

Shelf life Enhancement of Hardhead Catfish (*Aris felis*) Patties Making Use of Acetic Acid Induced Gelation of the Fish Proteins

G.K. Smruti^{*a}, V. Yardi^{*}, S.V. Sherekar, S.B. Warri^{**} and V. Venugopal

Food Technology Division
Bhabha Atomic Research Centre
Mumbai - 400 085, India

Hardhead catfish (*Aris felis*) meat was collected by mechanical deboning. A portion of the meat mince was converted into a gel by repeated washing in cold water followed by lowering its pH to 3.5 using acetic acid. The gel was also diluted in water to give a dispersion having a viscosity of 0.60 Pa.s. Patties from the catfish mince were prepared using a standard recipe. In some of the patties, the fish mince was replaced with the meat gel at a concentration of 10% (w/w). A few of the gel-incorporated patties were also given a coating with the gel dispersion. The patties containing the gel, coated with the dispersion or both were stored at 1-3°C. At periodic intervals, samples were analyzed for microbial and sensory quality. Sensory evaluation of the patties was conducted after shallow frying the product in refined vegetable oil. Incorporation of gel together with dispersion coating suppressed microbial growth in the product during storage. The product had a refrigerated shelf life of 3 weeks in comparison with a 2 week shelf life for the untreated patties, patties containing the gel, or those coated with the dispersion alone. The process of gel incorporation and dispersion coating offered a method for extended storage and distribution of catfish patties under chilled conditions.

Key words: Hardhead catfish, mild acid induced gelation, dispersion, patties, shelf stability

The need for better utilization of low cost fishery products as human food has been felt because of dwindling stocks of commercially important fish species and the rising demand for fishery products. There is increasing awareness of the nutritional benefits of seafoods, particularly among the elderly populations (Sloan, 2002). Techniques for value addition of fish should, therefore, be aimed to enhance shelf life and consumer acceptability of the products to satisfy changing market requirements.

Of the different methods currently popular for value addition, development of surimi and seafood analogues forms a major tool for utilization of low cost fish species (Lanier and Lee, 1992). Product development through surimi processing makes use

of gel forming properties of fish structural proteins at neutral or slightly alkaline pH conditions (Stone and Stanley, 1992). The gelation of fish proteins under these conditions could be modified by incorporation of suitable additives to alter textural attributes of products and simulate popular items such as lobster tails and shrimp. Currently there are interests in applying alternate methods of gelation in order to explore additional benefits of gel formation of fish proteins (Lian *et al*, 2002). We have observed that washed fish meat could undergo gelation when its pH is lowered to around 3.5 by weak organic acids (Venugopal & Shahidi, 1994). The property of fish meat to undergo mild acid-induced gelation could be used to prepare products such as spray dried fish

^{*} College of Home Science, Nirmala Niketan, Mumbai - 400 068; ^{*a} M.Sc. Home Science student.

^{**} Corresponding author

powder, biodegradable film and restructured steaks from shark meat (Venugopal *et al*, 2002; Venugopal, 1997). Some of the other plausible applications include use of acid-induced gel as a binder in products and use of water dispersion of the gel as an edible coating to control microbial spoilage, due to its antimicrobial properties. Recently, we have reported that protein dispersion from acid induced gel of fish meat could be used as a coating to enhance the shelf life of both marine and freshwater fish and prevent dehydration during frozen storage of mackerel mince (Panchavarnam *et al*, 2003; Kakatkar *et al*, 2004).

Catfish forms about 2% of total marine landings in India. Most catfish are freshwater varieties, but there are some salt water varieties which include hogfish and hard-head catfish. Hardhead catfish (*Aris felis*) is abundantly found in bay and Gulf waters. The fish has no commercial value mainly because of its unappealing appearance. Development of cost-effective technology to process the fish can help increase its market value. In this paper we report a process for extended storage of patties from the meat mince of the fish making use of the mild acid-induced gel forming properties of the fish proteins.

