Development of Edible Texturised Dried Fish Granules From Low-Value Fish Croaker (*Otolithus argenteus*) and Its Storage Characteristics

B. R. Chavan[1,3*], S. Basu[2], and S.R. Kovale[3]

[1]*AARM, SERD, Asian Institute of Technology, Pathumthani, Thailand*

[2]*Central Institute of Fisheries Education, ICAR, Varsova, Mumbai, India*

[3]*College of Fisheries, Dr. B. S. Konkan Agricultural University, Ratnagiri. India*

** Corresponding author. E-mail: st104172@ait.ac.th*

ABSTRACT

Malnutrition is one of the major problems faced all over the world and particularly prominent in the developing countries. However, large quantities of fish are discarded at sea because it is uneconomic to preserve and bring them ashore. Croaker, a by-catch, is the best example of such fish. The world consumption of fish would be doubled if its unutilized or underutilized resources could be brought into human food chain.

To find the utilization of the presently wasted by-catch, an attempt has been made in this study to prepare texturised dried fish granules, using minced fish meat and low-cost technology. The final product was obtained by using the salt concentration of 12g/100g of minced meat, boiling time of 10 min and mixing time of 6 min at 100 rpm.

Final developed texturised dried fish granules had moisture content 6.45±0.45%, crude protein 60.32±0.54%, crude lipid 1.56±0.52%, crude fiber 0.253±0.57% and ash 30.686±1.21% on dry basis. These dried fish granules were stored in 200-gauge polythene bags. During the four-month storage period, moisture content did not change much. The TVB-N values increased slowly but steadily, reaching a value of 39.2 mg% after four months. No bad odor was developed during the period of storage. Peroxide value and free fatty acid value also increased slowly with storage period. The low crude lipid content of dried granule i.e., 1.56%, the peroxide value of 6.8 milliequivalent/ 1000g of oil and free fatty acid value of 11.5% as oleic acid did not impart any off odor to the product after four months of storage. The total bacterial count increased very slowly with storage period. There was no discoloration of the product during four months of storage. Chemical analysis and sensory evaluation showed that the product was in prime acceptable form for four months of storage at ambient temperature.

The developed texturised fish granules from boiled fish minced meat imparted good odor and texture to the fish granules. Boiling reduces the bacterial count considerably and denatures the proteins. Use of 12g salt/100g of minced fish meat further denatures the protein, resulting in release of some moisture. Drying

for 12 hours at 43-45°C reduced the moisture level to 6-7%. Due to low moisture level and high salt concentration, the product was stable upto four months. A well-dried fish granule has a shelf life of several months and does not need any expensive facilities compared to frozen fish. If the raw materials used are quite fresh, the quality of the dried fish granule will also be very good. When stale fish are used, the texture of the dried fish granule is quite soft and disintegrates when boiled in water.

Key words: Texturised granules, Fish granules, Edible fish granules.

INTRODUCTION

World fish production has peaked at around 128.8 million tons but only just over 60% are used for human consumption and almost 40% are not used for this purpose. The fish that are not utilized for human consumption include 30 million tons of small pelagic fish used for production of fishmeal and some 20 million tons of discarded by-catch (Chandrapal, 2005).

Large quantities of fish are discarded at sea because it is currently uneconomic to preserve and bring them ashore and the lack of suitable refrigerated storage space onboard. Shrimp by-catch (other than shrimp) is the best example of such fish. Factors discouraging the landing of the shrimp by-catch are the low market value of the material, size and shape of the different species. Marine fish species like silver bellies, flatfish, ribbon fish, sciaenids, carangids and catfish constitute low value (FAO, 2005). In addition, a significant amount of fish quality is lost during improper distribution, handling and processing (Bhattacharaya et al., 1993).

In Asia, due to the recent interest in intensive deep sea fishing in the Exclusive Economic Zone (EEZ), lot of deep-sea fish are expected to land which may not be immediately acceptable to the consumer due to the unfamiliarity with the shape, size, color and flavor of the new varieties (Gopakumar et al., 1975).

World population will increase from 6 to 8.5 billion in the next 25 years. Meat and fish production must double in the next 25 years to meet projected demand. Food imports will not provide a complete solution to food security problems. Increases in productivity are the only real option. So there is still scope for improving supplies of fish for human consumption. Most of the fisheries resources have reached their maximum potential for captured-fisheries production, with the majority of stocks being fully or over exploited. Therefore, in order to prevent potential future shortages in the food supply, the maximum utilization of the existing catch will have to be assured (ASEAN-SEAEDEC, 2001).

