Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2020; 8(1): 69-72

Received: 06-11-2019
Accepted: 10-12-2019

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Quality attributes and shelf life assessment of black pomfret (*Formio niger*) steaks treated with salts of organic acids

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Abstract
The main objective of this study was to assess effects of food grade sodium acetate and water dip as control treatments on the chemical, physical and sensorial quality attributes of decapitated black pomfret (*Formio niger*) during chilled storage at 4 °C for 7 days. Results indicated that control fish samples have been shown to lose texture, and show a gradual deterioration in quality attributes with chilled storage. The rates of these deteriorations are increased as the time of storage progressed. On the other hand, Sodium acetate treated fish samples exhibit higher moisture retention, tenderness, and bound water at any given time of chilled storage as compared with control samples. The present data also demonstrate lower values of drip loss, TVB-N and TMAN, are recorded in sodium acetate-treated samples. Analysis indicated that chemical, physical and sensorial quality advantages have been resulted from soaking black pomfret (*Formio niger*) in chilled temperature at 2.5% Sodium acetate solution for 5 minutes prior to freezing. Organic acid treatment can be an alternative way to improve the quality of decapitated black pomfret (*Formio niger*) during chilled storage. We can conclude that, sodium acetate dip treatment is for the maintenance of the functional properties of the seafood proteins which helps the preservation of the muscle integrity.

Keywords: Black pomfret steaks, sodium acetate, organic salt, TVB-N, TMA-N

Introduction
Fish is a vital source of food for people. It is man's most important single source of high- quality protein, providing ~16% of the animal protein consumed by the world's population, according to the Food and Agriculture Organisation (FAO) of the United Nations (1997) [7]. However, it is highly susceptible to both microbiological and chemical deterioration, due to its high-water activity, neutral pH, relatively large quantities of free amino acids, and presence of autolytic enzymes (Jeyasekaran *et al.*, 2006) [9].
Black pomfret (*Formio niger*) is a species of carangid native to reefs of the Indian Ocean and the western Pacific Ocean, where it is found at depths from 15 to 105 m (49 to 344 ft), though it is rarely found deeper than 40 m (130 ft). This species grows to 75 cm (30 in) in total length and is very important to local commercial fisheries. This species is the only known member of its genus (Froese *et al*. 2013) [6]. Texture is considered to be one of the most important quality attributes of fish and meat. It contributes to consumer acceptance and therefore marketability of the final product (Cheret, Delbarre- Ladrat, Lamballerie- Anton, & Verrez- Bagnis, 2007) [4]. Fish texture is mainly dependent upon its fat and collagen content; however, muscles softening can occur as a result of myofibrillar protein degradation due to microbiological and autolysis processes initiated at fish death (Li *et al*., 2012) [14].
Sodium acetate is found to be effective in preventing microbial growth and improving shelf-life under different storage conditions (Kim *et al*., 1995) [11]. Sodium acetate is an approved (USFDA) flavouring and pH control agent. 2% NaAc (sodium acetate) was effective in controlling growth of natural micro flora on catfish fillets Zhuang *et al.* (1996) [25]. Black pomfret (*Formio niger*) is a species with high commercial value and much appreciated by world over consumers. It is sold as either whole fresh fish or in fillet form. Additionally, vacuum packaged fish are being consumed.

Materials and Method

Fresh Black Pomfret (*Formio niger*) was taken from Veraval (Gujarat) fish market. Than Preserve it in ice box and immediately transfer to laboratory. Wash material several times by freshwater and degutted and make steaks of fish. Weigh all steaks using electric weighing machine (Docbel Braun). Divide all steaks into two division by weigh for two treatments. Took water in one plastic tray and 2.5% Sodium acetate solution in another plastic tray. Half part of steaks dip into water and another half part of steaks dip into 2.5% Sodium acetate solution for 10 to 15 minutes. After onwards both types of sample was allow to dry partially at room temperature for 20 minutes. Then steaks was pack in polythene pouch with use of sealing machine (QS 200 FE). Both sample was labelled with A1 and A2. Where, A1 was Non-treated fish steaks (steaks dip in water) and A2 was treated with 2.5% sodium acetate. A1 and A2 sample was stored in chill storage at 4 °C.