Materials and Methods

Hard head catfish (*Aris felis*) were purchased from the local market and brought to the laboratory in ice. The average weight and length of the fish were 1.2 kg and 65 cm, respectively. The fish were beheaded, split dorsoventrally and eviscerated. The dressed fish were washed in cold potable water and the meat mince was collected using a laboratory model mechanical deboning machine. The meat mince was washed in cold water, homogenized in a food processor (Singer, Mumbai, FP-300) and was used for preparation of patties, using a standard recipe. The meat mince (100g) was mixed with chopped onion (85g), boiled potato (75g), tomato puree (50g), garlic (5g),

ginger (5g), green chilli (5g) coriander (10g), salt (5g) and refined vegetable oil (5g). The onions were fried for 5 min, to which garlic, green chilli, ginger, coriander and tomato puree were added and stirred for 3 min. To this the mince was added and fried. After removing from the flame, grated potato and salt were added and mixed well. The mix was filled in wooden moulds to get patties having 1 cm thick and 6 cm diameter.

A portion of the fish meat mince was used for preparation of gel as well as gel dispersion. For this, the mince (500 g) was suspended in three times its weight of cold water (<10°C) and stirred gently. After 30 min, the slurry was passed through a nylon sieve to remove the wash water and the washed mince was collected. The washing process was repeated twice and to the washed mince glacial acetic was added drop-wise while stirring, till the pH was lowered from 6.8 to 3.5.

In order to prepare the dispersion, the gel (100g) was homogenized for one min in a 'Sumit' kitchen homogenizer with 200 ml of cold water containing a few drops of glacial acetic acid. The dispersion thus obtained was used as edible coating. Viscosity of gel and dispersion was measured using a Brookfield synchro-electric viscometer model LVT (D.W. Brookfield Ltd., Cooksville, Ontario) (Venugopal and Shahidi, 1994). During measurements, the gel or dispersion (200 ml) was held in a chilled water bath. The viscosity was measured at a rotation speed of 50 using a spindle No. 1 for the gel, and No. 6 for the dispersion. The values were recorded after 30 sec rotation of the spindle in the sample. Viscosity values were obtained from the reading using the conversion factor provided by the manufacturer and were designated as apparent viscosity which were expressed as Pascal.second (Pa.s.) The viscosity of the dispersion was adjusted to 0.6 Pa.s by adding required chilled water.

The meat mince in the patties (40 Nos) were replaced with the gel at 0, 10, 15 or 20%

(w/w) level. Some of the patties were also given a coating with the dispersion by dipping in equal amount of the gel dispersion for one min. Thus, four groups of patties, (each containing 10 patties) were prepared, namely, untreated control (C), gel incorporated (GI), dispersion coated (DC) and gel incorporated and dispersion coated (GI-DC). The patties thus prepared were aerobically packaged in 300 gauge polyethylene pouches and stored at 1-3°C. At periodical intervals, the products were evaluated for microbiological and sensory qualities.

Total plate counts (TPC) were determined by standard procedures. The patties (10 g) was homogenized for 1 min in 90 ml sterile saline in a sterile Sorvall cup (Sorvall Corp., Norwalk, CT, USA). The homogenate was serially diluted in saline. The colony forming units (cfu) were determined by plating 1 ml aliquot of appropriate dilutions in sterile petriplates using nutrient agar. The plates were incubated at room temperature for 48 h and an average of two replicates was taken.

Sensory evaluation of the product was done according to the guide for new product development (IFT, 1981). The product was shallow fried to golden brown for about 15 min in refined sunflower oil. The fried samples were served to 6 staff members of the department experienced in seafood evaluation. The panelists evaluated the product for appearance, texture and flavour on a 5-point scale. A score of '5' indicated characteristic of freshly prepared patties associated with golden brown appearance, hard texture and fishy flavour, '4', slight loss of freshness characteristics, '3', noticeable loss, '2', significant loss of the above characteristics. A score of '1', indicated a product having disintegrated, soft and fibrous texture, and stale flavour.

Consumer evaluation survey was conducted to examine the consumer acceptability and market value of the product. For this, the gel incorporated and dispersion coated

(GI-DC) patties after frying were served to 100 persons (65 female and 35 male) of the general public, who were above 18 years of age, non-vegetarians and residents of Mumbai. The preference scale used was the following: A score of '9', I would eat this with every opportunity I have; '8', I would eat this very often; '7', I would eat this often; '6', I like this and would eat it now and then; '5', I would eat this but not go out of the way to do so; '4', I would eat this in absence of any option; '3', I would hardly ever eat this; '2', I would eat this under compulsion; and '1', I would not eat this even under compulsion. The data was analyzed statistically using standard methods.

