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# Studies on freezing and storage performance of tilapia (*Oreochromis niloticus*) fillets

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**Abstract**
Tilapia is the second most farmed fish in the world. It is mostly preferred to be consumed in form of fillets. The experiment entitled "Studies on freezing and storage performance of tilapia fillets", was conducted in Factorial Completely Randomized Design (FCRD) for different parameters with 4 main treatments *viz.* T0 (control) in which untreated fillets were done IQF at freezing temp:(- 40 °C) & storage at (-18 °C) for 120 days, T1 - Pre-treatment of NaCl (2%)+ STPP (3%) for 2 hrs + glazing - 10% + IQF freezing (Temp: - 40 °C) & frozen storage at (- 18 °C) for 120 days, T2 - Pre- treatment of NaCl (2%)+ STPP (3%) + blanching at temp:75 °C, Time: 2 Min + glazing - 10% + IQF freezing (temp: - 40 °C) & frozen storage at (-18 °C) for 120 days, T3 - Pre-treatment of NaCl (2%)+ STPP (3%) for 2 hrs, blast freezing & frozen storage at (-18 °C) for 120 days were analysed for changes in physical, biochemical, microbiological parameters and sensory qualities.
It was observed that fillets with pretreatment of NaCl (2%)+ STPP (3%) for 2 hrs+ blanching at temp: 75 °C, Time: 2 Min + glazing - 10% + IQF freezing (Temp: - 40 °C) exhibited higher rate of L*, a* and b* colour values at the end of storage period of 120 days as compared to other fillets. The biochemical parameter such as TVBN & microbiological parameter like TPC exhibited a decreasing trend with respect to other treatments while drip loss content of the fillets didn't exhibit any significant changes; In case of proximate analysis during frozen storage moisture, ash, protein decreased likewise there is an increase in fat and NPN content at the end of storage period of 120 days. As regards to the organoleptic evaluation, the fillets T2 obtained the highest sensory score in colour, flavour, texture, odour & overall acceptability as compared to control (T0) and treatments T1,T3 and were fit for consumption at end of frozen storage period of 120 days.

**Keywords:** Tilapia, fillets, treatments

## Introduction
Seafood has a great nutritional value due to its abundance in necessary amino acids, vital fatty acids, minerals, and vitamins, as well as its low content in saturated fats and cholesterol. One of the most significant sources of animal protein in the tropics is fish, which is also widely acknowledged as an excellent source of other nutrients for the maintenance of a healthy body (Andrew, 2001) [1]. Due to the superior product quality, fish has been preserved by freezing for thousands of years (Persson and Londahl, 1993) [4]. The value of fish depends on how fresh it is, and as its exportability decreases, its look, flavour, and other quality of flavour, texture, and consumer acceptability declines (Kagawa *et al*. 2002) [5]. Fish fillets comprise the meat of the fish, which is the cadaverous muscles and fat as opposed to the bones and organs. Tilapia are often grown in ponds using comprehensive, semi-intensive, and intense production techniques. Rapid growth, high change tolerance, adaptation to a variety of environments with varying salinity and dissolved oxygen, resistance to stress and disease, captive reproduction, brief gestation periods, feeding from low nutrition levels, and accepting artificial food right away after absorbing the yolk sac are the main causes of the high level of tilapia production. Fillets are generally attained by slicing the fish parallel to the spine, rather than vertical to the spine as is the case with steaks. Fish from both marine and aquaculture origins can be refrigerated using freezing-point storage, which regulates the temperature between 0 °C and the fish's freezing point. The freezing point of tilapia is about -7 °C, according to (Chen and Pan, 1995) [6].
I.Q.F is the latest technology available in freezing and with the advent of the same, it is now possible to preserve and store for more than a year, with the colour, flavour and texture of produce remaining as good as fresh. In IQF, each piece is frozen individually using technique of fluidization resulting in freezing only in 10 to 12 minutes which otherwise takes at least 3 to 4 hours or even more in the blast freezer (Pruthi, 1995) [9]. Air blast freezing is the process of taking a product at a temperature (generally chilled but occasionally at ambient temperature)

and freezing it between 12 and 48 hrs, to its asked storehouse temperature which varies from product to product(e.g. fish = -20 °C, beef = -18 °C) (Bansal *et al*., 2012) [7].

