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Quality Evaluation of Vacuum Packed Tilapia (*Oreochromis mossambicus*) Fillet during Refrigerated Storage

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A B S T R A C T

Quality of Vacuum packed tilapia (*Oreochromis mossambicus*) fillet was assessed by biochemical, microbiological and sensory parameters during storage at refrigerated temperature (3 ± 1°c). The tilapia fillet was air packed and vacuum packed in nylon laminated polyethylene pouches was treated with sodium acetate at level of 1.5% concentration. The shelf life of tilapia fillet air packed without any treatment was 15 days whereas Tilapia fillet air packed with 1.5 % sodium acetate treated and tilapia fillet vacuum packed without any treatment having shelf life had 20 days. While tilapia fillet vacuum packed with 1.5 % sodium acetate treated had been acceptable upto 30 days. The pH, TVB-N, PV and free fatty acid values indicated an increasing trend throughout the storage period. The TPC, anaerobic counts and psychotropic counts were higher in untreated samples compared to treated samples. Based on this results, it was observed that a combination of vacuum packaging and treatment with sodium acetate significantly increase the shelf life tilapia fillet during refrigerated storage at 3 ± 1°c.

Introduction

Aqua food occupies a unique position as a global food and nutritional security. A variety of nutrients are available in almost all in fish and fisheries products. Fish provides more than 2.9 billion people with almost 20 percent of their intake of animal protein and portion of 150 g of fish can provide about 50-60 percent of an adult's daily protein requirements. According to FAO Status of the World Fisheries and Aquaculture (FAO, 2014) global fish production in 2012 was 158 million metric tons, of which 91.3 MMT came from capture and 66.6 MMT from aquaculture. Presently India is the second largest fish producing and second largest aquaculture nation in the world.

Globally and domestically important trend has been the continued spread of tilapia products into the food service and restaurant sectors. Tilapia are now served in virtually all multi-national casual dining chains along with cruise ships, most dedicated Aqua-food restaurants and increasingly at schools and

hospitals. (K. Fitzsimmons, 2008). Apart from this, tilapia is one of the fastest growing fish farming fresh water species in India, provided healthy food choice for consumers because it is a relatively low-fat fish that is rich in proteins and minerals (Menaga and Fitzsimmons, 2017). Increasingly all types of consumers are demanding processed foods that are high in quality, nutritionally balance, and easy to prepare. Food processors have met this demand by developing refrigerated foods with extended shelf life. To improve the marketing of fresh fish products at retail level, various methods of packaging have been developed. One such current method is vacuum packaging.

Vacuum packaging is the one of method which extends shelf life of fish products. Vacuum packaging can supplement to ice storage or refrigeration to delay spoilage, extend the shelf life, maintain a high quality, assure the safety and reduce the economic loss of fish and fishery products (Reddy *et al.*, 1992). Vacuum packaging is widely used in food industry. It offers an excellent protection against rancidity and also decreases the growth of aerobic spoilage microorganisms (Ray, 2004).

Several studies has been made on vacuum packaging in combination with chemical preservatives, such as sodium acetate, acetic acid and potassium sorbate will further enhance the shelf life of marine of fish and fish products (Chinivasagam and Vidanapathirana, 1985: Shalini *et al.*, 2000: Rajesh *et al.*, 2002, Juvekar *et al.*, 2012 Lingham *et al.*, 2012). But very less attempt was made for fresh water fish and their products on their packaging. Therefore, an attempt has been made in the present study to find the effect of vacuum packaging and chemical preservative on the shelf life of tilapia fillet stored at refrigerated temperature for extending shelf life.

Materials and Methods

Fresh tilapia *Oreochromis niloticus*, size ranges from 500 to 700 g were procured from Meyo Fish market, Nagpur and brought to the laboratory of Fish Processing Technology, College of Fishery Science, Nagpur in the iced condition. Further, it was weighed, dressed (de-headed, eviscerated, gutted) washed, and prepared into fillet. The fillets (150 g) each were divided into four lots, as follows:

Lot I: Tilapia fillet air packed without any treatment *i.e.*, Sample A
Lot II: Tilapia fillet air packed with 1.5 % sodium acetate treated *i.e.*, Sample B
Lot III: Tilapia fillet vacuum packed without any treatment *i.e.*, Sample C
Lot IV: Tilapia fillet vacuum packed with 1.5 % sodium acetate treated *i.e.*, Sample D

Tilapia fillet was packed in nylon laminated polyethylene pouches and Lot I & II (air pack) were sealed using a heat sealer. Other lots III & IV were sealed using vacuum machine at –1 bar pressure. All the packs were stored in a refrigerator (3 ± 1^{o}C). The samples were drawn at intervals of five days and were analyzed for various biochemicals, microbiological and organoleptic characteristics.

