in boiling water. The biochemical composition of fresh, chemically treated and softened foot muscles, was analysed.

INTRODUCTION

The delicacy and food value of gastropods are being increasingly realized in different parts of the world. The meat of gastropods is soft in fresh condition but gets very tough on cooking. Foot muscles of *Chicorus ramosus* are eaten in Thailand and some rural coastal villages of India. However, it took 36 hours (Hylleberg, 1992) and 27 hours (Xavier Ramesh and Ayyakkannu, 1992) for the foot muscles of *C. ramosus* to soften. This cooking time is very long compared to other shellfish and indeed almost all other varieties of seafood. Prolonged cooking leads of the change of texture, shrinkage and loss of flavour of the meat. In addition, such prolonged cooking leads to considerable change in the biochemical composition of the foot muscles of *C. ramosus* (Xavier Ramesh and Ayyakkannu, 1992). Softening technique should result in short cooking time. This is the subject of this study.

MATERIALS AND METHODS

Sample Collection

Samples of *C. ramosus* were collected from the region of the Gulf of Mannar on the southeastern coast of India with lobster nets. The shells were cleaned with potable water, the opercula removed with an iron scalpel, and then immersed in boiling water for 30 minutes. The meat was removed from the shell with a stainless steel scalpel, and viscera, gonad, and the digestive gland were separated. The foot muscles were cut free with a stainless steel knife and repeatedly washed in potable water. Muscles were kept in an insulated container with crushed ice, and transported to the laboratory. The foot muscles were packed in a polythene cover and kept in deep freezer until use.

Softening experiments

Softening of the foot muscles was assessed by touch. Pieces of foot muscles (about 10 mm long and 3 mm thick) were used in all softening experiments. Attempts were made to soften the foot muscles at varying levels of pressure using traditional herbal materials: ginger, papaya and lemon; and the synthetic chemicals: vinegar, dibasic sodium phosphate and citric acid. For the pressures 0.35 kg/cm^2 and 0.7 kg/cm^2, an autoclave was used, and for 1 kg/cm^2 a pressure cooker.

Softening was attempted in two ways: 1. The foot muscles were cooked with varying concentrations of softening agents and 2. the foot muscles were immersed for varying period in potable water with different concentrations of softening agents under low temperature (4-6^{o}C) and then cooked.

Biochemical estimation

The treated, and softened foot muscles were dried at 60°C for 24 hours, then ground into fine powder using a pestle and mortar, tightly packed in polythene bags, and stored in a dessicator till analysis were made. The moisture content was calculated by the difference between the wet and dry weight of the tissue. Total protein content was estimated by the modified Biurete method (Raymont *et al.*, 1964). Carbohydrate by phenol-sulphuric acid method (Dubois *et al.*, 1956) and total lipid was estimated gravimetrically, using chloroform-methanol (Folch *et al.*, 1956).

RESULTS

Effect of pressure on softening

Pressure has a marked effect on softening of the foot muscles. The foot muscles were softened in 250, 210 and 150 minutes when cooked at 0.35 kg/cm^2, 0.7 kg/cm^2, and for 1 kg/cm^2 respectively.

Effect of herbal material on softening

The softening effect of the papaya, ginger, and lemon are given in Appendix 1.

Softening of meat was found in foot muscles treated with different concentrations of extracts of herbal materials, but only lemon was found effective. Foot muscles treated with 20% concentration of lemon for 12 hours softened in 100 minutes under pressure (1kg/cm^2) and in 11 hours in boiling water. When the herbal extract was directly added to the cooking medium (water), the softening effect was poor. Moreover the flavour and the colour of the foot muscles changed notably. When foot muscles were cooked with papaya-extract, the boiling water turned brown and had phenolic odour.

Effect of chemicals on softening

The three chemicals used in the present study were vinegar, dibasic sodium phosphate and citric acid. Vinegar was found to have had no effect. The effects of dibasic sodium phosphate and citric were promising as shown in Appendix 2 and softening was observed in foot muscles treated for 12 hours with dibasic sodium phosphate at concentrations of 4 and 5%. At this concentration the treated foot muscles softened in 40 and 30 minutes when cooked under pressure (1 kg/cm^2) and in 11 and 8 hours in boiling water. The softening effect of citric acid was superior to that of dibasic sodium phosphate. Effective softening was obtained in foot muscles which were immersed for 12 hours in 4% and 5% citric acid solution. At this concentration the foot muscles softend in 15 and 10 minutes at a pressure of 1kg/cm^2. At the same concentrations, muscles turned soft in 7.5 and 6 hours when cooked in boiling water.

The foot muscles were slippery when cooked immediately in 2% citric acid and dibasic sodium phosphate.

Changes in biochemical composition

Biochemical composition was estimated for citric acid treated foot muscles as shown in Table 1.

Table 1. Changes in the biochemical content in the foot muscles during citric acid treatment and softening conditions, Untreated (Untr.), Softned (Soft) and Treated (Treat).