World consumption of the fish could be more than doubled if present under-rutilized or unused resources are brought into human food chain. These resources remain unused, not through a lack of catching technology, but through our inability to transform them into stable, acceptable product and to distribute these products to the people who need them at a price they can afford.

To achieve this goal, portions of the catch that tend to be of low economic value/ trash fish may be used for the development of new value-added product by using low-cost technology.

MATERIALS AND METHODS

Fish

Croaker (*Otolithus argenteus*), low-value marine fish ranging from 180-250 mm long were collected in good condition and brought to laboratory under ice. The raw materials were washed thoroughly in potable water so as to remove the slime, blood, dirt, etc. and weighed on balance. The fish were dressed by removing head, scales and visceral parts after splitting open the belly. The dressed fish were again washed in water so as to remove blood and then again weighed. Care was taken to avoid damage of the fish flesh. The dressed yield was 75%.

Hand meat mincer

A stainless steel with single screw hand meat mincer (meat pickling machine) was used for preparation of minced fish meat (Gopakumar, 1997). The internal opening of the die was prepared by 3 mm in the central workshop of the Central Institute of Fisheries Education (CIFE), Mumbai. Food-grade sodium chloride (table salt) and fine turmeric powder were used in the development of granules.

Preparation of minced meat

The dressed fish were cooked at 73-75°C (Gautam, 1996). After cooking, the fish were taken out and allowed to cool at room temperature. The skin was removed by hand. The muscle proteins along with small bones were then separated from back bone by hand. This separated meat was then passed through small hand meat mincer to free it from the small bones. The minced meat can be used for the preparation of fish sausage, cake, cutlets, patties, ball pastes, texturised product, etc. (Morehead, 1974). This minced meat was used for preparation of texturised granules.

Development of granules

The texturised fish granules were prepared by using minced meat. For development of desirable texturised fish granules, different concentrations of sodium chloride (7.5%, 10%, 12.5% and 15%), different cooking times (5.0, 7.5, 10.0 and 12.5 minutes) and various mixing times at 100 rpm (2, 4, 6 and 8 minutes) and small pinch of turmeric powder were used. The granules were prepared in triplicates.

The ingredients were mixed thoroughly and left for 15 minutes. The salt denatures the protein and loosens the water. The loose water was squeezed out by hand-pressing it in a cheese cloth. These squeezed pressed materials were then passed through a hand meat mincer, having 3 mm single opening, keeping always a pressure on the feed.

Drying of granules

The granules emerging from the meat mincer were dried in a mechanical drier at 43-45°C for 12 hours. The moisture content of dried granules laid between 6 and 7% (Bhattacharya et al., 1993).

Integrity test

The dry, texturised granules were boiled in tap water for 10 minutes and the number of pieces from single test sample which had disintegrated was noted. After boiling, the samples were also chewed to determine the texture and examined visually for their shape, while the residual water was checked visually for cloudiness. Three replicated samples were used.

Proximate composition

Proximate composition of the fresh fish muscle and final dried fish granules were analyzed. The moisture content was determined by drying the samples at 105°C to constant weight; the crude protein content was determined with the Kjeldahl technique, using conversion factor of 6.25; the crude fat content was determined with the Soxhlet technique, with petroleum ether as a solvent (Folch et al., 1957); the total ash content was determined by combusting the samples at 550°C and the crude fiber was also determined by using the fibertec system (Tecator, 2000).

Biochemical and microbial changes

Free fatty acid (FFA) and peroxide value (PV) were analyzed by using standard method (Egan et al., 1981) and changes in biogenic amines such as TVB-N (Capillas and Horner, 1999) were also investigated.

Microbial analysis of dried fish granules, total plate count was quantified by using spread plate technique (Mehlman, 1984).

Organoleptic evaluation

Sensory attributes of dried fish granules, taste, texture, odor, appearance and overall acceptability were evaluated. The evaluation was conducted using a 7-point hedonic scale (1= Dislike extremely, 7= Like extremely) by ten semi-trained panelists who were selected from students and staff of CIFE, having same ethnic (Larmond, 1977).

Statistical analysis

Fish were treated as independent samples. Proximate composition (crude protein, crude lipid, moisture, ash and crude fiber) of fresh fish and final dried texturised granules of fish were subjected to one-way analysis of variance (ANOVA). Analyses were performed by using statistical application and differences were considered significant at an alpha level of 0.05.

