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Research Article
Quality Changes of Pangas Catfish (*Pangasianodon hypophthalmus*) Fillet During Ice Storage

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Abstract

Background and Objectives: Fish fillet has limited shelf life and is subjected to get more spoilage than the whole fish. Icing could be a suitable method to extend shelf life of fish fillet, among others. This research was designed to determine the changes in fillet quality of pangas catfish (*Pangasianodon hypophthalmus*) during ice storage. **Methodology:** Pangas catfish was collected from the farm directly with iced condition. Iced fish were filleted and packed with polyethylene pouch and stored into finely crushed ice (±1°C) into a well-insulated ice box for a period of 21 days. Fish handling, processing and hygiene's were maintained after following Food and Agriculture Organization (FAO) code of conducts for fresh fish handling. Sensory (organoleptic test) and biochemical test (protein solubility, gel forming ability, gel strength, total volatile based nitrogen, muscle pH) were conducted to determine fillet quality with a three days' interval. The data were analyzed and tested (significance) through one-way Analysis of Variance (ANOVA) single factor, Chi-square test and Duncan's Multiple Range Test (DMRT). **Results:** The pangas fillet was found acceptable up to 18 days of iced storage. Myofibrillar protein solubility for fresh fillet was 88.21%, gradually decreased to 28.12% at the end of 21 days. The gel forming ability and initial breaking force was found reducing at 21st day of study period; indicate gradual decrease in quality. Get strength was found highest in higher temperature. Total volatile base nitrogen value of fresh muscle was 1.68 mg/100 g, finally increased to 32.45 mg/100 g at 21 day, which exceed the recommended range. The pH of the muscle immediately after death was 7.07, fall to 5.89 after 12 days and again raised to 6.88 after 21 days of ice storage. **Conclusion:** Pangas catfish fillet could be preserved in iced condition for 21 days. However, 18 days shelf life was found best. Study showed a gradual decrease in fillet quality for the whole study period.

Key words: Fillet, quality change, sensory test, biochemical test, ice storage, *Pangasianodon hypophthalmus*

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

For decades, pangas catfish (*Pangasianodon hypophthalmus*) has become one of the most important and promising commercial aquaculture species in the South Asia[1]. Among the number of aquaculture species, pangas catfish has great aquaculture potential owing to its ability to grow under less nursing conditions, omnivorous feeding habit and common disease resistance capacity[2]. Pangas is a popular fish for its relatively cheaper price, high growth rate, juicy and tender taste, color, flavor and high market demand[3]. This species has usually been vended as whole fish, preferred in fresh condition[4]. Whereas, the consumers propensity to this fish is further toward fillets and packaged products rather than whole fish[5]. Therefore, the demand for quality pangas fillets is growing rapidly at the cost of frozen fillets[6]. Moreover, demand from domestic market for pangas catfish is growing. *Pangasianodon* spp., has become popular in the Europe, Asia and American catering sectors[7]. Demand for pangas catfish has been increasing throughout the world and will be. House hold consumption of this catfish is increasing expectedly and within ten years' demand will be doubled[5].

Fish and fish fillet has limited shelf life in compared to other fresh foodsdue to the high water activity[8], higher portion of non-protein nitrogen, sarcoplasmic protein and little amount of carbohydrate. For these factors, fish and fisheries products are suspected to spoil rapidly compare to other foods[9]. Spoilage of fish and fisheries products depend on both chemical, microbial and enzymatic activities[10,11]. Fish fillets cut from fish body are very susceptible to different types of spoilage because fish muscles are directly exposed to air and microorganisms. Only lateral muscles are cut out from fish body in such a way that it removes the bone, belly fats, viscera etc.[12]. So, it is very essential to store at low temperature to increase the shelf life of fillet[7,13].

At present processors have lots of options to preserve the fish fillet quality, but every implemented option adds some more extra price to the main products. Ultimately consumers get extra burden and unwilling to pay more price[14]. The consumers general attitude is to get optimum quality fish with a cheaper price. The crucial factor to increase shelf life of fish and fisheries products is the temperature lowering from harvest to consumption[6]. The consumer preference is the high quality fresh fish with minimum processed activities without chemicals and preservatives[15]. Among other methods ice storage could be a best option to extend the shelf life of fish fillet as well as to keep to the fillet price comparatively lower. Icing could be a cheaper option to meet the consumer preferences[10]. Icing is commonly used where perishable food items are preserved at freezing point of the food and sometimes 1-2°C below this[6]. Ice made from potable water is free from any sort of chemicals and preservatives. Generally, the early initial freezing points of most fish products ranges between -0.5 and -2.8°C extend the shelf life for weeks of fish and fisheries products[16].