Analyse sample by Measure Moisture, TVBN, TMA, pH, Colour (L, a, b), Appearance, Colour, Odour, Overall Acceptability of each treatment. Black pomfret steaks were sampled for examination at storage days 3, 5, 7.

Analysis method

Total volatile basic nitrogen (Tvb-N) analysis

Total Volatile Basic Nitrogen (TVB-N) was determined according to the method of Conway (1950) [3]. 1 ml of 0.01N Sulfuric Acid solution was added into inner ring (chamber) with the use of pipette. Then, 1 ml of standard N/100 sulphuric acid was taken in the inner chamber of the diffusion unit. To the outer chamber 1 ml of TCA extract was added and the glass lid applied with vacuum grease was covered over it, leaving a small space. Through this space 1ml of saturated potassium carbonate was added and the unit was sealed immediately with the glass lid, rotated slowly to mix the contents and kept undisturbed overnight. The amount of unreacted acid in the inner chamber was determined by titrating against standard N/100 sodium hydroxide using Tashiro's indictor (Kamalakanth, 2016) [10]. Similarly a blank was also run using 1 ml of 20% TCA instead of sample extract. TVB-N was calculated and expressed as mg N2 100 g–1 of the sample below.

$$\text{TVB-N (mg/100g)} = \frac{(Vb - Vs) \times 0.14 \times \text{Volume of extract} \times 100}{\text{Vol. of sample taken} \times \text{Weight of sample}}$$

Where

Vb = Titrate volume of 0.01 N NaOH for the blank (ml)
Vs = Titrate volume of 0.01 N NaOH for the sample (ml)

Trimethylamine nitrogen (Tma-N) analysis

TMA was determined as trimethyl amine nitrogen (TMA-N) by the micro diffusion method (Conway, 1950) [3]. 1 ml of standard N/100 sulphuric acid was added in the inner chamber of the diffusion unit. To the outer chamber 1 ml of TCA extract was added followed by 1 ml neutralized formaldehyde. This was kept for 3 min to ensure the binding of formaldehyde with all the primary and secondary amines and ammonia contained in the extract. To this, 1ml saturated potassium carbonate was added and the analysis was further carried out as explained in TVB-N determination (Kamalakanth, 2016) [10]. The only difference was the blank also run using 1 ml of 20% TCA instead of sample extract. TMA-N was calculated and expressed as mg N2100 g–1 of the sample.

$$\text{TMA (mg /100g)} = \frac{(Vb - Vs) \times 0.14 \times \text{Volume of extract} \times 100}{\text{Vol. of sample taken} \times \text{Weight of sample}}$$

Where

Vb = Titrate volume of 0.01 N NaOH for the blank (ml)
Vs = Titrate volume of 0.01 N NaOH for the sample (ml)

Moisture analysis

Moisture determination is one of the most important and most widely used measurements in the processing and testing of foods (Pomeranz *et al*., 1994) [21]. Black pomfret being perishable commodity contains 74.3% moisture content (P. Puwastien *et al*.) [20].

Dry the empty dish and lid in the oven (IFB 30SRC2) at 105 °C for 3h and transfer to desiccator to cool. Weigh the empty the dish and lid. Weigh about 10 g of sample to the dish. Spread the sample with spatula. Place the dish with sample in the oven. Dry for 3h at 105 °C. After drying, transfer the dish with partially covered lid to the desiccator to cool. Reweigh the dish and its dried sample (AOAC, 1999).

$$\text{Moisture (\%)} = \frac{(W1 - W2) \times 100}{W1}$$

Where

W1 = weight (g) of sample before drying
W2 = weight (g) of sample after drying

pH analysis

The pH value was recorded using a pH testing paper.

Colour analysis

In industry, the colour of foods has generally been measured using L*a*b* or CIELab colour space, which is an international standard accepted by the Commission Internationale de l'Eclairage (CIE) in 1976 (Leon *et al*., 2006) [15] In the CIE Lab system, L* denotes lightness component 0 to 100 scale from black to white; a*,(q) red or (y) green; and b*, (q) yellow or (y) blue (Schubring *et al*., 2003) [23]. Using whiteness meter (Konica Minolta Colorimeter CR-14) colour analysis had been done.