Biochemical analysis

Proximate composition of Tilapia fillet was determined at beginning and during storage of five days interval according to AOAC, 2005. A TVB-N content of fillet was determined by the procedure giving by Beatty and Gibbons (1937).

Peroxide Value and Free Fatty Acid was analyzed and expressed as milli equivalent of O2/ kg fat and mg/100 g and pH was recorded using a pH meter (AOAC, 2005).

Microbiological analysis

Enumeration of total plate count (TPC) and psychrotrophic counts were done as per the procedure of APHA (1992). The anaerobic count was determined by MPN technique as per USFDA Bacteriological Analytical Manual (2006). Pathogenic bacteria like *E. coli*, *Staphylococcus*, *Streptococcus*, *Vibrio* and *Salmonella* by method recommended by EIA (1995).

Organoleptic analysis

Sensory evaluation was performed by 05 trained panelists. They were required to evaluate the fillets based on the color, flavor, texture and overall acceptability using a 10-point hedonic scale. Recorded results were analysed by using appropriate statistical methods (Snedecor and Cochran, 1967) to find out whether significant differences existed among the samples.

Results and Discussion

The average weight of tilapia used for study in the range of 500- 700g and yield of tilapia fillet was found near about 27.50 percentages. The proximate composition such as moisture, protein, lipid & ash content of tilapia fillet was 76.12, 15.10, 4.84 & 1.20 percentages respectively. It was showed in the table No. 1. Similar observation was found by Olaniyi Alaba Olopade (2016) during his studies on tilapia. Whereas quality of tilapia fillet (raw material) was analysized by biochemical, microbiological and organoleptical evaluation and it was presented in table No. 2.

The biochemical & Microbial value of tilapia fillet was within the limit and overall acceptability score of tilapia fillet was 8.5 and it was showed that fish used for experiment was good quality.

Biochemical changes

pH

The pH is important parameter that shows depletion in fish muscle during storage. The present study showed increased trend of pH value in all samples. Initially pH value of tilapia fillet was 6.20 and it was slightly increased during storage at all samples (Fig. 1). The constant levels of pH might be attributed to increasing solubility of CO_2 at storage time, effecting on growth of aerobic micro-flora (Taheri *et al.,* (2012). The support of present study, the similar increasing pH value was found by Juvekar *et al.,* (2012) and Meenakshi *et al.,* (2015) during studies.

Total Volatile Base Nitrogen (TVB-N)

In Aqua food, TVB-N primarily includes trimethylamine, produced by spoilage bacteria and ammonia, produced by deamination of amino acids and nucleotide catabolites during spoilage of fish. Level of TVB-N in freshly caught fish is 5-20 mgN/100g. However, level of 30-35 mgN/100g flesh fish considered the limit of acceptability for chilled store fish (Connell 1995).

In the present study, TVB-N value showed the increasing trend in the all the samples from 12.40 to 36 in sample A, 12.40 to 20.40 sample B, 12.40 to 20.80 Sample C and 12.40 to 17.54 Sample D mgN/100g (Fig. 2). The sample A *i.e.,* Untreated air packed tilapia fillet showed exceeding value than the limit at 30 days storage study. In support of present study, Shalini *et al.,* (2000) and Juvekar *et al.,* (2012) found similar trend, in sodium acetate treated and untreated fish (*L. lentjan*) fillet during refrigerated storage and effect of vacuum packed black king fish mackerel (*Rachycentron canadus*) flesh stored at 5 ± 1°C respectively. Apart from this kedar *et al.,* (2016) observed similar increasing value of

TVB-N during his study on effect of sodium benzoate on the shelf life of vacuum packed catla fish steaks stored at chilled temperature.

Free fatty acids (FFA)

FFA value is a result of enzymatic decomposition of fat during storage and it was increase due to lipase action (Gopakumar, 2002). In present study, there was significantly difference found in all treatment. Value of FFA value increased constantly during storage period at refrigerated temperature. FFA value of sample A was shown as 0.62 to 5.92, sample B as 0.62 to 4.02 sample C 0.62 to 4.16 and sample D as 0.62 to 3.72 (Fig.3). Tilapia fillet without any treatment and air packed had shown higher FFA value while tilapia fillet with chemical treatment and vacuum packed had less FFA value at refrigerated storage.