In the rural market areas of the developing countries do not have well managed cool chain system and there icing is the mostly used preservation technique. But some changes in fillet quality may occur during ice storage. Proper storage at low temperature reduces the deterioration and improves the quality of fish. However, the duration of quality ice stored fillet of pangas catfish is still elusive Therefore, it is essential to study quality profiles of pangas fillet along with the ice storage duration. The aim of this study was to investigate the changes in fillet quality (sensory quality, protein solubility, gel forming ability, TVBN (mg/100 g) value and pH value) during ice storage.

MATERIALS AND METHODS

Experiment design: Pangas catfish were collected from fish farm directly, about 8 km away from Fish Processing and Quality Control laboratory, Bangladesh Agricultural University (BAU). Fishing was done with purse seine net. Right after harvesting fish was cleaned by chilled water (-4 to -5°C). Immediately, harvested fish were transferred into the ice box to ensure minimum quality changes after following Food and Agriculture Organization (FAO) code of conducts for fish handling[17]. Average weight, length and width of collected catfish were 1.60 kg, 46 and 13 cm, respectively. It should be noted that live fish were sacrificed just after collection by quick ice-cold shock and sealed accordingly with delicately crushed ice with well insulated icebox (ICEY-TEK-PET). During investigation period fish handling were followed by EC guidelines and Codex Alimentarius Commission (CAC)[18].

Preparation of fish fillet and storage: Just after transportation to the laboratory, without delaying, iced fish were washed with chilled water (4±1°C) prior to fillet. Filleting was done within the post rigor stages to obtain good quality regular shape and sized fillet. Fillets were taken out by cutting the flesh from one side of the vertebral column length of the fish starting just behind the head, then turning the fish over and cutting a similar strip of flesh from the other side of the backbone. Filleting was done manually with sharp knife and skinned properly[12]. Following filleting, fillets were washed immediately with chilled water (4±1°C) to remove blood,

Table 1: Grade used in the folding test of the gel

Grade	Results on folding
AA	No crack visible when disc is folded into quarter
A	No crack visible when disc is folded into half, but one or more cracks or breaks are visible when folded into quarter
B	One or more cracks or breaks are visible when folded into half
C	Breaks, but does not split into halves
D	Split into halves when folded into half
0	Sample too soft to evaluate

Table 2: Score used in the teeth cutting test of the gel

Score	Characteristics of the gel
0-1	Paste or mud like gel
2-3	Very frail gel
4-5	Frail gel
6	Medium gel strength
7-8	Strong gel
9-10	Very strong gel

Table 3: Changes in organoleptic qualities of fillet of *Pangasius hypophthalmus* during ice storage ininsulated box

Days of storage	Mean defect points	Grade	Overall qualities
0	1.25	A	Excellent
3	1.57	A	Excellent
6	2.00	A	Excellent
9	2.20	B	Acceptable
12	2.90	B	Acceptable
15	3.97	B	Acceptable
18	4.60	B	Acceptable
21	5.00	C	Rejected

Table 4: Grading of fresh pangas (*Pangasius hypophthalmus*)

Grade	Points	Degree of freshness
A	<2	Excellent/acceptable
B	2 to <5	Good/acceptable
C	5	Bad/rejected

visceral part. Extra attention was paid to remove kidney tissues as they form globular masses, which affect both texture and appearance of the final product. Then fillets were packed with polyethylene pouch and stored into finely crushed ice (±1°C) in a well-insulated ice box (Model-ICEY-TEK-PET) for 21 days Required amount of samples were taken for analysis with a 3 days interval. It should be mentioned that the box had a hole at the bottom to drain out the melted ice. Storage in the box consisted of a bottom layer of ice, about 5 cm thick, layer of fish fillet sprinkled with ice and a final top layer of ice again about 5 cm thick. The fresh block ice prepared with ice maker (Model-CU1526SW-1A) inside of laboratory. Ice was finely crushed into small pieces and used for the purpose of whole experiment's period. During the each and every morning (8 h) and in the evening (20 h) melted ice was replenished. At selected time interval the samples were obtained for rthe experimental trials. Handling and hygienic techniques were followed by FAO code of conducts[17].