**Blanching:** It is a unit operation previous to freezing, canning, drying in which substances are hotted for the purpose of inactivating enzymes; modifying texture; conserving colour, flavour, and nutritive value; and removing trapped air. (Corcuera *et al*. 2004) [8].

**The present study was undertaken for the following objectives**

1. Comparison of IQF and blast frozen storage performance of tilapia fillets
2. Evaluation of quality during frozen storage of tilapia fillets.

## Material and Methods

Freshwater tilapia (*Oreochromis niloticus*) locally known as *chilapi* were procured from the market and filleted. The fillets were taken to the factory in an icebox. The fillets were then washed thoroughly and divided into 15 each for 4 different treatments as $T_0$, $T_1$, $T_2$, $T_3$. Firstly the untreated/control ($T_0$) were frozen by IQF. Then the remaining fillets were treated with 2% NaCl and 3% STPP for 2 hrs.T1 & T2 are glazed & blanched and only T3 fillets were used for blast freezing, remaining T1, T2 fillets were separately IQF. At last all fillets were put into separate LDPE packets according to their treatments and packed in a corrugated fibre board & kept in frozen storage at -18 °C for 120 days.

### Methods of Analysis

The stored samples were analysed for different proximate, biochemical, microbiological quality and sensory parameters at 0 day (day of storage) and regular interval of every 15 days from the day of storage.

**Proximate Chemical Composition:** Proximate chemical composition analysis of the fish fillet, including total ash, moisture, crude protein and crude fat contents were determined according to the method of AOAC (2000) [3], sections 923.03, 925.09, 979.09 and 4.5.01, respectively. Crude protein and crude fat were analysed using Kjeldahl block digestion and steam distillation (2200 Kjeltec Auto distillation, Foss Tecator AB, Höganäs, Sweden) and Soxhlet extraction (Sox Tec service unit 1046, Foss TecatorAB) apparatus, respectively.

**TVB-N:** TVB-N of frozen fillets was measured following the procedure of Malle and Tao (1987). About 300 mL of 0.6 M perchloric acid was added to about 100 g of fish sample. After homogenization, the mixture was filtered using Whatman filter paper No. 42 (Whatman International Ltd., Banbury, UK), and 150 mL of the extract was transferred into distillation flask and 10 mL of 20% NaOH was added into it. After that, the sample was distilled until about 100 mL of the distillate was collected into 25 mL of 4% boric acid with methyl red indicator. Finally, the distillate was titrated with standardized $H_2SO_4$

**TPC:** TPC was determined according to the method of Gunasekaran (1995) [10]. About 20 g fish sample was homogenized with 180 mL sterile saline solution (0.85% NaCl) to prepare 10–1 sample suspension. Additional 10-fold dilutions were prepared with sterile saline solution. An aliquot (1 mL) of each sample dilution was spread onto nutrient agar plates using L-rod and the plates were inverted and placed in an incubator at 37 °C for 48 h. The plates containing the number of colonies ranging from 30 to 300 per plate were selected and the number of colonies was calculated by multiplying the number of colonies with the dilution factors.

### Colour

Konica minolta colour reader was used. The Color readings were expressed by machine (L*, a* and b*) system (Marcet *et al*., 2018) [11]. L*, a* and b* indicate the whiteness/darkness, which could be white. The minimum for L* would be zero, which could be black. The axes have no numerical limits. Positive a* is red and negative of a* is green. Positive of b* is yellow and negative of b* is blue. The Color of the samples was evaluated after 10 min cooling at room temperature.

### Drip loss

Take a sample day 0 were individually weighed and recorded as initial weight (W1).The samples were then placed in sealed polyethylene plastic bags, vacuum-packaged, placed within a container and were stored in a chiller at 4 degrees. After 1 and 7d of storage, the samples were immediately removed from bags, gently blotted dry, weighed and recorded as W2 (final weight).The percentage of drip loss was calculated and expressed as the percentage of differences of sample initial weight. The sample weight after 1 and 7d of storage was divided by sample initial weight (Honikel 1998) [16].