In support of present study, Balev *et al.*, (2011) reported that at the end of storage, the total FFA concentration of air packaged and vacuum packaged samples increased of 1.17 and 0.85g/kg fresh fish weight respectively in Russian Sturgeon during frozen storage. Juvekar *et al.*, (2012) also found FFA value increased significantly with storage period in air packed samples compare to treated vacuum packed samples. Meenakshi *et al.*, (2015) also observed same increasing FFA value during her studies.

PV

The peroxide value (PV) is a very important characteristic of lipid quality. The assessment of hydroperoxides provides an estimate of the overall oxidation status for lipids and lipid-containing foods especially in the primary phase of oxidation, generally known as the induction period.

In the present study, a constant increase in PV during refrigerated storage was observed in all samples. PV indicated from 2.96 to 9.90 in sample A, 2.96 to 7.28 in sample B, 2.96 to 7.20 in sample C and 2.96 to 6.20 in sample D (Fig. 4). In agreement with present study Chandra (2006) found increasing trend of PV value from 4.77 to 17.49 meq O2/ kg of mackerel (*Rastrelliger kanagurta*) stored with antimicrobials treated ice. Kedar *et al.,* (2016) also found same increasing trend of PV value of vacuum packed Catla fish steaks stored at chilled temperature.

Microbiological Changes

Total plate count (TPC)

TPC is designed to provide an estimate of total number of aerobic organisms in a food which reflects the microbial quality of the food and useful for indicating potential spoilage of perishable aqua-food products. In the present study, TPC was increased in all samples. The increased trend was observed during storage from 3.12×10^2 to 4.56×10^6, 3.08×10^2 to 5.48×10^5, 3.12×10^2 to 6.20×10^5 and 3.08×10^2 to 4.84×10^4 in samples A, B, C & D respectively (Fig. 5). Likewise, Rajesh *et al.,* (2002) reported the lower TPC count in sodium acetate treated seer fish steaks than in control. Manju *et al.,* (2007) also noted increased in TPC (from 8.71×10^4 to 1.0×10^7) of chilled stored vacuum packed pearlspot (*Etroplus suratensis*). This result is in agreement with that Juvekar *et al.,* (2012) and Kedar *et al.,* (2016) also found increasing TPC count in all samples during refrigerated storage.

Psychrophilic bacteria

Psychrophilic bacteria are extremophiliic organisms that are capable of growth and reproduction in low temperature, ranging from -20^oc to 10^oc. The observation found in present study was psychrophilic bacteria were increased during storage in all samples. Samples treated with chemical and vacuum

packed were low psychrophilic count while sample without treated had higher psychrophilic count during 30 days storage. It was due to antimicrobial effect of sodium acetate was found to prolong the shelf life of vacuum packed tilapia fillet. In 1996, Zhuang *et al.*, reported significant reduction in the growth of psychrotrophic bacteria by application of 2 % sodium acetate to catfish fillets. Juvekar *et al.,* (2012) and Meenakshi *et al.,* (2015) also found similar observations during studies.

Anaerobic count

The working principle of vacuum packaging of food preserve by deflating internal air to prevent aerobic bacteria from growing but spoilage in the seafood vacuum packed product generally occurs due to anaerobic bacteria (Zhuang *et al.,* 1996). The present study showed, air packed and Vacuum packed samples without chemical treatment had higher anaerobic count compare to samples treated with sodium acetate (1.5 %) air packed and vacuum packed. This result found might be to antimicrobial effect of sodium acetate. In support of this study, Lyon and Reddmann (2000) reported increase value of anaerobic bacterial count in control packs compared to treated packs. Shalini *et al.,* (2000) and juvekar (2012) also reported identical findings for sodium acetate treated *L. lentjan* fillets and antimicrobial effect of sodium acetate was found to lower down the anaerobic bacterial count in black king fish respectively.

Pathogenic bacteria

Pathogenic bacteria were not found initially and during entire storage study in all samples. The absence of pathogenic bacteria was found by Rathod *et al.,* (2014) and Kedar *et al.,* (2016), in fish cutlet made from Pangasius fish (*Pangasianodon hypophthalmus),* during storage in refrigerated display unit (-15 to -18^{0}C) and effect of sodium benzoate on the shelf life of vacuum packed Catla fish steaks stored at chilled temperature respectively.

Organoleptic evaluation

A score of overall acceptability as 4 was taken as the acceptable limit for determining the shelf life of tilapia fillet during refrigerated storage at 3 ±1 ^{o}C. The sensory quality changes and overall acceptability started decrease in all samples during 30 days storage and it was presented in table no. 3.