Organoleptic evaluation: In sensory analysis, general appearance, odor, flavor, color and texture were evaluated with organoleptic methods. The evaluation methods used in this study were based on the guidelines and methods for organoleptic quality of fish as described by FAO[17] code of conducts for fish freshness and EC guidelines[19] details in Table 1 and 2. The fish quality was graded by using the given score from 1.0-5.0 (Table 3, 4). The grades were defined in terms of the total number of defects points (Table 5).

Protein solubility

Preparation of myofibrils: Myofibrils was prepared from ice stored fish fillet muscle according to Fan *et al.*[20] and Groningen[21] with slight modification of Perry and Grey[22].

Myofibrllar protein solubility: A 2 mL of myofibrillar suspensions (5 mg mL^{-1}) were homogenized with 2 mL of 0.1 M KCl plus 100 mM phosphate buffer (pH 7.0) using a homogenizer. The homogenate could stand at refrigerated temperature (4°C) overnight. The suspension was centrifuged for 15 min at 1000×g in cold condition. The protein in supernatant was determined by Biuret method[23].

Gel forming ability

Preparation of meat paste: Fillets were taken out from icebox every 3 days' interval. Meat mincer (NOVENAii) was used to mince the fillets. Processing was done at 4°C during every operation to minimize denaturation. During preparation of mince, the products were always kept in ice cooled container. Immediately after mincing, the product was washed with chilled water containing 0.1% NaCl for two times. In every time, dewatering was done through pressing. Pressure was adopted on the mince kept in a flat cotton cloth bag at the rate of 5 kg cm^{-2} for 10 min and final pressing was done at 10 kg cm^{-2} for 15 min. Then washed mince was ground with 3% NaCl by a previously cooled (4°C) mortar for 25 min. Due to this grinding with salt, the mince was transformed into viscous paste. The salt ground paste was then carefully stuffed into heat stable polyvinyledene chloride cylinder manually and the both ends of the cylinder were wrapped with parafilm and polyethylene paper.

Table 5: Sensory (Organolaptic) quality attributes and of defect point specification of fish fillet[26]

Characteristics of whole fish	Defect characteristics	Defect points	Grade
General	Full bloom, bright, shining, iridescent	1	Excellent
Appearance	Slight dullness and loss of bloom	2	Acceptable
	Definite dullness and loss of bloom	3	Acceptable
	Reddish lateral line, dull, no bloom	5	Reject
Odor	Natural odor	1	Excellent
	Faint sour odor	2	Acceptable
	Slight moderate sour odor	3	Acceptable
	Moderate to strong sour odor	5	Reject
Color	Slight pinkish red	1	Excellent
	Pinkish red or brownish red, some mucus may be present	2	Acceptable
	Brown of gray color covered with mucus	3	Acceptable
	Bleached; thick yellow slime	5	Reject
Consistency of flesh	Firm and elastic	1	Acceptable
	Moderately soft and some loss of elasticity	2	Acceptable
	Some softening	3	Acceptable
	Limp and floppy	5	Reject

Preparation of gel: The paste in cylinders was heated to produce gel. Some samples were heated once only in well stirred water bath, whilst the rest were heated twice. For convenience, let's say the former method of heating is one-step heating and later is two-step heating. All heating treatment was done in triplicates.In one-step heating, samples were heated for 120 min in water bath at 50°C. For the two-step heating, the first heating was done for 120 min at 50°C. After this preheating treatment, they were immediately heated for another 30 min in water at 80°C. Then the samples were taken out and kept in iced water for 1 h. After cooling, samples were kept at refrigerated temperature (4±1°C) for overnight. Then cylinders were taken out from refrigerator, kept at room temperature for 15-20 min and subjected to the following tests.