Sensory analysis

Sensory appraisal of raw fillets (Pastoriza *et al*., 1998) [22] was done. The sensory appraisal was done by 4 panellists. The estimation was conducted for the appearance, colour, odour and overall acceptability of black pomfret raw material, marinated & non-marinated product. Overall acceptability was calculated by adding the scores for all the attributes and dividing by total number of attributes (C. O. Mohan *et al*., 2010) [19].

Statistical analysis

Differences between means were analyzed by one-way analysis of variance (ANOVA) followed by Tukey and Duncan tests. The results are presented as means ±SD. When a significant difference was detected between the groups ($p < 0.05$), either the Tukey or Duncan multiple comparison test was applied to obtain the conservative differences with multiple comparison (Berna Kilinc *et al*., 2009) [12].

Result and Discussion

Changes in total volatile base nitrogen (Tvb-N) and Trimethylamine nitrogen (Tma-N)

Due to microbial activity degradation of proteins and non-proteins compounds start and TVB-N produced (Connell, 1975) [5]. In freshly caught fish TVB-N concentration is normally between 5 and 20 mg N 100 g^{-1} (Huss, 1988) [8]. A level of 35–40 mg% is usually regarded as the limit of acceptability (S. Manju *et al*., 2007) [18]. The TVB-N value of raw fish was 12 mg N 100 g–1 at the beginning. A1 and A2 value 41 and 32 at the end of the storage period (7 days), respectively (Table 1).

Values of TVB-N found raise with storage period in treated and non-treated steak. Non-treated steak was more content of TVB-N compared to treated steak TVB-N value. TVB-N value low in treated samples were due to either a decreased capacity of bacteria for oxidative deamination of non-protein nitrogen compounds or a reduced bacterial population or both (Banks, Nickelson & Finne, 1980) [2]. The TVB-N contents of potassium sorbate treated samples were slightly lower than sodium acetate treated samples for both species *Parastromateus niger* and *Etroplus suratensis*. This might be attributed to the greater inhibition of gram-ve bacteria by potassium sorbate than by sodium acetate (S. Manju *et al*., 2007) [18]. Kim and Hearnsberger (1994) and Kim *et al*. (1995) [13, 11] observed that sodium acetate restricted aerobic gram-ve spoilage bacteria.

The beginning of TMA-N value was 2.1 mg N/100 g. Sodium acetate treated sample in TMA-N value low within 7 days, whereas for the non-treated samples in TMA-N showed a progressive increase. The Sodium acetate effect in fish steak inhibiting the increased production of TMA-N. However, the increase was higher for not-treated samples compared to treated samples. The acceptability limit of TMA-N (15 mg N2/100 g) according to S. Manju *et al*. (2007) [18]. That was exceeded on 7 day for non-treated sample, but limit not exceeded for treated steak in 7 days.

Table 1: TVB-N changes (mg TVB-N/100 g) and TMA-N changes (mg TMA-N/100 g) of black pomfret steaks stored At 4 ºC

Storage (days) Components	Zero days	3 days		5 day		7 days	
	Raw	A1	A2	A1	A2	A1	A2
TVB-N (mg N/100g)	12	24	22	31	28	41	32
TMA (mg N/100g)	2.1	8	7	14	11	19	14

A1: Non-treated fish steak, **A2:** Fish steak Treated with 2.5% sodium acetate.

Changes in moisture

Comparatively there was not much difference found between treated and non-treated fish steak shown in Table 2. Moisture content in black pomfret fish steaks was 82.26% in the beginning and at end of the 7th day moisture content was 75% in non-treated, 75.69% in treated fish steaks. It indicate that Sodium acetate treated fish steak was slightly more moisture content.

Table 2: Moisture content in Black Pomfret Steaks Stored At 4 ºC

Storage day	Raw Material	3rd day	5th day	7th day
A1	82.26	81.34	79.21	75.00
A2		82.16	79.83	75.69

A1: Non-treated fish steak, **A2:** Fish steak Treated with 2.5% sodium acetate.

Changes in pH

The changes in pH for Black pomfret steaks treated with and without sodium salts are shown in Table 3. The pH of the Sodium treated and non- treated fish steak was 7.1±0.21 measured where both had same pH value. On day 7, this value was determined as in non-treated sample was 5.25±0.20 and in treated sample was 5.85±0.19. Due to the effects of sodium salts less pH decreased in treated samples comparatively non-treated steak more pH decreased. (Berna Kilinc *at. al*., 2009) [12] revealed that pH value increased with use of Sodium acetate treatment packed with polyvinylidene film in raimbo trout. Usually limit of acceptability is 6.8–7.0 (Ludorff and Meyer, 1973) [16].