Protein, moisture, crude fat and salt contents of catfish mince and patties were determined according to standard methods (AOAC, 1990). Protein (N x 6.25) was determined by micro-Kjeldahl method using a Kjel-plus KPS - 012 digestion system and Distil M semi-automatic distillation system (Pelican Instruments Co., Chennai). For measuring pH, the patties were homogenised in equal amount of distilled water, and was subjected to a pH meter (Global Electronics, Hyderabad).

Results and Discussion

Mechanical deboning of dressed catfish gave a mince which was greyish in colour, with a yield of 45% of total fish weight. Repeated washing of the mince with cold water enhanced the appearance and odour of the mince by removing blood, pigments and nitrogenous odor producing compounds. However, washing did not completely decolourise the meat. Table 1 gives the proximate composition of the fish mince.

Table 1. Proximate composition of washed hardhead catfish mince

Parameters	Concentration (%)
Moisture	83.2±0.4
Fat	0.7±0.2
Protein	16.0±1.2
Ash	0.4±0.2

Lowering of pH of the washed mince gave a thick gel. The gel was grey in colour and had an apparent viscosity of 144 Pa.s and a pH of 3.5. The protein content of the gel was 14.56%, the remaining water, with traces of lipids. The gel dispersion prepared was almost colourless with an apparent viscosity of 0.6 Pa.s.

Table 2 shows the proximate composition of patties. It was observed that incorporation of gel at 10% level gave a product, which after frying was acceptable as judged by sensory evaluation. However, incorporation of the gel at 15 or 20% level significantly affected the sensory acceptability of patties. The panelists observed a definite sour taste in patties having more than 10% gel (Table 3). Therefore, a gel concentration of 10% was used in further studies.

The patties, immediately after preparation had total plate counts in the range of 10^1 to 10^2 cfu per g. During chilled storage, microbiological counts increased in the case of untreated control (C) and gel incorporated (GI) samples, which reached a value of 2×10^8 and 9.8×10^7 cfu/g, respectively, after four weeks. The dispersion coated (DC) patties had a lower TPC of 7.4×10^6 cfu/g after 4

weeks of chilled storage, whereas, gel incorporated together with dispersion coated (GI-DC) patties had lowest microbial counts of 4.3×10^5 cfu per g after 4 weeks under the same conditions. (Fig.1). After 21 days of chilled storage, untreated control samples had a fungal count of 3.5×10^3 cfu per g, as compared with 1×10^3 for GI samples. DC and GI-DC patties had counts in the range of 2.5×10^1 cfu per g, only after the same period. The results suggest the effectiveness of gel incorporation and dispersion coating on control of microbial spoilage of the patties. The result could be attributed to the low pH as well as bacteriostatic effect of acetic acid, present in the gel as well as the dispersion. Acetic acid is known to inhibit most bacteria including pathogens as well as several yeasts and moulds. Acetic acid and/or lactic acid dips of catfish fillets have been shown to suppress the growth of aerobic microorganisms to give shelf life extension of the fish up to 16 days (Marshall and Kim, 1996). The inhibitory effect of acetic acid could be operating in conjunction with chilled temperature, both synergistically providing hurdles to microbial proliferation in the product.

Table 2. Proximate composition of hardhead catfish patties

Parameters	Control	GI	DC	GI-DC
Moisture	65.0±0.5	63.0±0.64	66.5±0.5	67.5±0.4
Fat	2.0±1.3	1.5±0.5	1.5±0.3	1.5±0.7
Protein	18.5±2.1	21.6±2.4	20.0±1.6	22.0±1.1
Carbohydrate	11.5±0.6	11.8±0.4	9.3±0.7	7.3±0.2
Ash	2.1±0.02	2.1±0.4	2.1±0.9	1.92±0.4

Patties: GI, Gel incorporated; DC, dispersion coated; GI-DC, gel incorporated and dispersion coated.

Table 3. Mean sensory score of catfish patties containing varying concentrations of fish meat gel

Sensory score	Gel concentration in patties			
	0%	10%	15%	20%
Appearance	7.8±0.8	7.6±0.6	7.6±1.3	7.3±0.2
Flavour	8.0±1.0	7.3±1.4	7.0±0.2*	6.1±0.3*
Overall acceptability	7.9±0.6	7.9±2.0	7.5±0.6	6.8±0.3*

* Significantly different from control, $p < 0.05$. Freshly prepared patties were evaluated.