Measurement of gel-strength: Products gel strength was assessed with both instrumental and organoleptic methods. A five person panel was hired for the organoleptic assessments[24]. The gels were removed from the cylinders and subjected to puncture test, folding test and teeth cutting test. Puncture test was done to measure the breaking strength of the gel against insertion of a ball type plunger (6 mm diameter)[25]. The folding test was conducted to measure the resistance against breaking along with the folds when sample discs of 1.0 mm thickness were folded into halves, then quarters[26]. The gel was graded using the scores presented in Table 1. Moreover, the teeth cutting test was followed to measure the resistance of the disc cut by the incisors by the members of the panel[27,28] and presented numerically in Table 2. It should be mentioned here that the gel forming ability was found highest after heating at 50°C both in both one and two step heating. Therefore, heating temperature of 50°C was chosen for both one and two steps heating.

Total Volatile Base Nitrogen (TVBN): Exactly 10 g of ground sample was weighed, mixed with 90 mL of 6% perchloric acid and homogenized for 2 min in cooled condition. A 100 mL of extract with 4-6 drops phenolphthalein were put in kjeldahl flask and then some glass-beads and 10 mL of 20% NaOH were added to the flask after placing on the distillation. The distillation continued for about 15 min. The distillate was collected in the conical flask containing 50 mL of 3% H_3BO_3 and one drop mixed indicator. Distillation was confirmed through changing the color of mixed indicator, i.e., violet to greenish. Then the collected distillate was titrated with 0.01 N HCL and regaining the violet color of mixed indicator confirms the end-point[29]. The results were expressed as mg of TVB-N/100 g sample according to the following equation[30].

$$\text{Amount of TVBN}\left(\frac{\text{mg}}{100\text{ g}}\right)\text{of sample} = \frac{\text{Miliequivalant}\times 0.014\times \text{Normality of acid}}{\text{Sample weight (g)}}\times 100$$

Measurement of muscle pH: The muscle pH of each individually identified fish fillet was measured. The pH was measured with inserting a pH probe (Checker 200, USA) into the upper mass of the fillet, just behind the head.

Statistical analysis: The data of such was analyzed by Randomized Completely Block Design (RCBD) and tested (significance) through the one-way Analysis of Variance (ANOVA) single factor, Chi-square test and Duncan's Multiple Range Test (DMRT) at $p<0.05$. The results have been presented as mean and standard deviation[30].

RESULTS

Organoleptic evaluation: The fillets were found acceptable upto18 days of ice storage and after this become inedible. The changes occurred in organoleptic quality during the storage period. There were very little changes occurred between 0-3 and 3-6 days without loss of normal flavor and odor. At these steps fishes had the characteristics of excellent quality. Between 6-9 and 9-12 days, there were little deterioration apart from some slight loss of natural flavor and odor and some loss of blossom. However, fillets were found acceptable in these days. During 12-15 days, there were signs of early spoilage with tart flavor. In the beginning of this phase the off-flavor was slightly sour, sickly sweet, fruity of like dried fish but the fillets were judged as acceptable quality. Within 15-18 days, fillet begins to taste stale, its bloody appearance and texture begins to show obvious signs of spoilage had an unpleasant smell in the limit of acceptance. For the duration between 18-21 days, fillets were become putrid by all characteristics and hence rejected (Table 5).

Protein solubility: The protein solubility decreased with the increasing storage period. The myofibrillar protein solubility was 88.21% in fresh samples and decreased to 28.12% at the end of 21 days of ice storage. It could be stated that, solubility decreased continuously with increasing of iced storage period (Fig. 1).

Gel forming ability during one step heating and two step heating: Gel-strength was found highest in two steps heating than one step heating process. Gel forming ability as well as initial breaking force of fish where initial gel strength was 790±4.472 g which decreased to 190±3.224 g at 50°C for 120 min after 21 days of ice storage whereas, it was 980±2.683 to 330± 3.898 g, at 50 and 80°C for 120 and 30 min, respectively after 21 days of ice storage (Fig. 2).

Total Volatile Base Nitrogen (TVBN): The initial TVBN value was 1.68 mg/100 g, which gradually increased with storage period. At the end of 21 days of ice storage TVBN value increased 32.45 mg/100 g, which is not within the range of recommended value of 25-30 mg TVBN/100 g for fresh fish (Fig. 3).