RESULTS AND DISCUSSION

Dehydrated texturised granules were developed from sciaenid fish croaker (*Otolithus argenteus*), using simple chemicals like common salt and turmeric powder (Setty,1989). The proximate compositions of fresh fish croaker were moisture 77.13±0.44%, crude protein 18.56±0.52%, crude lipid 2.63±0.41%, crude fiber 0.367±0.41% and ash 1.39±0.52%. To determine the optimum salt concentration in the product in order to get most acceptable dried product as far as texture and binding is concerned, four different concentrations were used. The effect of different concentrations of salt on granular texture is presented in Table 1.

Table 1. Effect of different concentrations of salt on granular texture.

Sample no.	Minced meat (gm.)	Concentration of salt (%)	Texture of the product.
I	100	7.5	Very tough and rubbery texture
II	100	10.0	Soft close texture
III	100	12.5	Soft close texture
IV	100	15.0	Soft open texture

It can be seen that the low concentration of salt gives tough texture of the fish product while high concentration of salt gives soft texture, so optimum salt concentration in the fish product can be adjusted on the basis of organoleptic examination (Shenoy et al., 1988).

In the integrity test and organoleptic evaluation, it was found that 7.5g salt/100g fish meat gave very tough and rubbery texture while sample with 15g salt/100g meat gave too soft open texture and the product disintegrated very easily (inadequate binding). The texture of the product with 10g and 12.5g salt/100g fish meat was quite soft and acceptable. To finalize the optimum salt concentration, another experiment was conducted with the salt concentration of 10, 11, 12 and 13g per 100g minced fish meat. The integrity test and organoleptic evaluation showed that sample III with 12g salt /100g of minced fish meat gave the best soft close meaty texture. In this experiment, boiling time used arbitrarily was 10 minutes.

To see the effect of different boiling times 5, 7.5, 10 and 12.5 minutes on quality of the texturised granules, the integrity test and organoleptic evaluation showed that the product prepared from minced fish meat which was boiled for 10 minutes at atmospheric pressure gave best soft meaty texture (Table 2).

Table 2. Effect of different boiling times on granular texture.

Sample no.	Boiling time (min)	Texture of the product.
I	5.0	Less juicy, tough and slightly rubbery texture
II	7.5	Less juicy, tough and slightly rubbery texture
III	10.0	juicy, soft and meaty texture
IV	12.5	tough and rubbery texture

As a result of cooking, taste, appearance and nutritive value of the products are improved through protein coagulation, partial extraction of moisture, arresting microbial and enzymatic activities. Collagen (connective tissue) hydrolyses and gets converted into a soft gelatinous substance. The skin of the flesh softens, the substances in tissue break down and the bond between the skin and muscle weakens. The connective tissue as a supporting structure is destroyed through hydrolysis of collagen tissue in the septa and perimysium region, so that there is no longer any link between the muscle and bones. So muscle can be easily separated from bone. As a result of protein coagulation and the break down of cells during boiling, flesh releases fat and moisture, water-soluble nitrogenous substances. These losses are directly proportional to the temperature and duration of cooking and inversely proportional to the fat content of the flesh and are ultimate reasons for cooking loss. The collagens in fish are less stable and are denatured at lower temperatures (Montero and Mackie, 1992). Most of the proteins get coagulated at 73-75°C; product can be considered cooked when core temperature reaches 75°C (Gautam, 1996).

Finalizing the mixing time

The ingredients, boiled minced fish meat, table salt and pinch of turmeric powder were mixed thoroughly before preparing the product. The ingredients were mixed in silent cutter at 100 rpm. at different time intervals, 2, 4, 6 and 8 minutes. The integrity test and organoleptic evaluation showed that the product prepared from minced fish meat which was mixed for 6 minutes mixing at 100 rpm gave the best acceptable binding and texture to the granules (Table 3).

Table 3. Effect of different mixing times on granular texture.

