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CHEMICAL, BIOCHEMICAL AND TEXTURAL PROPERTIES OF CHANNEL CAT FISH MUSCLE AS INFLUENCED BY EGG WHITE ADDITION AND THE TUMBLING PROCESS

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INTRODUCTION

This research involves the transfer of tumbling techniques to seafood products in order to utilize the fish muscles which have been under-utilized. Objectives of this research were:

to evaluate the chemical, biochemical and structural changes of muscle tissue during fish processing, to monitor the activity of indigenous proteases (in situ), to observe the effects of a non-fish protein incorporation which attempted to limit the indigenous protease activity with a globular protein, and
to evaluate tumbling technique on the gel forming and water holding properties of fish muscle.

MATERIALS AND METHODS

Fresh Channel Cat fish fillets (low cost) utilized in this research were rinsed, drained, diced and a proper amount of ingredients (2% salt, 1% egg white, 1% sucrose, 0.5% white pepper, 0.1% garlic, 0.25% sodium tri-polyphosphate, 0.01% nitrite and 0.01% natural lemon flavour) were placed on the product before intermittent tumbling (40 minutes rest, 20 minutes work) for 12 hours at 6°C.

Total N, moisture, fat, ash and pH tests were conducted (Ockerman, 1985) and the TBA number was determined by using the extraction method as outlined by Pensel (1990). Degree of proteolysis was determined as described by Aksnes (1988) with a slight modification. In this method, trichloroacetic acid soluble nitrogen was determined by the standard micro kjeldahl technique (AOAC, 1980) and the results expressed as proteolysis. Protein fractionation analyses was conducted using a modification of the method described by Parrish and Paterson, (1988) and Toyahora *et al.* (1990). Collagen fraction was determined from the amount of hydroxyproline measured by the colorimetric method as outlined by Bergman and Loxley (1963). SDS-PAGE electrophoresis using a 4-20% gradient slab gel (Bio-Rad) was conducted as described by Anon (1991). The effective protein hydrophobicity values of the samples from the myofibrillar fraction were measured by an alkane binding method according to the modified method of Mangino *et al.* (1985) and Rasyid (1992). Gel strength of the raw fish muscle gels were measured by using the Instron Universal Testing Machine (model 1000) as described by Chung and Lee (1990). The hardness was measured with quintuplicate samples using a 6mm circular probe which was allowed to penetrate 75% of the sample length and gel strength (hardness) was expressed as Newton/g sample. Expressible moisture (EM) measurements were conducted as described by Lee and Chung (1989) and was reported as percentage of the gel sample moisture content determined by the oven dry method (Ockerman, 1985).

RESULTS and DISCUSSION

Proximate Composition

Alterations of fresh fish muscle were affected by the processing practices and support the findings of Nettleton *et al.* (1990) with the only major differences being the ash values which were higher due to additives including salt in this product.

Protein fractionation

These results varied between the treatments indicating some alterations in the ratio of the protein fractions with the effects of tumbling and egg white incorporation.

In this experiment, average myofibrilar protein was approximately 60% and sarcoplasmic protein was 30%. The reason for this not supporting the findings of Suziki, (1981) and Haard, (1992) might be due to the treatments involved which contained salt. However, similar results were reported in beef and chicken which was tumbled in the presence of salt (Booren *et al.*, 1981; Maki and Froning, 1987). In general, the tumbling caused an increase in myofibrilar protein extraction and a reduction in the sarcoplasmic fraction (Table 1). The results showing changes in proteolysis, TBA, gel strength (GS), expressible moisture (EM) and effective protein hydrophobicity (EPH) values are shown in Figures 1, 2, 3 and 4.

The table and figures would indicate that the combination of incorporation of egg white and the tumbling process significantly altered the biochemical and textural properties of fish muscle tissue. In general, tumbling increased the amount of extracted myofibrilar protein (MfP) and gel strength (GS) while it slightly reduced the proteolysis (TCA soluble nitrogen), sarcoplasmic protein extraction (ScP), NPN, expressible moisture (EM), pH and effective protein hydrophobicity (EPH) values of the processed but uncooked fish muscle as compared to the non tumbled control group. Booren *et al.* (1981) reported similar results for beef muscle protein fractions in which myofibrilar protein extraction was increased and sarcoplasmic fraction was decreased with tumbling. Egg white incorporation had a positive effect on GS, EHP, % protein, NPN and pH while % lipid, TBA and EM values of the gels were reduced. Additionally, egg white incorporation accompanied by tumbling had a synergistic effect on maintaining the moisture content, extraction of MfP and GS while both together also had a reducing effect on proteolysis, EM and TBA values of the processed but uncooked fish muscle. The electrophoretic pattern was not noticeable different and the reason for these small alterations in the protein components might be due to very little proteolysis taking place during the short tumbling time, and the fact that the sample was only approximately three days of post-mortem age in this experiment. Although all the treatments showed a fairly low proteolysis rate (TCA soluble nitrogen), the influence of tumbling and incorporation of egg white on proteolysis was statistically significant ($P<0.05$). As was expected, the results of the gel hardness with egg white addition was significantly higher than the control groups which agreed with Haman *et al.* (1990). Effective hydrophobicity was significantly influenced by the tumbling action and egg white addition. There were significant positive correlations ($P<0.01$) between pH and EPH, lipid content and TBA, and total nitrogen and GS. Increasing of the pH in the product, yielded more protein hydrophobicity which is thought to be related to a number of functional properties of food proteins (Kato and Nakai, 1981). As was expected, as the amount of protein increased, gel strength of the product increased, and the same is also true for the total lipid and TBA numbers. There was a negative relationship between pH and EM, pH and GS, and GS and lipid content. These correlations indicate that increasing the pH caused reduction in the amount of expressible moisture, and as would be expected, increasing the lipid content decreased the gel strength of the product.