Muscle pH: The fish muscle pH immediately after death was around 7.07, which decreased gradually to 5.89 after 12 days in ice. Then it increased gradually up to 6.88 after 21 days (Fig. 4).

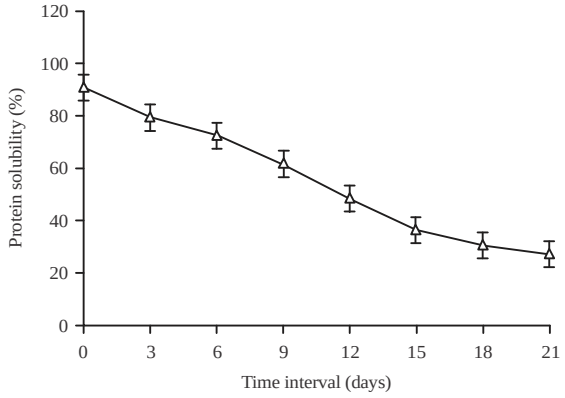

Fig. 1: Changes protein solubility (Mean±SD) of (*Pangasianodon hypophthalmus*) meat paste

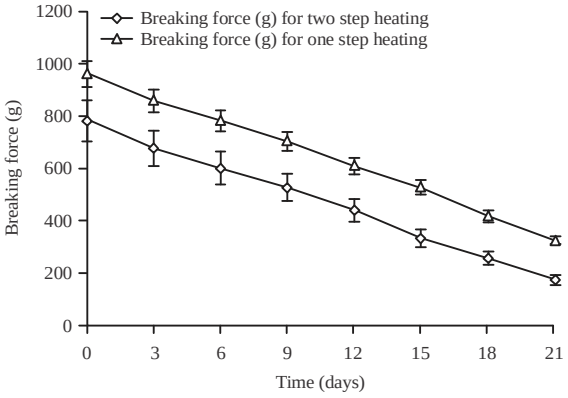

Fig. 2: Changes in gel strength breaking force (g) of pangas (*Pangasianodon hypophthalmus*) meat past in one step and two step heating during ice storage. Values were presented as Mean± SD

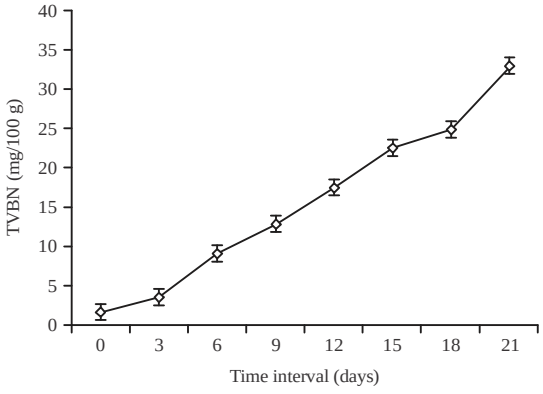

Fig. 3: Changes of TVBN-value (mg/100 g) (Mean±SD) of pangas (*Pangasianodon hypophthalmus*) muscle during ice storage

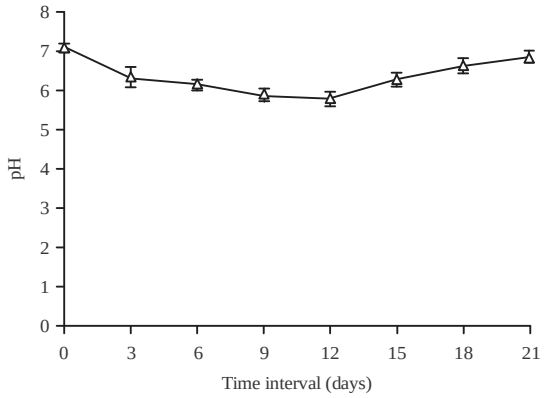

Fig. 4: Changes in pH (Mean±SD) of fish muscle of pangas (*Pangasianodon hypophthalmus*) during ice storage