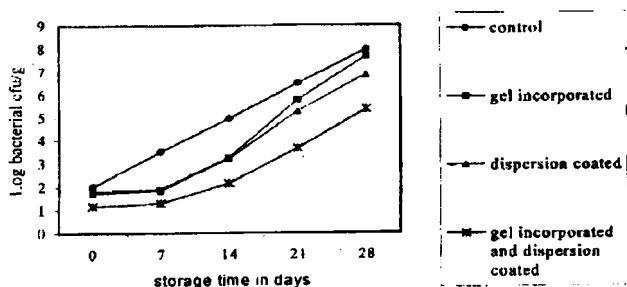


Fig. 1. Total bacterial score of *Aris felis* patties during chilled storage

Sensory evaluation data on the product during refrigerated storage is presented in Fig. 3. All the samples had comparable acceptability up to 14 days of storage. However, after 14 days, control, GI and DC samples had higher microbial counts, as shown above, whereas GI-DC patties had lower microbial counts. Therefore, the GI and DC samples were not evaluated after 14 days because of the higher bacterial counts (10^4 cfu per g or above). The GI-DC samples, on the other hand, had lower microbial counts up to 21 days ($< 10^4$ cfu per g) and also had sensory acceptability when evaluated on 21 days of storage. The results suggested enhanced shelf life for the patties incorporating 10% gel and coated with the dispersion. None of the panel members reported sour taste in any of the products. This suggested that traces of acetic acid in the product could not impart any unacceptable flavour to the product.

Development of edible coatings and films is one of the current areas of research because of the realisation of their potential to act as adjunct for improving overall food

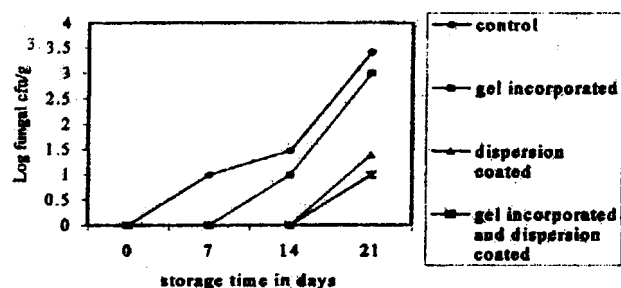


Fig. 2. Total fungal score of *Aris felis* patties during chilled storage

quality, extending shelf life and possibly improving the economic efficiency of packaging materials (Venugopal, 1998; Cuq *et al*, 1995; Krochta *et al*, 1994). These films can also function as carriers of food additives such as antioxidants and antimicrobials (Labuza, 1996; Krochta *et al*, 1994). While most of the studies deal with use of films made of polysaccharides and alien proteins, in the present study, the catfish patties were coated with a gel dispersion prepared from the same fish muscle proteins, which provided protection against microbial growth. In addition, the gel incorporated in the patties also suppressed microbial growth, apart from serving as a binder. We have recently reported feasibility of application of mild acid induced fish meat gel in controlling quality loss in fresh chilled fishery products and frozen mackerel (Panchavarnam *et al*, 2003; Kakatkar *et al*, 2004).

Consumer evaluation indicated acceptability of the product. Male (34%) and female (38%) of the consumers opined that they would eat the product often, while 29% male and 18% female members were willing to consume the patties at every opportunity they have. Several consumers were of the opinion that the patties could be popularized in the form of fish burgers. The male and female members were willing to pay a price of Rs.14.5 $\pm$ 2.0 and Rs.10.25 $\pm$ 0.75, respectively per patties. The cost price of preparing one patties at the laboratory was approximately worked out to be Rs.3/-. Therefore there is potential for value addition of the fish through this method. The extended shelf

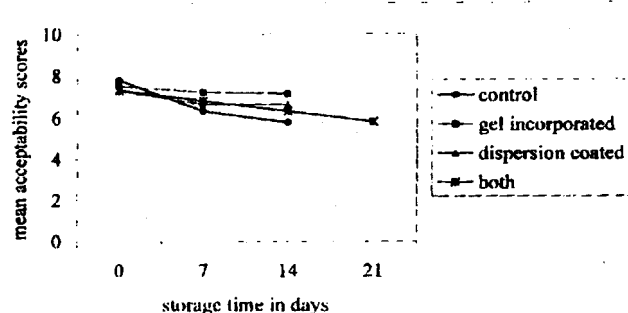


Fig. 3. Mean acceptability scores of patties

life through gel incorporation and dispersion coating could help in better distribution of the product. There is scope for application of this technology to other low cost fish species also for their better utilization.

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