Juvekar *et al.,* (2012) found similar decreasing trend and result as 2% sodium acetate treated and vacuum packed Black king fish (*Rachycentron canadus*) was accepted at 33 day at refrigerated storage.

Table.1 Proximate composition of tilapia fillet

Proximate Composition (%)	Tilapia fillet
Moisture	76.12
Crude Protein	15.10
Fat	4.84
Ash	1.20

Table.2 Quality of fresh tilapia fillet

Parameters	Tilapia fillet
Biochemical Analysis	
PH	6.20
TVB-N	12.40
FFA	0.74
PV	2.96
Microbiological Analysis	
Total plate count	3.12 $X10^2$
Pathogenic Bacteria (*E. coli, salmonella, Staphylococcus aureus)*	ND
Organoleptical Analysis	
Sensory score for overall acceptability (10 point hedonic scale)	8.5

Table.3 Organoleptic evaluation (Overall acceptability)

Storage days	Sample A	Sample B	Sample C	Sample D
0	8.5	8.5	8.5	8.5
5	6.2	7	7	7.6
10	5.5	6.2	6.3	7
15	4.2	5.8	5.9	6.40
20	3.8	4.5	4.6	5.5
25	-	3.7	3.9	5
30	-	-	-	4.2

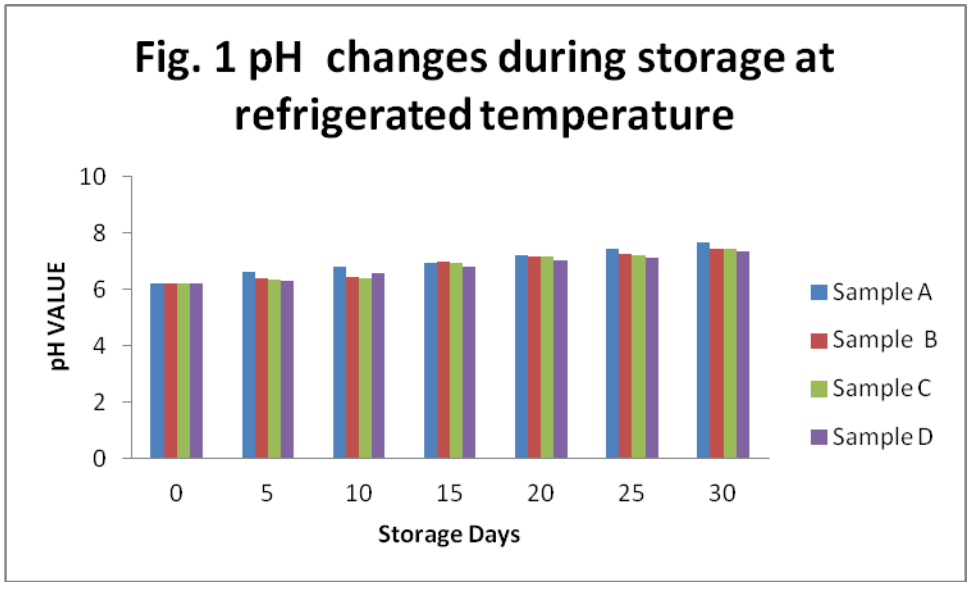


Fig. 2 TVB-N changes during storage at refrigerated temperature