DISCUSSION

Results of the organoleptic quality assessment of fillets of pangas (*Pangasius hypophthalmus*) fishes during ice storage in insulated box are presented in Table 5. The score points less than 2.0 were considered as excellent. The points from 2.0-<5.0 were judged as good or acceptable conditions, while 5 and above considered as bad or rejected. From the combination of all quality parameters from both sensory and biochemical test. The *Pangasianodon hypophthalmus* fillet was found safe to consume up to 18 days.The shelf life of pangas fillet is almost similar to that of reported for carps and other commercially fresh water fish species[22]. The shelf-life of sea bass stored in ice, as determined by overall acceptability sensory scores and microbiological data, is 8-9 days for filleted and 12-13 days for whole un-gutted fish. A general description provided by the FAO in the guide for assessing the quality of fish[17,31]. The high susceptibility to autolysis, oxidation and hydrolysis of fats and to alteration by microorganisms generate changes that affect the quality of the fish meat in terms of color, aroma, flavor and texture[16,28]. These sensory changes depend on the species[31] and the method of storage[32]. In possessing catfish flesh with a comparatively low fat content, it is expected that the lifetime will be higher when compared with other species such as salmon or trout. Smell and taste of catfish meat decrease in value over time[28]. In case of trout fish, when stored at refrigeration temperatures (2-4°C) shelf life increased up to 20 days[4].

At the end of 22 days of ice storage, solubility profile of catfish muscle proteins in high ionic strength buffer and calcium adenosine triphosphatase (ATPase) enzyme, reduced significantly ($p<0.05$)[33]. The protein solubility of *P. hypophthalmus* fillet at chilled stored condition, decreased with increase in storage time[7]. Similar observations were

Table 6: Changes in gel-strength of pangus (*Pangasiushypophthalmus*) meat paste at 50°C for 120 min in one step heating

	Measurement		
Storage time (days)	[1]BF(g)	[2]FT	[3]TCT
0	790±4.47	AA	9
3	680±8.94	AA	8
6	610±3.57	AA	8
9	530±7.74	A	7
12	440±2.68	A	7
15	350±3.89	B	6
18	260±5.68	B	5
21	190±3.22	C	4

Mean±SD, [1]BF: Gel Strength breaking force, [2]FT: Folding test, [3]TCT: Teeth cutting test

reported while studying the changes in quality of hybrid catfish fillet stored at 4°C and by Chomnawang *et al.*[34] and for Indian milk fish, *Chanos chanos*[6]. Chilling is an efficient way of reducing spoilage in fish but it should be done rapidly and hygienically. Instant chilling of fish ensures high quality value added products[23]. A shelf life of 10 days for vacuum packaged and chill stored *P. hypophthalmus* fillets[13]. A shelf life of about 8 and 15 days, respectively was observed for air packed pearl spot (*Etroplus suratensis*) during chill storage[35]. Up to 5 days of ice storage premium quality of fish fillet is expected, after which a progressive decline in the value was observed[4].

The major protein fraction showed association-dissociation-denaturation phenomenon during ice storage as revealed by gel filtration profile and viscosity measurements. The initial Folding Test (FT) was 'AA' which decreased to'C' and Teeth Cutting Test (TCT) was 9 which decreased to 4 after 21 days of ice storage for both one-step heating and two step heating (Table 6, 7). The results obtained from this study clearly indicated that the gel forming ability decreased with increasing the storage. Figure 2 shows the comparative study between one step heating and two steps heating. The gel strength of Pangas meat paste gradually decreased with the increase of ice storage time. The study observed that the gel-strength was highest in two steps heating than one step heating. Slight differences in texture measurements (shear force and toughness) were obtained from the farmed giant catfish muscles during the 14 days of refrigerated storage ($p<0.05$).

Continuously decreases of shear force were observed when storage time increased. Toughness resulted in a differential effect of refrigeration so that a decreasing value was obtained with refrigeration time[29]. The texture of the fish muscle depends on various inherent biological factors associated to the density of the muscle fibers, as well as the lipid and collagen content of muscle[36,37]. A research has revealed that fish become less hard with longer chilling

Table 7: Changes in gel-strengthof pangas (*Pangasius hypophthalmus*) meat paste at 50°C and 80°C for 120 min and 30min respectively in two step heating

	Storage time (days)							
Measurement	0	3	6	9	12	15	18	21
[1]BF(g)	980±2.68	860±4.47	790±1.78	710±8.94	610±2.68	530±3.89	420±3.22	330±3.89
[2]FT	AA	AA	A	A	A	B	B	C
[3]TCT	9	8	8	7	7	6	5	4