Citric acid concent.	Nature of the foot muscle.	Moisture (%)	Protein (%)	Lipid (%)	Carbohydrate (%)
0	Untr.	64.66	38.12	1.71	9.65
	Soft	72.32	36.43	1.29	9.12
3%	Treat	71.33	37.19	1.28	8.63
	Soft	72.13	35.23	1.18	8.51
4%	Treat	71.66	35.02	1.20	8.36
	Soft	73.21	34.64	1.14	8.14
5%	Treat	71.84	34.36	1.17	8.20
	Soft	74.42	32.18	1.08	7.92

There was no marked variation in lipid and carbohydrate content.The moisture content increased, and protein decreased in foot muscles treated and softened with different concentrations of citric acid. The mositure content of the foot muscles gradually increased from 64.66% (untreated foot muscles) with increasing concentration of citric acid and reached a maximum of 74.42% when treated with 5% citric acid and then softened. The protein content of the softened foot muscles decreased more with increasing concentrations of citric acid compared to untreated muscles. Maximum protein loss was measured in muscle treated with 5% citric acid and softened.

Toughness of cooked muscles of gastropods has been reported in species of *Haliotis, Busycon, Strombus* and *Buccinum* (Dore, 1991). In order to tenderize gastropod meat, the foot muscles generally were subjected to repeated pounding with a wooden mallet for the fibrillar connection of the foot muscles to get loosened, thereby enhancing the tenderness of the meat during cooking. Such physical treatment, however, has resulted in great weight loss. In the food processing industry up to 5% dibasic sodium phosphate and citric acid are commonly used in the preparation of pickles from different meat sources. Therefore, the effect of 5% of both chemicals was studied. Though chemically treated foot muscles softened well in the present study, when cooked under pressure, unsatisfactory results were obtained when the muscles were cooked in boiling water. To achieve maximum softening effect through boiling water, it would be better to increase the total time of immersion instead of increasing the chemical concentration before cooking. It was observed that cooking foot muscles without treatment with citric acid and dibasic sodium phosphate resulted in a slippery product. It was observed that the softening time significantly changed with the size of the pieces of meat and also the quantity. Effective softening was obtained only in the 500 to 600 g meat pieces submerged in one litre solutions of citric acid and dibasic sodium phosphate at low temperature. In the present study about 5% protein loss was observed in foot muscle treated with citric acid and then softened. It may be due to the leaching of protein during the immersion process.

CONCLUSION

Though dibasic sodium phosphate and citric acid have promising softening effect with regard to *C. ramosus* foot muscles, the long time needed for immersion treatment and pressure cooking would not be possible in private households. At present, such chemical treatment can easily be done in the seafood processing centres and restaurants. More light should be thrown on the softening of the foot muscles in a very short time, even if cooked without pressure. A detailed study is essential to understand the secret behind the toughness of *C. ramosus* foot muscle.

REFERENCES

Dore, I. 1991. *Shellfish. A guide to oysters, mussels, scallops, clams and similar products for the commercial users*. Van Nostrand Reinhold, New York.

Dubois, M., K.A. Giller, J.K. Hamilton, K.A. Befors and F. Smith. 1956. Colorimetric method for determination of sugars and related substances. *Analyst. Chem*. 350-356.

Folch, J., M. Lees and G.H.S. Stanley. 1956. A simple method for the isolation and purification of total lipids from animal tissues. *J. Biol. Chem.* **226**: 497-509.

Hylleberg, J. 1992. The Thai way of cooking King Abalone alias *Chicoreus ramosus*, with a note on cooking in India. *Phuket mar. biol. Cent. Spec. Publ. no.* **10**: 11-13.

Raymont, J.E.C., A. Austin and E. Linzford. 1964. Biochemical studies on marine zooplankton. I. Biochemical composition of *Neomysis integer. J. Cons. Perm. Explor. Mer.* **28**: 354-363.

Xavier Ramesh, M. and K. Ayyakkannu. 1992. The effect of long-term cooking on the nutritive value of the edible portions of *Chicoreus ramosus*. *Phuket mar. biol. Cent. Spec. Publ. no.* **10**: 23-26.

Appendix 1

Softening effect of herbal materials on the foot muscle of *Chicoreus ramosus*.

Herbal material	Concentration	Time taken for softening: Duration of treatment (in hrs.)	Boiling water (in hrs)	Pressure 1 kg/cm^2) (minutes)
Papaya	10% v/v	4	18	140
		8	17	130
		12	15	125
Papaya	20% v/v	4	16	130
		8	15	125
		12	14	115
Lemon	10% v/v	4	15	125
		8	13	120
		12	12	110
Lemon	20% v/v	4	13	120
		8	12	115
		12	11	100
Ginger	10% w/v	4	17	140
		8	14	135
		12	12	130
Ginger	20% w/v	4	14	125
		8	13	120
		12	11	110

Appendix 2

Softening effect of (A) dibasic sodium phosphate and (B) citric acid on the foot muscle of *C. ramosus*

Concent.	Duration of treatment (in hrs.)	A Time to soften: Boiling water (hrs)	(1 kg/cm^2) (minutes)	B Time to soften: Boiling water (hrs)	(1 kg/cm^2) (minutes)
	3	18:00	145	18:00	140
1%	6	17:30	140	17:00	130
	9	17:00	135	16:00	110
	12	15:00	130	15:00	100
	3	17:00	125	16:00	130
2%	6	16:00	110	17:00	75
	9	15:30	115	15:00	60
	12	14:00	90	14:00	45
	3	15:00	110	14:00	120
3%	6	13:30	90	13:00	65
	9	13:00	75	12:00	60
	12	12:00	65	9:00	20
	3	14:30	80	12:00	100
4%	6	14:00	75	10:00	60
	9	12:00	60	8:30	50
	12	11:00	40	7:30	15
	3	12:00	70	9:30	90
5%	6	10:00	60	8:00	55
	9	9:30	45	7:30	40
	12	8:00	30	6:00	10