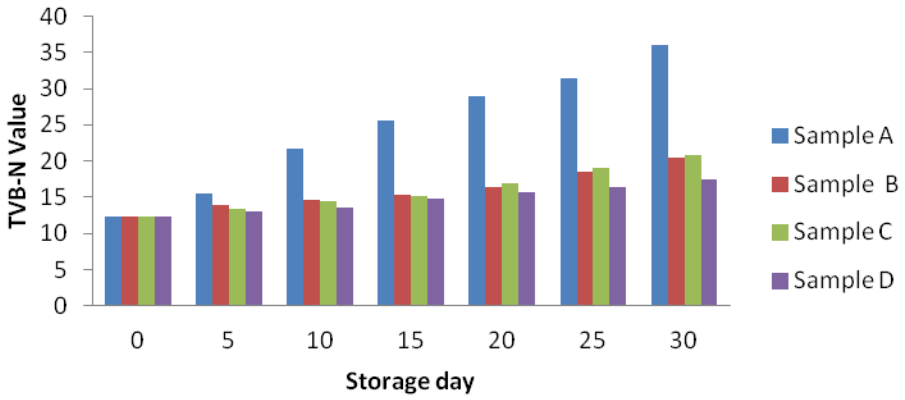


Fig. 3 FFA change during storage at refrigerated temperature

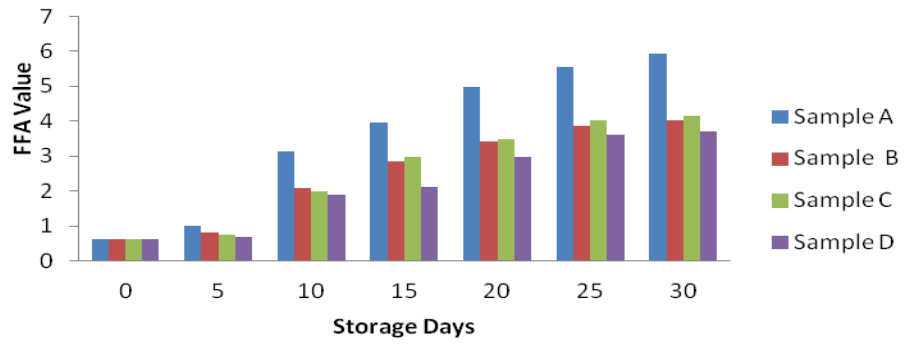
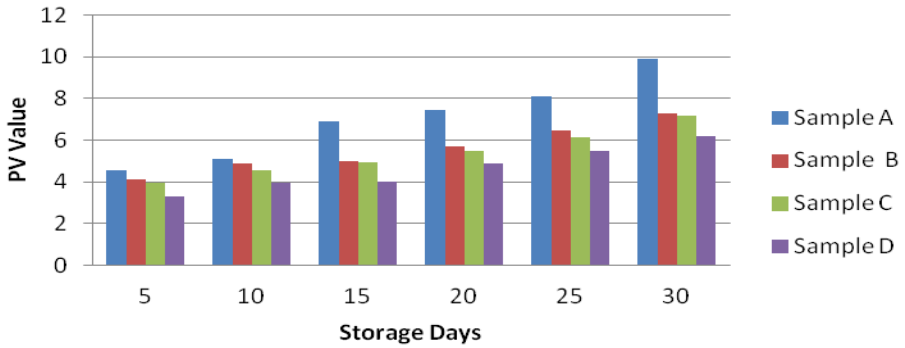
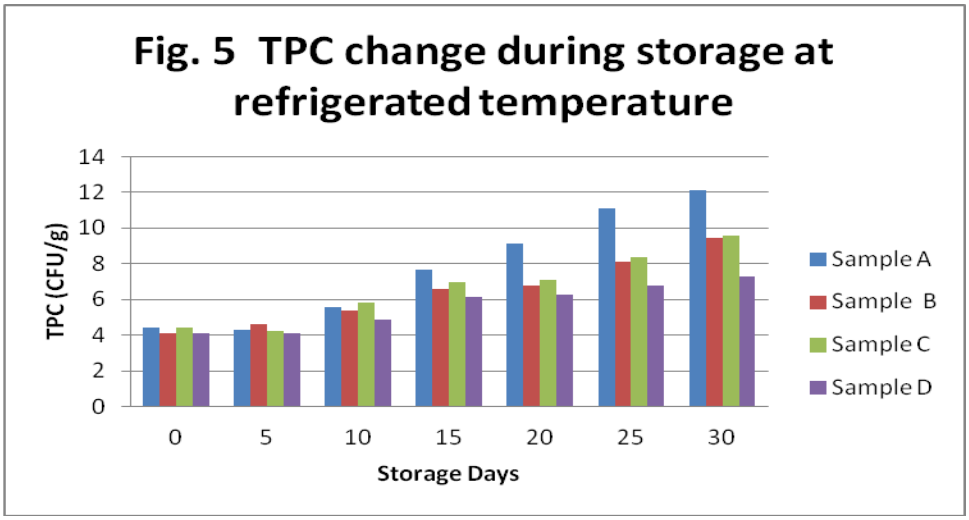


Fig. 4 PV change during storage at refrigerated temperature





In conclusion, the tilapia fillet air packed without any treatment at refrigerated temperature 3 ±1°C having shelf life was nearly upto 15 days whereas Tilapia fillet air packed with 1.5 % sodium acetate treated and tilapia fillet vacuum packed without any treatment having shelf life nearly upto 20 storage days. While best result found in tilapia fillet vacuum packed with 1.5 % sodium acetate treated had acceptable upto 30 days which was supported by biochemical and microbial parameters. The present study give idea about combine effect of antimicrobial substance and vacuum packaging will help for increasing shelf life of fish fillet at refrigerated storage.

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