### Sensory evaluation

Samples were subjected to sensory evaluation after brining. The fillets were kept out of the packet at room temperature for half an hour and then used for brining for sensory evaluation. Carried out for 5 minutes and allowed to cool down and then give it to the panel for sensory analysis.10 member's panel composed of students and faculty conducted sensory evaluation. Each panel list was asked to evaluate the characteristics like Appearance, colour, texture, odour, flavour, taste and overall acceptability of each sample on 9–point hedonic scale (Ranganna, 1986) [17]. 1 very poor and 9 excellent.

### Statistical Evaluation

The data were analysed to test significant differences by applying an analysis of variances (ANOVA) tool available in MS-Excel 2010. The significant differences were tested by 5% level of significance and are mentioned as $p<0.05$ for significant differences (Panse and Sukhatme, 1989) [18]. The experimental data was analysed statistically using Factorial Completely Randomized Design (FCRD).

## Results and Discussion

### Proximate Composition

The results of proximate composition of tilapia fish fillets are presented in Table 1.

**Table 1:** Proximate composition of tilapia fish fillets stored at -18 °C for 4 months [initial (0) day]

| Treatments | Moisture | Fat | Ash | Protein | Non protein nitrogen (NPN) |
|---|---|---|---|---|---|
| T0 | 80.00 | 0.65 | 1.22 | 17.32 | 2.22 |
| T1 | 79.00 | 0.71 | 1.41 | 19.37 | 2.18 |
| T2 | 86.00 | 0.76 | 1.52 | 20.50 | 2.11 |
| T3 | 88.33 | 0.64 | 1.13 | 18.28 | 2.33 |

**Table 2:** Proximate composition of tilapia fish fillets stored at -18 °C for 4 months [final (120) day]

| Treatments | Moisture | Fat | Ash | Protein | Non protein nitrogen (NPN) |
|---|---|---|---|---|---|
| T0 | 78.33 | 0.71 | 1.32 | 15.33 | 2.45 |
| T1 | 76.00 | 0.76 | 1.53 | 16.21 | 2.29 |
| T2 | 82.00 | 0.79 | 1.62 | 16.47 | 2.24 |
| T3 | 83.33 | 0.67 | 1.26 | 15.23 | 2.56 |

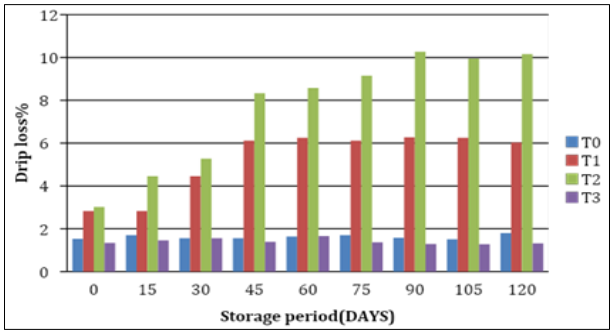
Moisture decreased slightly at the end of storage period. The reduction in moisture content is an advantage since it reduces the fish susceptibility to microbial spoilage, oxidative degradation of polyunsaturated fatty acids, and consequently it improves fish quality and preservation. Similar results were reported for frozen tilapia fish by (Sawant and Magar, 1961) [12], (Pawar and Magar, 1969) [19] and (Arannilewa *et al*. 2005) [20]. In case of fat the tilapia fish used in this work is considered lean fish (< 2% fat). Similar increases in fat content during storage have been reported in tilapia fish fillets by (Emire & Gebremariam, 2010) [21] and sea bass fillets (Özyurt *et al*., 2005) [24]. The reason for the fat increase is lipid oxidation which is a major cause of deterioration for many foods containing fats and oils. The large amount of polyunsaturated fatty acid moieties found in fish lipids makes them highly susceptible to oxidation by an autocatalytic mechanism (Smith and Hui 2004) [23].

With respect to ash it increased at end of storage period. Similar results were observed by (Inass malik *et al*., 2021) [15] in five commercial fishes frozen at -18 °C for 45 days. Loss of water in any food substances produce an uneven increase in the percentage of other nutrients, therefore, the consequential increase in ash content during freezing might be due to the decrease in moisture and protein contents of the studied fish samples. (Castrillon *et al*., 2008) [13]. There is increase in protein and NPN at the end of a storage period of 120 days.