CONCLUSIONS

It could be concluded that the tumbling technique and egg white addition would be a useful practice to increase functional properties and to alter structure of fish proteins during the processing of an acceptable restructured fish product.

REFERENCES

AKSNES, A. 1988. Location of enzymes responsible for autolysis in bulk-stored Capeline. *J. Sci. Food Agric.* 44:263.

ANON. 1991. *Mini-protean II Ready Gels Instruction Manual.* Bio Rad Co. Richmond, Ca.

AOAC. 1980. *Official methods of Analysis of Association of Analytical Chemists.* 13th edition. Assoc. Offic. Anal. Chemists, Washington, D.C.

BERGMAN, M., and LOXLEY, R. 1963. Two improved and simplified methods for the spectrophotometric determination of hydroxyproline. *Anal. Chem.* 35: 1961.

BOOREN, A.M., MANDIGO, R.W., OLSON, D.G., and JONES, K.W. 1981. Vacuum mixing influence on characteristics of sectioned and formed beef steak. 46:1673.

CHUNG, K.H., and LEE, C.M. 1990. Relationship between physicochemical properties of non-fish protein and textural properties of protein incorporated surimi gel. *J. Food Sci.* 55:972.

HAARD, N. F. 1992. Control of chemical composition and food quality attributes of cultured fish. *Food Res. Int.* 25:289.

HAMANN, D.D., AMATO, P.M., WU, M.C., and FOEGEDING, E.A. 1990. Inhibition of modori (gel weakening) in surimi by plasma hydrolysate & egg white. *J. Food Sci.* 55:665.

KATO, A., and NAKAI, S. 1980. Hydrophobicity determined by fluorescence probe method and its correlation with surface properties of proteins. *Biochim. Bioph. Acta.* 624:13.

LEE, C.M., and CHUNG, K.H. 1989. Analysis of surimi gel properties by compression and penetration tests. *J. Texture Studies.* 20:363.

MAKI, A.A., and FRONING, G.W. 1987. Effect on the quality characteristics of turkey breast muscle of tumbling whole carcasses in the presence of salt and phosphate. *Poultry Sci.* 66:1180.

MANGINO, M.E., FRITSCH, D.A., LIAO. S.Y., FAYERMAN, A.M., and HARPER, W.J. 1985. The binding of n-alkanes to whey protein concentrates as predictor of their functionality. *NZ J. Dairy Sci. and Technol.* 20:103.

NETTLETON, J.A., ALLEN, V.H., KLAT, L.V., RATNAYAKE, W.M.N., and ACKMAN, R.G. 1990. Nutrients and chemical residues in one to two pound Mississippi farm raised channel catfish (Ictalurus punctatus). *J. Food Sci.* 55:594.

OCKERMAN, H.W. 1985. *Quality Control of Muscle Tissue.* The OSU. Dept. of Anim. Sci., Columbus, OH.

PARRISH, F.C., and PATERSON, B.C. 1988. Effects of salt and phosphate on myofibrilar/cytoskelatal proteins of bovine skeletal muscle. *Proc. 34th ICMST.* Brisbane, Australia. p.315.

PENSEL, N.A. 1990. *Influence of experimental conditions on porcine muscle and its effect on oxidation.* MS Thesis. The OSU. Dept. of Anim. Sci., Columbus, OH.

RASYID, F. 1992. *Properties of protein extracted from desiccated coconut.* PhD. Dissertation. The OSU. Dept. of Food Sci. and Tech. Columbus, OH.

SUZUKI, T. 1981. *Fish and Krill Protein Processing Technology.* pp 260, Applied Sci. Pub. Ltd. Essex, UK.

TOYOHARA, H., SAKATA, T., YAMASHITA, K., KIMOSHITA, M., and SHIMIZU, Y. 1990. Degradation of oval-filefish meat gel caused myofibrillar proteinases. *J. Food Sci.* 55:364.

Table 1. Least Square Means with Standard Error for protein fractionation results of fresh, or processed but uncooked fish muscle (% ± standard deviation).

	FRESH	CNT	CT	ENT	ET
Fresh protein (%)	16.02^{b} ± 0.56	16.39^{a} ± 0.70	16.52^{a} ± 0.52	16.55^{a} ± 0.42	16.60^{a} ± 0.58
Myofib. protein (%)	10.17^{b} ± 0.73	9.69^{b} ± 0.55	9.92^{b} ± 0.32	10.08^{b} ± 0.60	10.81^{a} ± 0.27
Sarcopl. protein (%)	4.66^{b} ± 0.46	5.08^{a} ± 0.60	4.89^{ab} ± 0.55	5.17^{a} ± 0.91	4.93^{ab} ± 0.82
Collagen protein (%)	0.83 ± 0.08	0.89 ± 0.08	0.91 ± 0.07	0.86 ± 0.09	0.84 ± 0.06
% Non-protein nitrogen	0.19^{c} ± 0.10	0.22^{b} ± 0.11	0.20^{bc} ± 0.09	0.25^{a} ± 0.09	0.21^{bc} ± 0.06

SD: Standard deviation
FRESH: Zero Time Condition
CNT: Control-Non-Tumbled
CT: Control-Tumbled
ENT: Egg White Added-Non-Tumbled
ET: Egg White Added-Tumbled

^{a,b,c} Means with the same superscript letters in a column are not significantly different (P>0.05).