Sample no.	Revolution per minute (rpm)	Salt Conc. (%)	Mixing time (min)	Texture of the product.
I	100	12	2.0	Less juicy, tough and rubbery texture
II	100	12	4.0	Less juicy, tough and slightly rubbery texture
III	100	12	6.0	juicy, soft and meaty texture
IV	100	12	8.0	tough and rubbery texture

The final product was prepared with boiled fish, the optimum boiling time of the fish before mincing was found to be 10 minutes. The minced fish meat, when mixed for 6.0 minutes at 100 rpm with 12% salt and pinch of turmeric powder and passed through the hand meat mincer under positive pressure, gave the desirable texturised fish granules. These granules were dried in a mechanical drier at 43-45°C for 12 hours. The moisture content of dried granules was 6.45±0.45%, crude protein 60.32±0.54%, crude lipid 1.56±0.52%, crude fiber 0.25±0.57% and ash 30.69±1.21%. Texturised meat of Alaska pollock, moisture content 8%, gives colorless granules having no fishy smell and has good texture (Shenoy et al., 1988). The final dried fish granules contained 27.26±0.42% salt. The adequate salt absorption helps stop normal bacterial spoilage (Sankat and Mujaffar, 2004).

The dried fish granules were then packed in 200gauge polythene bag and sealed. The sealed bags were kept in screw-cap transparent plastic jars at room temperature and its storage characteristics were studied (Table 4).

Table 4. Storage characteristics of granular texture.

Storage period (month)	Moisture (%)	TVB-N mg%	Peroxide value milliequivalent peroxide/1000 g of oil	Free fatty acid % of oleic acid	Total plate count / g	Overall accepta-bility
0(initial)	6.45	33.4	2.92	3.8	2.1×10^2	7
1	6.50	33.6	3.49	4.9	2.4×10^2	7
2	6.38	35.2	3.70	5.2	3.2×10^2	6
3	6.50	36.4	4.90	8.7	4.3×10^2	6
4	6.52	39.2	6.80	11.5	5.0×10^2	5

Overall acceptability points: Like extremely - 7, Like very much - 6, Like slightly - 5, Neither like nor dislike - 4, Dislike slightly - 3, Dislike very much - 2, Dislike extremely - 1.

During the four-month storage period, moisture content did not change much. The total volatile bases nitrogen (TVB-N) values increased slowly but steadily, reaching a value of 39.2 mg% after four months (Fig 1). No bad odor was developed during the period of storage. Peroxide value and free fatty acid value also increased slowly with storage period, this is due to the fish muscle contains low levels of antioxidants such as ascorbic acid and tocopherols; however, their concentrations decline as storage time increases (Richards et al., 1998).

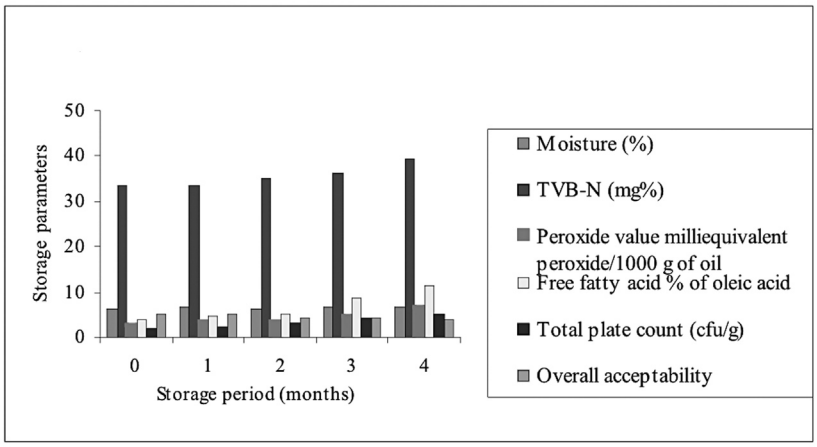

Figure 1: Storage characteristic of dried fish granules.

The crude lipid content of dried granules was as low as 1.56% and the peroxide value of 6.8 milliequivalent/1000g of oil and free fatty acid value of 11.5% as oleic acid during four-months storage period did not impart any off odor to the product after four months of storage. The oxidative stability of an oil or fat depends on the degree and nature of the unsaturation of its triglycerides, its antioxidants content, the presence of prooxidants such as trace metals (copper and iron) and storage conditions such as temperature (Pegg, 1999).

The total bacterial count increased very slowly with storage period. As the water content of the fish granules was very low (6-7%), the multiplication of bacteria was also slow at that low-water activity. Pinch of food-grade turmeric powder was used to prepare the fish granules which imparted the light yellow color to the fish granules. There was no discoloration of the product during four months of storage. Chemical analysis and sensory evaluation showed that the product was in prime acceptable form for four months of storage at ambient temperature.