**DRIP Loss**

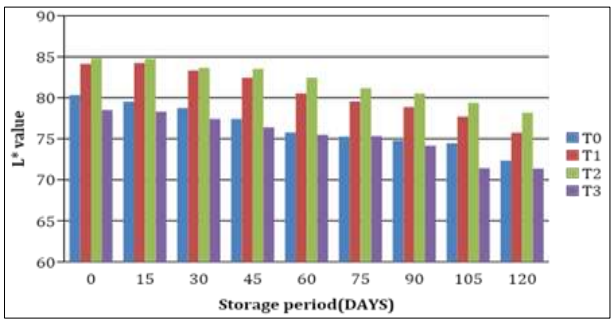
The mean value of treatments for drip loss content in all treatments was observed 2.18% on initial (0) day while at the final (120) day of storage period the drip loss content was observed to be 4.82%. Thus, it was clear from the data that drip loss varied with different treatments. Similar results were observed by Erkoyuncu *et al*., (2004) [14] in rainbow trout where usage of sodium polyphosphate and sodium metaphosphate with NaCl was not effective in preventing drip loss. Also Dyer *et al*., (1964) [25] have found that treatment with sodium tripolyphosphate (STPP) had no effect on drip loss although the net weight of the muscle increased, while MacCallum *et al*., (1964) [27] found that it was only effective in some instances.

**Colour**



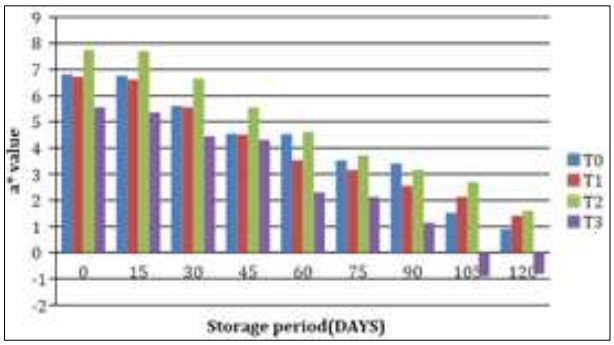

L* Value

**Fig 1:** Effect of treatments on drip loss content of tilapia fillets during frozen storage




a* Value

**Fig 2:** Effect of treatments on L* value of tilapia fillets during frozen storage




b* value

**Fig 3:** Effect of treatments on a* value of tilapia fillets during frozen storage

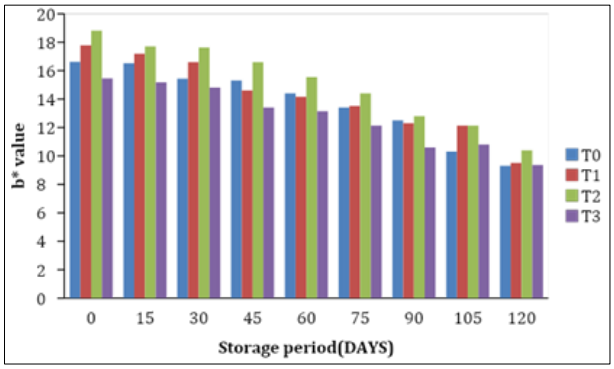



**Fig 4:** Effect of treatments on b* value of tilapia fillets during frozen storage

Colour values decreased as the storage period increased. Similar results were observed by Sajjan *et al*., (2015) [28] in deboned tilapia fish in which the highest colour values (L *= 52.10, a *=2.08 and b *= 12.30) were observed in the fresh deboned samples that were not subjected to frozen storage, while the least colour value (L *= 45.93, a *= 0.28 and b *= 10.86) was recorded for a deboned meat sample that was stored for 90 days. With the increase in the storage period the colour values were decreasing. Also the similar trend was observed by Kermit and Jerry (1991) [29] on characterization and frozen storage stability of cod mince subjected to mechanical separation of seal worms or cod worm. The difference in colour values in samples probably could be attributed to dissimilarities in properties of the light-scattering cellular matrix, as mentioned by (Little *et al*., 1979) [26].