Mean±SD,[1]BF: Gel strength breaking force, [2]FT: Folding test, [3]TCT: Teeth cutting test

periods[38]. The results suggested that denaturation of muscle proteins during the storage period was a negligible effect on muscle texture. Texture loss throughout the storage of fish samples has been frequently reported, which may be related with low muscle pH or due to the contribution of several proteolytic enzymes[36]. Study indicated that there was a denaturation of muscle protein during storage condition and this result is more or less similar[39,40]. The gel forming ability of carp myofibrils decreased from 95-20% during ice storage within 2-3 weeks[40]. Similar results were also obtained by Malinowska-Panczyk *et al.*[31] for *Cirrhina mrigala* and *Labeo rohita*. The gel forming ability decreased with increasing the storage period which is the result of denaturation of myofibrillar protein[6]. The results obtained from the present study are more or less similar with Howgate *et al.*[19], who reported for tilapia (*Oreochromis niloticus*), in one step heating the gel-strength was highest at an incubation temperature of 40°C for 120 min in case of washed and unwashed mince. In two step heating, gel strength was highest at 50°C for 120 min both in washed and unwashed mince; [4] also reported that the breaking force of the resulting suwari-gel of ice stored *Catla catla* was the highest at 50°C at incubation of 180 min.

The increased in TVBN with the lapse of storage may be attributed to bacterial spoilage. However, the available information indicated that TVBN accumulated in fresh fish at later phase of spoilage when bacterial population has grown. Thus, the TVBN is low during the consumable storage period and only when the fish is near rejection level increasing amount of TVBN were found. The Total Volatile Basic Nitrogen (TVBN) the most widely used as biochemical indicators for assessment of shelf life of fresh fish products[26,27]. Thus, the TVBN could be used as an effective indicator of deterioration of meat due to the high degree of relation with sensory analyses regarding product acceptance with values between 30-40 mg/100 g being reported as the limits of acceptability for cold and temperate water fish[35]. Also, there is a large variation in TVBN values for different species, storage time and processing mothods. In this study, at the end of 21 days of storage the TVBN value was 32.45 mg/100 g, which exceed the acceptable value. The results obtained from the present study indicate that there is a denaturation of muscle protein during storage condition, the results is compatible with[38] who reported that the TVBN content value of tilapia (*Oreochromis niloticus*) increased from 5.3-28.4 mg/100 g at the end of 16 days of ice storage. Another study showed that *Leiarius marmoratus* meat, when subjected to diverse retention times before being stored at 0°C, had TVBN content values between 13.8 and 20.7 mg of 100 g meat[28]. Whereas, the *Clarias macrocephalus* reaches the permitted level of TVBN after only 9 days, when stored in polyethylene bags at 4°C[34].

The muscle pH of fish immediately after death was close to neutral. Muscle pH turns to acidic condition which is certainly due to the accelerated turnover of ATP. In post mortem muscle the rate of pH fall is entirely due to ATPase activity. But during long term storage in ice, pH again turns to alkaline condition which may be due to slight autolytic and bacterial activity. Live sardine muscle has a pH 7.2. After death, the muscle pH decreases to 6.8 after 2 h, to 6.2 after 8 h and to 5.8 after 24 h[41]. The pH value of sardine (*Sardina pilchardus*) stored in ice was *5*.8 at day 0, 6.36 at day 9 and 6.57 at day ofeighteen[25]. The present study also found that after 21 days of ice storage pH gradually increased because of formation of basic compounds and finally reached up to 6.88.

CONCLUSION AND FUTURE RECOMMENDATION

In this study, shelf life of ice preserved pangas catfish, *Pangasianodon hypopthalmus* fillet was studied. The pangas fillets were found acceptable until 18 days of ice storage. The degradation of fillet quality during ice storage was proteolysis of myofibrillar protein and loss of sarcoplasmic protein. Muscle gel strength was found gradually decreasing over the study period. Further study is required with different packaging condition under ice storage.

SIGNIFICANCE STATEMENTS

The findings from this study will be helpful to the fish processors who lack freezing facility. This study result will bring some quality indications and value addition to the processors and consumers.

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