CONCLUSION

The developed texturised fish granules from boiled fish minced meat imparted good odor and texture to the fish granules. Boiling reduces the bacterial load considerably and denatures the proteins. Use of 12g salt/100g of minced fish meat further denatures the protein, resulting in release of some moisture. Drying for 12 hours at 43-45°C reduces the moisture level to 6-7%. Due to low moisture level and high salt concentration, the product was stable to four months by preventing the normal bacterial spoilage. A well-dried fish granule has a shelf life of several months and does not need any expensive facilities compared to frozen fish. If the raw material used is quite fresh, water release after addition of salt is quite small and the quality of the final product would be very good. When stale fish is used, more water is released after addition of salt and the loose water should be squeezed out by hand pressing in a cheese cloth otherwise the texture of the final product will be soft and the fish granules will disintegrate when boiled in water.

The dual advantages of the developed texturised dried fish granules are: finding ways for maximum utilization of low-value fish species and providing protein-rich convenience foods, as has been pointed out. However, the key to the success of this approach depends largely on the market strategies utilized.

ACKNOWLEDGEMENTS

The authors are thankful to the Head, Department of Fish Processing Technology, CIFE for providing necessary facilities to carry out present work.

REFERENCES

ASEAN-SEAEDEC. 2001. Conference on Sustainable Fisheries for Food Security in the New Millennium. p.165-172.

Bhattacharaya, S., H. Das, and A.N. Bose. 1993. Effect of extrusion process variables on the product texture of blends of minced fish and wheat flour. Journal of Food Engineering 19: 215-235.

Chandrapal, G.D. 2005. Status of trash fish utilization and fish feed requirements in aquaculture in India. Paper presented at the Regional Workshop on Low Value and "Trash Fish" in the Asia-Pacific Region, Hanoi, Viet Nam. 7-9 June 2005.

Capillas, C. R., and. W.F.A. Horner. 1999. Determination of trimethylamine nitrogen and total volatile basic nitrogen in fresh fish by flow injection analysis. J. Sci. Food Agric. 79: 1982-1986.

Egan, H. R., S. Kirk, and R. Sawyer. 1981. Pearson's chemical analysis of foods. Eighth edition, Longman.

FAO. 2005.Asian fisheries today: The production and use of low value/trash fish from marine fisheries in the Asia-Pacific region. RAP publication 2005/16.

Folch, J., M. Lees, and G.H. Sloane-Stanley. 1957. A simple method for the isolation and purification of total lipid from animal tissue. J.Biol.Chem.226: 497-509.

Gautam, O.S. 1996. Fisheries World pub.: p.20-21.

Gopakumar, K., A.V.Shnoy, M.P.K. Ayyappan, M.A. James, and K.M. Iyer. 1975. Symposium on fish processing industry in India, Central food Technological Research Institute, Mysore. Feb, 13-14.

Gopakumar, K. 1997. Fisheries World, Feb.22.

Larmond, E. 1977. Laboratory methods for sensory evaluation of food. Research Branch, Canada Department of Agriculture, Publication.

Mehlman, I. J. 1984. Coliforms, fecal coliforms, E. coli and enteropathogenic E. coli. p. 265-285. In M. L. Speck (ed) Compendium of methods for the microbiological examination of foods. 2nd.ed. American Public Health Assoc. Washington, D.C.

Morehead, B. C. 1974. A report on national marine fisheries service comminuted fish cake survey. Mar. Fish, Rev. 36 (5): 34-37.

Montero, P., and I. M. Mackie. 1992. Changes in intramuscular collagen of cod (Gadus morhua) during post mortem storage in ice. J.Sci. Food Agric. 59: 89-96.

Pegg, A. 1999. Shelf-life. Nutrition & Food Science 99(3):131-135.

Richards, M.P., S.D Kelleher, and H.O. Hultin, 1998. Effect of washing with or without antioxidants on quality-retention of mackerel fillets during refrigerated and frozen storage. Journal of Agricultural and Food Chemistry 46(10): 4363-4371.

Sankat, C.K., and S. Mujaffar. 2004. Sun and solar cabinet drying of salted shark fillets. Proceeding of the 14th International Drying Symposium, Brazil, 22-25 August 2004, Vol.C:1584-1591.

Setty, T.M.R. 1989. Fish sausage and past product, recent trends in processing low cost fish.

Shenoy, V., T. Gopakumar, and L. Nair. 1988. Fishery technology, Vol. 25, No.2. Pub. : Society of Fisheries Technologists. p.127-129.

Tecator, F. 2000. Application Note 300: The digestion of nitrogen according to Kjeldahl blocks digestion and steam distillation.