Table 3: pH content in black pomfret steaks stored at 4 ºC

Storage day	Zero day	3rd day	5th day	7th day
A1	7.1±0.21	6.6±0.14	5.7±0.14	5.25±0.20
A2	7.1±0.21	6.2±0.21	5.9±0.18	5.85±0.19

A1: Non-treated fish steak, **A2**: Fish steak Treated with 2.5% sodium acetate.

Changes in colour

Color measurements of Sodium acetate treated and non-treated black pomfret are shown in Tables 4. The L* (Lightness), a, b value of Sodium acetate treated and non-treated were determined as 42.9, 24.1, 16.5 at the before the storage period. On 7th day, L* value changed to 29.9 and 27.4 for Sodium acetate treated and non-treated, respectively. The a* (+ red or – green) value changed to 7.6 and 8.2 for Sodium acetate treated and non-treated, respectively. The b* (+ yellow or – blue) value changed to 26.5 and 25.4 for Sodium acetate treated and non-treated, respectively.

Table 4: Colour analyses in black pomfret steaks stored at 4 ºC

	RAW			DAY 3			DAY 5			DAY 7		
	L	a	b	L	a	b	L	a	b	L	a	B
A1	42.9	24.1	16.5	35.8	14.5	20.5	29.4	8.4	19.2	27.4	8.2	25.4
A2				39.7	16.4	19.2	30.2	7.4	24.2	29.9	7.6	26.5

A1: Non-treated fish steak, **A2**: Fish steak Treated with 2.5% sodium acetate.

Changes in sensory evaluation

The overall sensory assessment of Black pomfret fish steaks are given in Table 5. On the beginning day, black pomfret fish had different sensory component appearance, colour, odour which was changed with storage period. Sodium acetate treated and non-treated samples were significant difference ($p< 0.5$) found during the storage period. At the end of 7th day non-treated fish steaks over all acceptability was 6.5±0.57 and treated fish steaks was 7.75±0.5. On this basis we can say that non-treated fish steaks self-life not more than 7th days and treated fish steaks self-life was more than 7th days. The treated samples extended shelf life by antibacterial effect of this chemicals (Lee YL *et al*., 2002) [17]. (Khalid Ibrahim Sallam, 2007) [24] reported that dipping of sliced salmon in 2.5% aqueous solution of NaA, NaL, or NaC significantly delayed the microbial growth and extended the shelf life of the product up to 15, 12, and 12 days, respectively.

Table 5: Sensory panel scores of black pomfret steaks stored at 4 ^{0}C

Storage (days) Components	Zero time	3 days		5 days		7 days	
	Raw	A1	A2	A1	A2	A1	A2
Appearance	9.25±0.5	8.75±0.5	9±0	7.75±0.5	8.25±0.5	7.5±0.57	8.25±0.5
Colour	9.5±0.57	8.75±0.5	9.25±0.5	8.25±0.95	8.75±0.5	7±0.81	7.5±0.57
Odour	9.5±0.57	8.75±0.5	9.25±0.5	8±0.81	8.5±0.57	7.25±0.95	7.75±0.5
Overall Acceptability	9.5±0.57	8.75±0.5	9.25±0.5	7.75±0.5	8.5±0.57	6.5±0.57	7.75±0.5

A1: Non-treated fish steak, **A2:** Fish steak Treated with 2.5% sodium acetate.

Conclusion

The results of the present study revealed that, chemical reactions, enzymatic as well as non-enzymatic reactions could proceed at low temperatures (4 °C) of storage. All of reactions have the potential for reducing the quality attributes of chilled fish, the rates of these deteriorations are increased as the time of chill storage progressed. Based on present study we can conclude that, sodium acetate dip treatment is for the maintenance of the functional properties of the seafood proteins which helps the preservation of the muscle integrity. Sodium acetate dip treatments were effective in inhibition of flavour, colour and lipid oxidation and thereby enhancing tenderness of seafood by restricting protein denaturation and reduces other deterioration of black pomfret quality during chill storage.

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