**TVBN**

There is a significant increase of TVBN values which varied with different treatments. A level of 35mg/100 g has been considered the upper limit, above which fishery products are considered spoiled (Connell, 1990) [30]. Similar results were observed by Nazemroaya *et al*., (2011) in samples of Spanish mackerel (*Scomber commersoni*), who obtained a total increment of 15 mg TVB-N/100g after 6 months of storage at -18 ºC. While, in samples of a lean fish as the sea bass (*Dicentrarchus labrax*) the TVBN total increment, after nine months of frozen storage at -18 ºC, was 2.87 mg /100 g, obtained by (Özyurt, Polat and Tokur, 2007) [31]. The reason for the increase may be due to the degradation of nitrogen-containing compounds, such as proteins, to various amines.

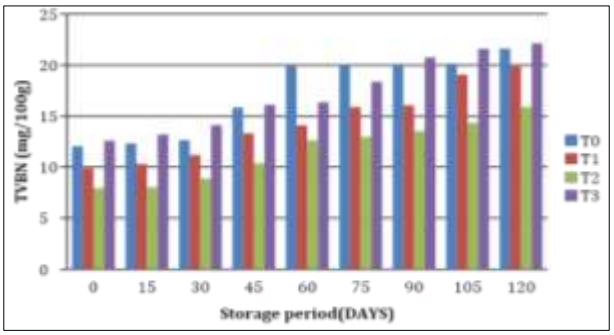



**Fig 5:** Effect of treatments on TVBN content of tilapia fillets during frozen storage

**TPC**

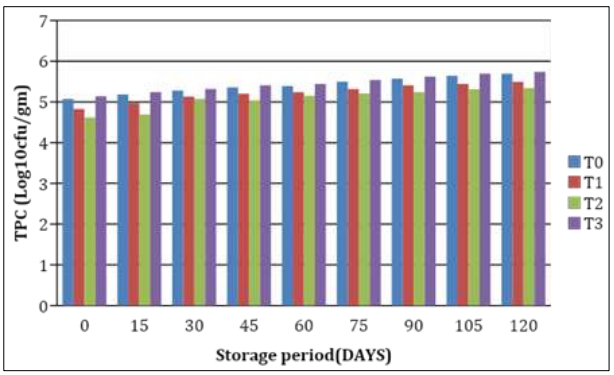



**Fig 6:** Effect of treatments on TPC content of tilapia fillets during frozen storage

The results clearly revealed that the microbial growth was more with increasing storage period. Similar increment on total bacterial load in at low temperature storage was reported by (Lawire, 1998; Obemeata *et al.*, 2011) [32, 33]. The reason for microbial growth promoting effect of moisture on microbes in meat stored in chiller to the is due to less acid enzymatic reactions of fish flesh.

**Sensory analysis**

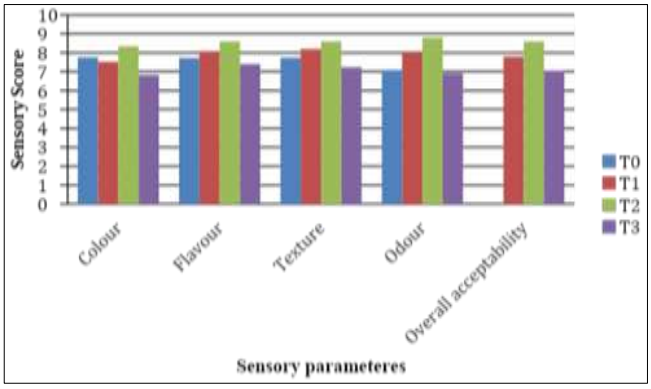



**Fig 7:** Effect of treatments on sensory quality parameters of tilapia fillets

The fillets stored at -18 °C condition for 4 months showed different performances in sensory score. The fillets of T2 obtained the highest sensory score for colour (8.35), flavour, texture as well as overall acceptability (8.60). The fillets T0 recorded the minimum score for different parameters.

**Conclusion**

Present investigation concluded that different treatments to fillets prior to freezing have an additional effect on storage performance in relation to proximate, biochemical, microbiological parameters on final (120) days of storage.. Thus, the study suggests that the tilapia fillets should be given pre-treatment of NaCl + STPP + Blanching- Temp: 75 °C, Time: 2 Min+ Glazing - 10% + IQF Freezing (Temp: -40 °C) & Frozen Storage (-18 °C) to improve their storage performance.

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